BRAIN SCIENCE PODCAST

with Ginger Campbell, MD

Episode #94

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Interview with Benjamin Bergen, Author of, *Louder than Words: The New Science of How the Mind Makes Meaning*.

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INTRODUCTION

Welcome to the *Brain Science Podcast*. I'm your host, Dr. Ginger Campbell, and this is Episode 94. Today we are going to be talking with linguist, Benjamin Bergen, about his book, *Louder Than Words: The New Science of How the Mind Makes Meaning*.

But before I tell you about that, I want to remind you to visit our website at brainsciencepodcast.com. We just launched a completely redesigned website, and I would love to hear what you think. You can send me email at docartemis@gmail.com. I'll tell you more about the new website after the interview.

Dr. Benjamin Bergen is one of a new breed of linguists who are teaming up with neuroscientists in attempt to unravel how our brains generate and understand language. His work is strongly influenced by the embodied cognition movement.

In his book, *Louder Than Words*, he discusses the experimental evidence that argues that traditional theories of meaning should be supplanted by a new hypothesis called 'embodied simulation.' If you are new to the podcast, please

don't be intimidated by these unfamiliar terms. Bergen's book is aimed at general readers, and he does a great job of making his material both accessible and fun.

On the other hand, those of you who are long-term listeners know that embodied cognition is one of my favorite topics. So, I was intrigued to see how the insights of embodied cognition are beginning to influence the work of linguists like Bergen.

I'll be back after the interview to review the key ideas, and to tell you a little bit more about the new *Brain Science Podcast* website.

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INTERVIEW

Ginger: Benjamin, it's great to have you on the *Brain Science Podcast* today.

Benjamin: It's a pleasure to be here.

Ginger: Could you start out by just telling us a little bit about yourself?

Benjamin: Sure. I'm on the faculty in the Cognitive Science department here at U.C. San Diego. I've been here for about three years. Prior to that I was actually in a linguistics department at the University of Hawaii. Even before that, I was a PhD student at U.C. Berkeley, also in a linguistics department.

So, my personal history has actually come to the mind and the brain through language. Most of what I do now is research on exactly what's going on while people are using language; while they're producing words, like I'm doing right now, or while they're processing words, like you're doing right now. I use a variety of different methodologies to get at that.

The questions that I like to ask in my research really are basic science: what are the basic brain processes that people engage in order to perform these kind of monumental cognitive achievements—that we take very much for granted, but in fact, make us unique among species, and unique in the known universe in our ability to be able to produce meaningful language and understand meaningful language?

Dr. Campbell: Do you think it's a new trend for linguists to be really thinking about what's really happening in the brain, as opposed to Chomsky's *this is what I think, but I don't care about the actual evidence* approach?[1]

Dr. Bergen: Yes. I think it's been a growing trend—in a lot of the social sciences actually—that more and more contact has been made, starting really in the '70s, but taking up more speed in the '80s; then, as fMRI started to become more prevalent, in the '90s really going whole hog.

I think you see it in sociology, you see it in management science, in economics; all of these fields, there's a neuro version of each of them. Right? And I think that language has also been picking up steam in that direction.

I think your intuition is exactly right; even before the Chomskyan revolution in the '50—even stretching back for centuries that people have been looking at language—we've known that, of course, the brain has something to do with it. Obviously, things that don't have brains don't have language—your printer doesn't have language, and a rock doesn't have language.

And it seems to be a special type of brain that allows you to have language; it's not the brain of a lizard, it's the brain of a human. And so, obviously the brain matters, but it's been relatively recent that we've actually been able to delve into the details to see exactly in what way the brain matters.

[1] This was discussed in BSP 31, which was about the evolution of language.

Dr. Campbell: So, you mentioned in your acknowledgments that writing *Louder than Words* was the most painful thing you had ever done?

Dr. Bergen: That's right.

Dr. Campbell: Which leads me to my next question: why did you write it?

Dr. Bergen: Well, probably in equal portions of stubbornness and naiveté. You know, one doesn't really know, going in, exactly how much work one has ahead of one's self. When one is half of the way through—or at least, appears to be half of the way through—one thinks, *Well, it's just another couple years of that*.

Writing a book is… I don't of anyone for whom it's been an easy process—especially not the first one. What was particularly hard about it is this is a book for a general audience. It's a book that I wrote that my mom could read—and she's not a scientist. And I wrote that book because I thought there was really valuable research coming out of cognitive science that really revealed things about how language works, that regular people might care about.

That was the objective; but it's really hard to do when you're not trained to do that. Scientists aren't trained to write things that are accessible; to constantly be addressing why this is important, justifying how it connects to people's everyday lives. We're used to writing journal articles, and those are in this specialized code. We memorize the ways that you write up a method section, and this is how you report this statistic, and this is how a result section goes.

That's what we do. And we get very good at that over the course of years and decades of being scientists. But there's no training in writing compellingly—not just writing for people who already care about what the answer is, but writing in such a way that you convince people that they should care what the answer is; so that they should care about these basic questions about the brain, and the mind, and language. That's a very hard thing to do.

Dr. Campbell: I guess that's why my friend, Sandra Blakeslee,[2] has made quite a living helping people write books. I think she's been the co-author of two or three of the most popular neuroscience books for lay audiences, that people usually just associate with a name. Like V.S. Ramachandran; his book was co-written by her. I think she was the one that did all that translating stuff.

Well, I have a confession. I usually wait until I finish reading a book before I invite an author onto the *Brain Science Podcast*. But I have to admit, I broke that rule for your book.

Dr. Bergen: Did you? Shame!

Dr. Campbell: It was partly because of the wonderful forward by George Lakoff, who promised that yours was the first book to really look at the experimental evidence about how embodied cognition affects behavior. Long-term listeners know that embodied cognition is one of my favorite topics. You mention Art Glenberg's work often; I had him on way back in 2008[3].

But the other thing that really impressed me was your engaging writing style—which it sounds like it was a lot of hard work to develop. Your book is fun to read. I mean, after all, on the first page you start out with an image that's both humorous and irresistible; that image of the polar bear hiding its nose.

Dr. Bergen: Thank you very much. I'm blushing; you can't see it right now, but I'm actually blushing. I should say that what you're reading is certainly very far from the first draft of those chapters. Writing is a process of many, many, many layers of editing.

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[2] Sandra Blakeslee's book *The Body Has a Mind of Its Own: How Body Maps in Your Brain Help You Do (Almost) Everything Better* was discussed in BSP 21 and she was interviewed in BSP 23.
[3] Art Glenberg was featured on BSP 36.

