

# **BRAIN SCIENCE PODCAST**

*With