Part of the reason I think I was able to write a convincing story is that there are so many people who have done the foundational research that I'm talking about. It's not just about my research in this book. People like Art Glenberg—who's a good friend and, in some ways, a mentor to me—and people like George Lakoff—who, of course, was my graduate adviser—these are people who really set the stage and created the contours of the narrative.

What I feel I've done is just bring together the research in a way that I could kind of do two things: Tell the story of what the current state of the art is. What do people think they know? The scientists who are really in the trenches, who are conducting experiments, what do they think they know about the mind and language?

And simultaneously convey—and I guess this is what you're getting at when you talk about all the experimental research that's in there—really convey what it is to do this science; what the things are that people who are the scientists asking these questions have to keep in mind.

How do you ask a research question? How do you design an experiment that can answer that question? How do you interpret the results? How many different ways are there of interpreting the results, and how do those different interpretations lead you to have to conduct further experiments down the line?

I was trying to sort of convey, not just a clean, nice, pat story, but science as it actually is—which is evolving, and complex, and slightly messy and confusing.

Dr. Campbell: You really did a great job of that, in the sense of every time you did an experiment, talking about what you thought it meant—or implied what you thought it meant—alternative interpretations, and also objections. But you did that in a way that wasn't confusing; and that has to have been a huge, huge challenge.

Dr. Bergen: Yes, it was. You don't want to bury people in the snow. Right? You don't want to overwhelm people with, *Well, if nothing ever means anything, if there are always 10 different ways to interpret things, well why do we care about the results in the first place?*

But at the same time, there are some objections that are more important than others. That's kind of a hard thing to carve out; but I think worthwhile, because that really is how science advances.

Dr. Campbell: The main goal of your book, then, is to explore what we know about how we figure out what language means?

Dr. Bergen: Yes; that's right.

Dr. Campbell: So, I guess a good place for us to start on that is to talk about why it matters, and what the theories are about it.

Dr. Bergen: So, we should talk about the different possible views. There's a long history of people trying to figure out exactly how people make sense of language: what people are doing; what's happening in the brain—in your brain right now—as sound waves hit your ears and you try to convert them into some idea of what it is that I intend. It's a really complicated process.

The science has sort of best coalesced on the front end of that process; so, the part that's just really low-level physics, where you have vibrations that are causing pressure fluctuations in the air, and that mechanically transfers into movement of the tympani in the ear, and that makes bones move, and that gets conducted into electrical signals. The hearing part is understood pretty well.

And a little bit of the low-level auditory stuff that happens in auditory centers in the brain is relatively well-understood; in large part because that's stuff that we don't do uniquely as humans, that's stuff that we share with lots of other

primates. A lot of the machinery is quite similar. And we understand pretty well how you hear, at least at the low level of hearing.

But then what, right? What happens once you've, let's say even recognized a word? How do you know what it means? Does the story get more complicated if the meaning of the word depends on the context? The exact same word, 'bank,' could mean one thing if you say, 'I need some money, I'm going to the bank,' or 'I need to go relax by the river, I'm going to the bank.' Exactly what is your brain doing in order to interpret this thing that it thinks it has recognized—*bank*? And how does it do it in context?

The fact that we haven't had good science on this for most of history doesn't mean that we haven't had lots of philosophy on it. People have built up theories saying all kinds of things. One such theory (sort of the most intuitive lay notion, I think) is that meanings are kind of like dictionary entries inside the brain; somehow you have a representation of—a description of—what that word would mean.

So, there's a description of 'bank' that says in your brain, somehow, 'a financial institution where money is held'—or something like that. And there's another one for 'bank' that says, 'Oh, it's a…'—I don't actually know what a river bank is—'it's a part of earth next to a river.' So, that's a kind of definitional theory of meaning.

There are some problems with that definitional theory of meaning. It's kind of an old theory, and one that hasn't actually panned out so well. And part of the reason for it is that it raises this really important question which is *what language are the definitions written in*? Let's say you're an English speaker, and you have definitions in your brain, and they're written—I don't know—in English, then you haven't actually solved any problem. Right?

In order to understand 'bank,' you look up the meaning of 'bank' in your brain dictionary, and it says 'a financial institution.' What does 'financial' mean, and what does 'institution' mean, and what does 'a' mean? And so you would, I guess, have to look those up. So, what does 'institution' mean; well, an institution is a human construct for—I don't even know; I'm making it up—but it's basically just turtles all the way down.

Another theory would say, *Well no, it's in a different language; there's a special language of thought*. So, the way that you understand the word 'bank' is you translate 'bank' into your mental language; which isn't English, it's not Chinese, it's not Japanese, it's Mentalese.

This is an idea that's been associated with some of Steve Pinker's work, among many others. That's kind of an attractive way out of this problem of definitional meaning. It says it's a bilingual dictionary; your brain translates from words in the language that you're speaking or listening to, into your innate mental language.

There are some problems with this Mentalese idea too, though. This is sometimes also called the language of thought hypothesis. One of the problems is that it's not clear where this mental language would come from exactly. It certainly couldn't be learned through your native language, because then you end up in a sort of cyclical definition. You learn this mental language—you learn the Mentalese word for 'bank' by being exposed to the word 'bank' in English—but then you use the Mentalese word for 'bank' to understand the English word, 'bank.'

Otherwise, what would it have to be? It would have to be that Mentalese is innate. And some people have actually proposed this; that you've got this mental repository of concepts. People like Jerry Fodor, for example, who say that anything that you can ever think is innate, and it preexists anything that you learn about the world—anything you learn through language.

You could imagine, well maybe there are some basic concepts that you have that are innate, that we are predisposed to have. Like babies like to attend to faces; so maybe you could believe that 'face' is a type of thing that would be innate. But it certainly gets more complicated with Spiderman, and fiberglass powerboats, and stuff like that. It's not clear exactly how those things would be innate.

So, there are some problems with this language of thought hypothesis. Basically the problem is something called the grounding problem. It's the idea that if you've got mental stuff—stuff happening in your brain—somehow it's got to relate to your experiences in the world; it's got to be grounded in what you know about the things that you've perceived, and the actions you've performed, and how you've felt about all that.

And so, the grounding problem has been haunting people, really for centuries. That's kind of the stage that's set, when there's a turn in the road in the late 1980s, where, as you mentioned earlier, people start thinking about embodiment as a possible solution to this grounding problem.

This idea of embodiment is the idea that your mental stuff isn't actually in some other language; it's not distinct from what you feel, and perceive, and the things that you know how to do, but it actually is that. That is the stuff of thought. The stuff of thought is plans for action, and memories of things that you've seen, or heard, or smelled, or felt; and that's the stuff inside your head that language relates to.

Dr. Campbell: And so, that brings us to the embodied simulation hypothesis?

Dr. Bergen: That's right. It's sort of a way to turn that vague notion that maybe the body matters to the mind—it takes it and creates a theory out of it. It's the idea that the body doesn't just relate to language, and meaning, and the mind in some vague way, it's in a very specific way.

And it goes a little something like this: maybe when you're understanding language, what you're doing is you're using the parts of your brain that are responsible for perception, for action, for feeling; and you're using them to re-create the experiences that I'm trying to get you to have—the things that I'm describing through language.

So, I'm in my office right now, and my dog is sleeping very quietly on the floor (which is somewhat surprising, given that she's only a year old). So, if I tell you something like that, then what's going on in your brain?

Well, the embodied simulation hypothesis would say you are activating, among other things, parts of your vision system to create an experience of what you think it would look like for maybe me to be in my office, maybe for the dog to be in my office, maybe for the dog to be lying down, and what it would look like if my dog were a puppy. You might be using your auditory system to re-create an experience of what it would be like to hear a sleeping puppy, if you have had such experiences; maybe a little bit of puppy snoring, or something like that.

If I, however, use language describing something a little bit more active—maybe if I said 'I had to slam the door to my office in order to get it closed, because it's a little bit jammed'—then you might use your motor system. Those parts of your brain that are responsible for actually performing actions with the skeletal muscles might come online, and might become engaged, in order for you to re-create this experience, what it would be like to pull closed an office door through the resistance imposed by a tight jam.

So, that's the idea: that language understanding involves simulating; not actually directly perceiving, but re-creating a virtual experience of perceiving, or acting, or feeling.

Dr. Campbell: And this is something that we do automatically and unconsciously, according to the theory.

Dr. Bergen: That's right. You can sometimes bring it to conscious light. So, when I suggested what you might have been experiencing when you were listening to those sentences, you, Ginger, obviously knew where I was going with that, so you were probably paying close attention to the visual experiences you were having and the motor experiences you were having. That's actually something that we know; that people can actively bring the use of their vision system—their motor system, their olfactory system, and so on—they can bring that to conscious awareness, sometimes.

Often that's called mental imagery. When I say, 'Imagine a pink elephant,' or, 'Don't imagine a pink elephant,' you sort of actively and consciously experience this visual thing that's pink and elephant-shaped. And it's sort of weird, because there isn't anything pink and elephant-shaped in front of you and you're consciously aware of it. That's possible; but the use of the motor, and perceptual, and affective systems that we're talking about with this mental simulation hypothesis is not necessarily conscious; it's not necessarily available to reflection.

Dr. Campbell: And you made the point in your book that we bring our individual mental resources to this. I loved the discussion of the flying pigs—which, of course, you have a flying pig on your cover, too. And you had two possible images that would be common things people would draw when given the words, 'flying pig.' And I realized that, since I live in the South, where barbeque is very popular, my flying pig was the barbeque version—I mean the one that's usually on barbeque signs; not the super pig.

Dr. Bergen: Not super pig, with the wings on the sides?

Dr. Campbell: No. But the focus of your book—despite the wonderful imagery of polar bears and flying pigs—is to talk about the fact that we can actually study this stuff scientifically and do replicable experiments.

So, I guess you start from what we know about things like imagery and memory; because these, we know, use the parts of the brain that we would… My audience mostly already knows the fact that memory involves activating the same parts of the brain that you had during the original experience. But would you talk a little bit about the Perky effect?

Dr. Bergen: Yes. So, this is a great case of just solid American cognitive psychology from the early 20th century.

C.W. Perky was a graduate student, actually; one of the first female graduate students, I think, in cognitive psychology. And she was fooling around with early film projection technology—remember, in 1910, I guess they maybe had begun to have black and white films; but certainly silent features. So, she was just sort of fooling around with what you could do with this technology—and this is, I think a case where technological advances actually drive science forward.

And what she found was that she could present images onto a blank wall at varying degrees of illumination. And at some levels people could see them; and if she made them a little bit less illuminated, they couldn't quite discriminate what was up there.

And so, she was really interested in mental imagery; what is it that people do when they're trying to hold in mind an image of something. She suspected that what people were doing with imagery is just like what you just described with memory—that people who are conjuring up mental images are actually using the vision system to do that.

So, the way that she tested that was really clever. First she established thresholds for people. She had people come in and look at this blank wall; and she projected something onto it—maybe it was a leaf, maybe it was a banana—and she asked them what they saw. And she found some level of illumination that, when people weren't doing anything else at the same time—when they were just staring at the

wall—they could just barely make it out; they could just say, 'Oh yeah, it looks like a banana.'

So, she then brought in another group of people, had them look at the wall, with those images projected with the exact same degree of illumination. But these people she had simultaneously conjure up a mental image. For example, she'd say 'Okay, now imagine a banana. It's right there on the wall; imagine a banana.' And she'd project this very faint image of a banana, and would ask them, 'Do you see anything actually on the wall?'

Somewhat amazingly, she found that they couldn't see the actual banana on the wall while they were performing visual imagery. This was the first of a long line of studies showing that imagery—that conjuring up images in your mind's eye—actually interferes with your real eye. You can't actually see things as well, you can't discriminate them as well, if you're performing visual imagery at the same time.

And this is taken as evidence that the two tasks, the two behaviors, use the same underlying system; that's why they can interfere with each other. Like I said, that's led to a whole range of work showing that people, to the extent that they can see and perform imagery at the same time, they'll integrate the two together—which suggests that they're sort of part of the same system, again.

Location seems to make a difference. So, if you're imagining something to your right, and you see something to your left, you perceive it just fine; but you can't imagine something to your right, and also see something to your right at the same time.

There's sort of a large body of work showing that, in a lot of different ways, imagery is really dependent upon the perceptual system— just like memory is.

Dr. Campbell: And, as you point out in the book, this brings up the idea that maybe this demonstrates a fundamental organizing principle of the brain. What would be some of the key things that, by looking at memory and looking at imagery, we might expect—well, first of all learn—and then could look for them?

Dr. Bergen: With language, you mean?

Dr. Campbell: Yes.

Dr. Bergen: So, it appears that evolution is an inveterate tinkerer. We've got a good, solid mammalian system for perceiving—for doing all this visual processing—that's taken hundreds of millions of years to evolve. And it's really good at doing all the things that mammals can perceive. It can identify regions of particular color; it can detect edges around those regions; it can detect objects; it can detect maybe faces.

Now, suppose that you want to build onto that—because it adds to your likelihood of reproductive success—let's say you want to build onto that a new system that is able to, not just perceive, but do something different; it's able to remember things that you've perceived. Well, the way that evolution solved that, it appears, is the exact same way that it solved imagery; which is to just use the existing system, tweak it a little bit, add in a couple more functions into an existing system.

It was sort of repurposed, or modified, or exacted, you could say, so that it has multiple functions at the same time. And if language works that same way, if the human adaptation for language is, in fact (at least, for the meaning part of language) like the human adaptation for imagery and for memory, then it ought to rely on systems for perception, and systems for action, as well.

Dr. Campbell: Yes, one of the things that stood out for me, especially in terms of memory, is that memory is not necessarily intentional. And, as you said, it

isn't necessarily accessible for conscious introspection. So, that means we wouldn't necessarily be aware that we did this.

Dr. Bergen: That's right—the same way that we're very unconscious of most anything that happens in our brain.

I try this with my undergrads when we talk about language—because people seem to think that they know everything about how language works, because everyone's an expert at language. And I ask them, 'Okay, well, if you're such an expert on what's happening inside of your head, how does vision work?' And some of them will say things (because they've taken introductory neuroscience classes) like, 'Well, you know, there are these retinal cells, and they have these projections to the lateral geniculate nucleus, and there are these center surround cells,' and all this kind of stuff.

And I say, 'Yes, that's exactly right. And how much of that would you have known if you hadn't taken introductory neuroscience? How much of that could you just guess through introspection? How much of that do you actually have conscious feeling experiences of? Do you actually know about the center surround cells, or the edge detecting cells? Are these things that you have conscious access to?'

You know, of course not. And the same is true when you're using the perception system or the motor control system for any other purpose, like memory, or imagery, or language.

Dr. Campbell: Okay; well, we're going to take just a quick break, and be right back.

[music]

Dr. Campbell: Benjamin, I'm sort of confused about the difference between priming and the Perky effect. And in particular, when you get down to the motor

things, why sometimes you see the Perky effect and sometimes you see what Art Glenberg showed—the compatibility effect. What determines whether it's going to be a compatibility effect or a priming effect vs. an interference-type Perky effect?

Dr. Bergen: Yes, that's a great question. And that's a question that's at the core of the story that we want to tell about simulation. So, I think it's a great question, and one I'm happy to talk about.

Suppose it's the case that you use the same brain system, or overlapping brain systems, to perform two completely distinct tasks—say, to move your hand through space and also to understand a word that describes moving your hand through space in the same way; the word, 'punch,' let's say. How exactly would that show up in, let's say behavioral experiments—experiments where you have people perform these two tasks?

Well, it depends on at least two things. The first is the timing—in an interesting way. So, if I first have you move your hand through space—pretend to punch—and then I give you the word, 'punch'—at a reasonable delay, let's say two seconds later—then you're using the same brain system for both of those things, but there's no interference between the two tasks.

You're performing one task, you use that brain system; and then, soon thereafter, you're performing another behavior, but using the same brain system in a very similar way. So, it ought to be the case that it's easier for you to do it the second time; because you've already warmed up that system, is one metaphor; you've lowered the threshold in order to excite it; you've got latent activation there; or something like that.

If, on the other hand, you are asked to do the two things at the same time, and there's any degree of incompatibility between them (so, if you're asked, for example, to perceive an 'x' on a screen while simultaneously maintaining a

mental image of an 'o;' and experiments have been done that are exactly this), then those two tasks which use the same brain system—in fact, since they're in the same place in space, both real space and imagined space, they'll use the same parts of those retinotopic maps in the vision system—having to do those two things at the same time ought to be harder. It ought to decrease your ease, speed, accuracy, and so on.

So, the two components that go into predicting whether you're going to get interference or whether you're going to get facilitation are: First of all the timing; if you're doing them at the same time, you're more likely to get interference. And then, the second is something that's been called 'integratability' of the two tasks. So, if they're really exactly the same, then you're more likely to get priming. If they're hard to integrate together—that is, perceiving an 'x' and imagining an 'o'—then they're more likely to interfere with each other, if they're using the same brain system.

Basically if you're using the same brain system to try to do two different things at the same time, they're going to interfere. If you're using the same brain systems to do two very similar things with some time delay, you're probably going to get facilitation. If you're using the same brain system to do the very same thing for two different tasks at the same time, you're also going to get facilitation.

Dr. Campbell: Say that last one again.

Dr. Bergen: So, if you are using the same brain system to do the exact same thing—if you've basically got two systems that are calling on your motor system; language is saying, *Okay, the word 'punch,' now think about what that means*, and also, you're trying to control an action where you're actually punching in real time—and the timing is exactly right, then you can get a facilitation effect. It's kind of like getting driving directions at exactly the right time—that's one way to think about it.

Dr. Campbell: Okay, so would the experiments like the ones that Art Glenberg did fall into that third category?

Dr. Bergen: They're actually the first category. These are the action sentence compatibility effect experiments. I think these are the ones you mean; he's got newer stuff that falls into a different category.

But in those experiments, you have people just listen to or read sentences that describe people performing actions; like, 'you are opening the drawer,' or, 'you are closing the drawer.' To perform them would require moving your hand. Opening the drawer would be moving your hand toward you, and closing the drawer would be moving your hand away from you, let's say, by default.

And what people have to do, after they've read or listened to the sentence, is just make a decision about whether it makes sense or not. And half the time it'll be a sentence that makes sense, like those, and half the time it'll be a sentence like, 'The fox jumped, the monkey tripped.' That doesn't make any sense. And then you have to decide that it doesn't make any sense.

The trick in these experiments—which are very clever—is to have people make their judgment (say it makes sense or not) by pressing an assigned button that's either away from their body or toward their body. So, they have to actually perform that same or a different movement; they have to move their hand away from their body or they have to move their hand toward their body. But they're doing it after the end of the sentence. They first read the sentence, decide whether it makes sense or not, and then they're going to move their hand.

So, they're very similar. It's understanding language about moving your hand in a particular way, and also then performing an action by moving your hand in a very similar way.

Dr. Campbell: Now I see that that's the first category.

Benjamin, before we talk about grammar—because that's a real tricky one—is there anything else on this vision/body motion stuff that you want to talk about? I know I haven't really done many of the experiments; but we would have a four-hour interview if we did that.

Dr. Bergen: Yes! No, I think that's great. I think there's a lot of fun stuff sort of toward the end of the book—grammar. I don't know if that's categorized as fun. It's fun for a linguist. That stuff, and the individual differences stuff, I think is fun too, to talk about.

Dr. Campbell: Well, I wanted to talk about the grammar, because I was a little actually surprised to learn from reading this that grammar really does contribute to meaning. Because, obviously it does; but I kind of was an anti-grammar kind of person. And you had great examples. Perhaps you could just tell us a little bit about what we do and do not know about how grammar fits into the embodied simulation hypothesis.

Dr. Bergen: So, language is more than just one word at a time. Right? I gave this in the 'bank' example; the meanings of the words that we process are modulated by the context that they're in. And that includes the physical context—if we're standing next to a financial institution and I say 'bank,' you're likely to think of that type of bank—but also of course, by the linguistic context—the sentences that frame them.

And, for a very long time, it was thought that really all that grammar did was just sort of provide a structure for meaning to hang off of: You could think of it as kind of like the skeleton; but the real meat—the real meaning part—comes from the words. Words have meaning and grammar doesn't.

People have thought, now and then, over the course of history, that maybe that's not exactly the right story. And it comes up for the following reason: when you look at language that differs only in its grammar—has all the same words, but

with sort of different grammatical configurations—it turns out that the meaning can be different, in ways that are either subtle or very profound.

So, think about the following two sentences, for example: I can say, 'I threw my water bottle to my brother;' or, I can say, 'I threw my brother my water bottle.' Now, those two have all the same key components; there's 'my water bottle,' there's 'my brother,' there's 'threw,' there's 'I.' The key difference is the order of 'my brother' and 'the water bottle.' Most people would think—and this is the transformational grammar; sort of old Chomskyan theory—many people have thought that these really have the same meaning; that the grammar doesn't make a difference, it's really the words that are important.

But it turns out that you can see that even these very similar grammatical structures have subtle differences. So, I can say, 'I threw my brother my water bottle,' but I can't say, 'I threw the floor my keys.' But I can say, 'I threw my keys to the floor.' So, why can't I say, 'I threw the floor my keys'? It's really funny, right? Because you can think about ways in which that might be true.

What would have to be true in order for me to be able to say that I threw the floor my keys? Like maybe the floor is animate; it's like a Pee-wee Herman kind of animate floor that has hands, and a face, and can actually catch the keys—or something like that.

What seems to be going on is that this particular grammatical structure—it's called the double object construction—that I'm trying to use to say, 'I threw the floor my keys,' actually has a meaning component to it. It says, 'I'm about transferring objects.' And you can only transfer objects to recipients who can possibly possess them. And that's why you can't throw the floor your keys, even though you can throw your keys to the floor.

So, there are these very subtle differences in meaning. And it turns out that when you start to dig in (as many linguists have; and I'm not going to bore you with all

the details), it's almost impossible to find two sentences that have different grammatical structures and mean exactly the same thing.

You can think about things like active vs. passive sentences. Well, superficially, 'I punched John,' and, 'John was punched by me,' describe the same event. But that doesn't mean that your experience of the meaning of that event is actually the same.

You might be more likely to emphasize with 'I' in the case where I use the active sentence; you might be more likely to empathize with 'John' in the passive sentence, where 'John was punched by me. And there are going to be lots of other subtle semantic differences between those two sentences.

Dr. Campbell: So, how does this affect what you do when you're trying to study this in the laboratory?

Dr. Bergen: Yes, right. Well, you get to do basically one of two things: One, you have to be very careful with your stimuli. Whether you're sliding someone into an fMRI, or you're measuring response times (eye movements, hand movements), whatever you're doing, you've got to be very careful that you're not mixing and matching different types of sentences with different sorts of grammar.

That's one thing. The second thing that you do is you actually use that to your benefit; you actually ask questions about what grammar does for simulation. Does it matter, for example, what person you use? If it's 'you threw the tennis ball' vs. 'John threw the tennis ball,' does that subtle difference change the experiences that comprehenders have?

And that leads you to ask a different range of questions. It's not the basic question about do you use your perceptual system or do you use your motor system; it leads you to kind of second-order questions: like, what in the language

drives you to do what sort of perceptual work, or what sort of motor work, to adopt what sort of perspective, depending on the type of language that people are exposed to? So, you ask, like I said, a second-order question—a little bit more nuanced question.

Dr. Campbell: So, do you use grammar to figure out the question of when we start doing this embodied simulation?

Dr. Bergen: You mean over the course of processing a sentence?

Dr. Campbell: Yes, like at the beginning of a sentence vs. the middle.

Dr. Bergen: That's exactly right; you can manipulate stuff. You can even use the fact that you've got different word orders in different languages to play around with that.

This is one study that we did. We wanted to know when people start simulating. How early do you start? Do you start with the first word? When I say 'I,' do you start simulating me; and then I say 'went,' do you start simulating motion? Or do you wait until you're reasonably confident that you have an idea what's going on?

So, if the third word in that sentence, 'I went,' is 'crazy,' then the going—the motion—that you might have simulated early on would have been incorrect, and you would have to go back and revise your simulation. So, do you wait until the end, or do you simulate early and often? And so, you can play around with word order to sort of tease apart—as you said—exactly when people are simulating.

For example, take a language that sticks the verb at the very end, like Japanese does. In Japanese you wouldn't say 'I gave my brother' (where' gave' is the verb; in English, it's in the second position) 'I gave my brother…' I can't remember what the example was.

Dr. Campbell: Water bottle.

Dr. Bergen: Water bottle, okay. In Japanese it would be, 'I to my brother the water bottle gave.'

And we can actually detect that people are already predicting—as we have them process the sentence from beginning to end; 'I,' 'my brother,' 'the water bottle'—we can tell that they're already predicting what the verb is going to be. They're already showing signs that they're simulating the interactions between those objects, assuming that they already know what the verb is going to be.

So, we can tell, using grammar, that people are making predictions as soon as they have a pretty good idea of what's going to happen next.

Dr. Campbell: That really isn't the focus of this embodied work, but it certainly dovetails with all the research that shows that language has a big predictive component. I mean that's why we don't even hear when people say misspoken words, usually—usually we don't hear them, we hear what we expect.

Dr. Bergen: Well, that's right. It's like the old riddle: if there's a barn that has an east side and a west side, and a rooster lays an egg on the top of the barn, which way does it roll? And most people forget to remember that roosters don' t lay eggs.

So, that's exactly right; people are predicting. They're spending all their time trying to figure out what's going to come next, what's going to be important; they're not just doing passive appreciation and processing of input as it comes in. They are predictive machines—absolutely.

Dr. Campbell: And you have a lot of interesting stuff about cognitive style in the book that we're not going to have time to talk about. But perhaps we should

talk just briefly about the role of culture—and I'm including different languages in that as part of culture.

Dr. Bergen: That's right.

Your individual experiences that you have are going to color the nature of your embodied simulations. And as a consequence, when you're exposed to different experiences—systematically, by dint of the fact that you're in a particular culture (that's, in fact, in large part what culture is; it's the range of practices and experiences, that are idiosyncratic, that you're exposed to)—to the extent that you have different experiences depending on your culture, then the things that you re-create in your mind's eye are, in fact, going to be specialized to that culture.

So, I think about examples, like what it is to pray or to eat might be radically different depending on your culture; and as a result, those simple words might evoke very different sorts of experiences. And you might make different assumptions, you might draw different conclusions, you might expect different things to come next, based on those idiosyncratic experiences.

Of course, there are also differences in the languages, themselves. Languages ask you to focus on particular things. One language might ask you to slice up the color space in a particular way. In English, for example, we have a distinction between pink and red, but not really a hard distinction between light blues and dark blues. But that might be different in other languages—like in Russian, where there is a difference between light blue and dark blue—and that might lead people to process the meanings of those words differently.

There can be huge differences across cultures that shape the nature of our experiences, and therefore, the nature of our simulation

Dr. Campbell: Yes, it really got me thinking about the fact that this podcast has a large audience of people for whom English is not their first language. And I'm sure that I occasionally use idiom, without even realizing it.

Dr. Bergen: Oh, I'm sure you do; and I'm sure I do. There's all kinds of non-compositional, non-literal language that we use all the time—there's a whole story to tell about that, too.

But you're right; language is full of culture-specific and language-specific learning. And it's not simply the case that you find a good word-for-word dictionary and then you'll be able to process some other language.

Dr. Campbell: And then, when expertise comes in, basically our simulations are going to be different. If we are an expert in something, I guess we would be having a much more detailed simulation, when somebody says something about something in our field, than one who is not in that field.

Dr. Bergen: That's exactly right.

You can imagine a conversation between an expert mechanic and someone who goes in to try to assist the mechanic. The mechanic asks for a particular type of wrench, and the assistant has no idea of what to look for, and starts looking around for wrenches: *Is this it? Is this it?* Because they don't have any mental representation of what exactly that word is supposed to refer to.

Expertise also changes the depth of processing. There are some cool studies—brain imaging studies—looking at how people understand language about actions in domains that they're expert in vs. not. So, you take expert hockey players and you have them listen to language about hockey actions—in an fMRI—vs. people who don't play hockey at all, and you find very interesting differences in how they use their motor system.

The hockey players, as you'd expect, use parts of the premotor cortex—which sort of coordinates high-level learned routines—much more so than the novices do (the people who've never played hockey). Just having expertise in a particular domain shapes the way that you understand language about those things that you know about or don't.

Dr. Campbell: So, the embodied simulation theory sounds really good; but what about if we're talking about something abstract?

Dr. Bergen: Well, that's exactly right. That's sort of the limiting case.

And there's been a lot of work on it. This is actually work that starts with an idea of George Lakoff's—that people aren't just talking about abstract things in terms of concrete things. When we're in a relationship, say, we talk about 'being at a crossroads,' or 'at a fork in a road,' or having to 'go our separate ways.'

He's argued for a long time that you don't just talk that way, you think that way, too; and that the way that people think about abstract things, like love relationships (which are actually quite hard to get your head around) is in terms of more concrete things, like journeys, that you can wrap your head around—that you do know about perceptually, and motorically, and so on.

And there's been some research showing that, to some extent, this is exactly right; that the way that people understand language about abstract things—like love relationships, or time—uses our notions of and our brain systems for perceiving in space, and moving through space, and so on.

Dr. Campbell: But we, right now, don't really have a good way to figure out if there's a difference between a metaphorical simulation and a concrete simulation.

Dr. Bergen: They seem to be subtly different; they sort of have different profiles of exactly what they look like in experiments.

But you're exactly right; we have a lot to learn. Sometimes it seems like people are simulating metaphorically, and sometimes it seems like there's no signature of it at all when people are given metaphorical language. That's definitely one of the frontiers of this area of research.

[music]

The main source of financial support for the *Brain Science Podcast* is donations from listeners like you. But we are also fortunate to have a long-term sponsor, Audible.com. Audible.com is the world's leading provider of downloadable audiobooks; and Audible has been sponsoring the *Brain Science Podcast* since the fall of 2007. During that time, their library has grown to over 100,000 titles in all kinds of genres.

Unfortunately, Benjamin's book, *Louder Than Words* is not yet available. So, my suggestion for this month comes from a listener who suggested a book, *Search Inside Yourself: The Unexpected Path to Achieving Success, Happiness, and World Peace*, by Google's Chade-Meng Tan. This is a great book for anyone who is interested in a different take on meditation. It also comes with a PDF that includes a lot of great cartoons.

You can get this audiobook, or any other book of your choice, free if you aren't already a member of Audible. Just go to audiblepodcast.com/brainscience.

[music]

Dr. Campbell: So, Benjamin, does embodied simulation serve a purpose?

Dr. Bergen: Well, that's the big question. A lot of science starts by ascertaining whether something actually happened, and then moves on to questions about its function—its functionality.

There are a number of people who are asking this very question—who are asking what is it used for. Is it used to access just the low-level meanings of words? Is it used to disambiguate between the meanings of words? Is it used to make inferences? Is it used to prepare for appropriate actions?

And there are a lot of experiments going on. There are some experiments going on here in my lab. You mentioned Art Glenberg; he's doing experiments. There are experiments all over the world—in Europe—trying to tease apart exactly what the simulation is good for.

The main way that you figure it out is by knocking out simulation—in a variety of ways—and then seeing what effects that has on language; how people's ability to recognize words, or make inferences, or respond appropriately is impacted when they're unable to simulate what something would look like or feel like.

Dr. Campbell: Well, I think I've read that if you have damage to visual cortex, that has an effect on your ability at least to imagine visual things.

Dr. Bergen: That's right. So, there are these interesting dissociations with brain lesions where, let's say even within nouns, people will get anomia. They'll have inability to process or produce words differently, depending on where they have brain damage.

People who have prefrontal lesions will have more trouble with nouns describing things that they know about interacting with using their body; so, they'll be more likely to lose like 'hammer' and 'spoon.' And people with posterior lesions will be more likely to lose nouns describing the things that they know most about through sight; so, like 'giraffe' and 'butterfly.'

But these things are tendencies. And it's really tough with lesion studies, because there's always something else going on, and there's always recovery post trauma. So, people are trying to use other ways to induce temporary lesions through transcranial magnetic stimulation, or using behavioral tools to sort of temporarily knock out people's ability to process using these brain regions.

Dr. Campbell: So that in a behavioral study you'd sort of be doing like an intentional Perky effect.

Dr. Bergen: Basically. Well, people habituate to a particular thing. So, you have them look at lines moving in one direction for a long time, or look at a particular color for a long time, and that knocks out people's ability to use that dedicated brain system for some subsequent task. It's like habituation, actually.

Dr. Campbell: Okay.

So, the embodied approach really suggests that human cognitive abilities are built on parts of the brain we share with other mammals—and I guess, especially primates. And it implies that language uses parts of the brain that were previously used for other things.

Dr. Bergen: That's right.

Dr. Campbell: That's an idea that not everybody is comfortable with, I guess.

Dr. Bergen: I guess that's true. But it's the simplest explanation of what we see, so far, with the evidence.

Clearly there are differences. Other primates don't do such a good job with human language. And part of the puzzle is why not; what are they missing? Part of it appears to be the ability to robustly and dynamically conjure up these

simulations of non-present things in dynamic ways, putting together parts that you never thought of before.

I can talk to you about a purple Lamborghini with blue spots. It's hard to envision, but you can do it; and you do it real quickly, just on the basis of a couple words. And that sort of dynamic construction of simulation doesn't seem to be something that other primates have the ability to do.

And so, exactly how we're able to use these brain systems for perception and action in a novel way is part of what's mysterious, but really tantalizing, about this idea that we are using systems, that we share with other primates, in a new way.

Dr. Campbell: Well, you did end your book with an important note about why we should not drive and do something else at the same time.

Dr. Bergen: That's right.

Dr. Campbell: It's not just because our attention is limited—which is the usual explanation. This suggests there's more to it than that.

Dr. Bergen: That's right. Well, our attention is limited. But this embodied simulation work actually shows that language interferes with driving in another way.

And that's the content-specific way: You're using your vision system when you're processing language about visual stuff; and as a result, your vision system is slightly less available to see the car that's about to merge in front of you. You use your motor system when you're understanding language about motor stuff—when you're listening to the baseball game—and as a result, you're slightly slower to put your foot on the brake.

We know that from experiments using a driving simulator here in my lab. This is one of the places where this basic science research is starting to interface with the things that people actually do in the real world, like driving and talking on a cell phone. And I think it's an exciting area of future development.

Dr. Campbell: Yes, I read somewhere that they think that one of the issues with talking on a cell phone vs. say, talking to another person in the car, is that you are visualizing the person at the other end of the phone. So, based on what you just told us about how this works, then that would definitely be interfering with us visualizing the road out in front of us.

Dr. Bergen: That's right. You could imagine (and I don't know whether anyone has ever done this) a study in which you have people talk over the phone while driving—in a simulator, so that no one gets hurt—while they're talking to people whom they either know or don't know; or where they know what they look like, or don't know what they look like. And you could see whether there's more indifference when they do know what they look like, because they're sort of visualizing what their face would look like when they're saying certain things. It's possible. I don't know that anyone has actually looked at that.

Dr. Campbell: But we do know that hands-free doesn't help. And this is an explanation for that.

Dr. Bergen: That's right; hands-free doesn't help. And even worse, what people are doing nowadays is they're having their email read to them by their phone, or whatever, and they have their phone listen to what they're saying and convert it to text. That's just as bad. Even though you're not using your hand, it interferes more than just typical hands-free conversation.

Basically what we need is self-driving cars. That's the only way out. Once Google finally releases them, so that all of us can have cars that drive themselves, we'll be much better off.

Dr. Campbell: I'm kind of an audiobook person, myself. I have a long commute to my emergency room that I work in. And I would like to think that it doesn't affect me, but I have missed my exit once or twice. Obviously, it is distracting.

Dr. Bergen: It is; that's right.

Dr. Campbell: Benjamin, is there anything else you'd like to share before we start to wrap up?

Dr. Bergen: Well, no. I mean this has been really delightful. It's been just a pleasure to speak with you.

Dr. Campbell: Well, I've enjoyed it, also. Do you have any advice for students?

Dr. Bergen: For students who are interested in working on language, or the brain, or whatever?

Dr. Campbell: Yes.

Dr. Bergen: Let's see. Oh, yes; here's the best piece of advice that anyone ever gave me: Don't waste a year in the lab to save an hour in the library. For any good idea that you've had, there's a high probability that someone else has already done it better.

I think that the more people think creatively and then go seek out how people have addressed that problem before, the more they'll realize exactly how much work there is that's been done in really interesting areas, and how refined the questions are that they can ask—the experimental research questions that they can ask—about those particular areas.

Dr. Campbell: Okay. Well, that's actually a unique piece of advice that no one has mentioned before. So, you did good!

So, what's next for you?

Dr. Bergen: I continue to do all this type of research in my lab. We've got stuff on driving, looking at the various different reasons why talking to someone interferes with driving. We're working some on this metaphor problem. If you say that Senator Smith has a 'disgusting' tax plan, clearly it's not literally disgusting, but how does that affect you emotionally. And we've been working on that a little bit.

And then, I've got this project where I'm working on a book about swearing, actually. Because swearing is usually ignored in language research—just because there are these taboos associated with it—but it actually can tell us amazing things about how the brain works; things that we wouldn't know if we just looked at clean language. So, that may be the next book to come out—may be our next conversation.

Dr. Campbell: I think Steven Pinker had something about swearing in one of his books. But I have to admit that I didn't actually make it to that chapter, because… I just didn't[4].

Dr. Bergen: That's okay. He published it as a self-standing book, actually. It's called, *The Seven Words You Can't Say on Television*.

And in Pinkerian style, it's compelling prose. He tells a really nice story, and brings together a lot of interesting research. My book is a little bit different. It's sort of wider, and covers a lot more of language.

Dr. Campbell: So, I can't believe it, but you actually are going to write another book?

[4] Dr. Campbell is referring to *The Stuff of Thought: Language as a Window into Human Nature* by Steven Pinker, which was originally published in 2007.

Dr. Bergen: Well, the swearing book is easier to write, because it writes itself. It's so fun to talk about swearing.

Dr. Campbell: Okay. Well, you'll have to keep me posted on that.

Dr. Bergen: I will.

Dr. Campbell: So, thanks so much for taking time to talk with me. And I appreciate your patience with my Internet connection and sound problems.

Dr. Bergen: I appreciate it, Ginger. Thanks, so much. It really has been quite enjoyable. You're right; this is way more detail than you'd get to do with a typical interview. And it's really fun.

Dr. Campbell: I actually had somebody write me that I was the Terry Gross of neuroscience.

Dr. Bergen: Yes! That's right.

Dr. Campbell: Okay. Well, I'm going to let you go. And I look forward to talking to you again.

Dr. Bergen: Sounds great. I look forward to it.

[music]

I want to thank Benjamin Bergen for coming on the *Brain Science Podcast* to talk about his new book, *Louder Than Words: The New Science of How the Mind Makes Meaning*.

I enjoyed his insight into the challenges a scientist faces when trying to write a book for a general audience. I think he succeeded brilliantly. This was, no doubt, partly due to the influence of his mentors, Art Glenberg and George Lakoff. I

refer you back to Episode 36 for the interview I did with Art Glenberg about embodied cognition.

The main goal of this book was to explore what we know about how our brain processes language. We started out by looking at the problems with the old theories of meaning; one of these, a definitional theory, which leads to the question of where would these definitions be in the brain, and how would your brain know which definition for a word to use if the word has different meanings depending upon the context. His example was the word, 'bank,' which could refer to a financial institution or something entirely different.

The main theory has been that there's a special language of thought—sometimes called 'Mentalese'. This is called the 'language of thought hypothesis,' and is often associated with Steven Pinker. But then, where does this Mentalese come from? There's a grounding problem: how does the stuff in your brain relate to the real world?

Which brings us to the alternative hypothesis, the simulation theory; which basically says that when we hear or read language, our brain simulates whatever is described, in the same parts of the brain that would experience this if it was happening in real life. It's as if we're experiencing the words.

This may sound odd, but it's actually just an extension of what we already know about memory and imagery. We know, for example, that memories are recalled in the same parts of the brain in which they were originally experienced; and the same thing is true for imagery. So, in this theory we would say, for example, that if we hear about something visual, we use the visual cortex. And there is evidence supporting this hypothesis. There's a lot of functional MRI evidence, which we didn't really get into; and there are also many interesting psychological experiments, which we touched on.

One point that I want to emphasize is the idea about what happens when you're talking on a cell phone. If you're talking on the cell phone, it takes you longer to see trouble. The evidence for this actually goes way back to the early 20th century, when C.W. Perky—who was one of the first female graduate students in cognitive psychology—demonstrated what is still called 'The Perky Effect.' She showed that if a person was imagining an object, it was actually more difficult for them to see real objects; implying that if you're already using a particular brain function, it interferes with trying to use that same function for something else.

Now, this is the opposite from the kinds of experiments that Art Glenberg did when he had people read sentences involving motion—either toward or away from their body—and then had them push a button that required either the same or opposite direction of movement of their hands. He found that the subjects responded more quickly if the two movements were compatible.

I was thinking about this when I asked Bergen to explain the difference between these results. He said that there are two factors to consider: timing, and whether the two activities are compatible.

When it comes to timing, if you're using the same system but there is a delay between the actions, then they don't interfere and the first action can prime the second. But if you try to do two things at the same time and there is incompatibility, this will slow you down—the Perky Effect. Trying to do two things at once causes interference if the tasks are incompatible.

When it comes to compatibility, if the two things are similar, you get priming; but if they conflict—like trying to imagine an 'x' while looking at an 'o'—they will interfere with each other if they are using the same brain system. The bottom line is it is really hard to do two different things at the same time, if they use the same brain system; but if you do two very similar things at the same time, you can get facilitation—as in Glenberg's experiments.

Bergen didn't say so explicitly, but from what he said it sounds like the mechanism for priming and facilitation are similar, but that priming implies a time delay; facilitation may or may not. Priming is a type of facilitation that implies a specific timing component.

We also talked a bit about grammar. And I have to say that *Louder Than Words* gave me a new appreciation for the role grammar plays in the meaning of language. It also made me realize how being sloppy with grammar could have an impact on experimental results.

Finally, we touched on the issue of abstract language. This is an issue that hasn't really been resolved for proponents of the embodied simulation theory, but their working hypothesis comes from George Lakoff's theory that we actually think metaphorically; that is to say, when we talk about something abstract, we think in terms of something concrete that we can imagine. An example of this would be our tendency to describe time in terms of space.

So, that hits the high points of the interview. As always, I recommend that you read the entire book, because there's so much there. And in the case of this particular book, there are lots of experiments discussed that we didn't have time to talk about. And, as I mentioned during the interview, I think that Bergen does an amazing job of making these experiments interesting, instead of them getting tedious.

So, I highly recommend *Louder Than Words: The New Science of How the Mind Makes Meaning*, by Benjamin Bergen, for everyone—especially for someone who thinks that they hate science or that it is boring; because he makes it fun and interesting. And I look forward to his next book, which he said is going to be about cursing.

As I mentioned in the introduction, I've just launched a new version of the *Brain Science Podcast* at brainsciencepodcast.com. And I hope that in this new design

it will be easier for you to find things, including the free transcripts. There are also Contact forms at several points inside the website to make it easier for you to send me feedback. And I'm going to be using two emails now: besides the familiar docartemis@gmail.com, you can now also write to me at brainsciencepodcast@gmail.com.

One of the things that is on the new website is a video, which my friend, Roger Reid, from the Discovering Alabama television show, recorded for me. I hope that you will share this video. It's short. It's also on YouTube, and you can share the link or imbed it any place you like.

There's also a new page of Testimonials, which contains interesting stories from listeners. And I would really like to have some more content for this page; especially I would love to hear from listeners from outside the United States.

And, for those of you who have been having trouble with the Donation buttons on the old site, I think that problem has also been fixed.

Now, next week I'm going to be going to South by Southwest in Austin, Texas. So, if you're going to be there, please do drop me an email or send me a message on Twitter. I am Doc Artemis on Twitter.

Now, we do have a couple other ongoing campaigns. One is the Audience Survey, which, on the new website you can find very easily if you click on Resources, which is at the top right-hand side of the banner. There is a pull-down menu there, and you will see Audience Survey right there.

There's also a new Announcements, or news page, which contains the Audience Survey and details about the ongoing campaign to get me onto *Triangulation*, which is part of the TWiT network.

So, I'm going to let you go, but I will be back next month with Part Two of our discussion of pain.

[music]

[music]

Transcribed by Lori Wolfson
All errors or omissions responsibility of the transcriber.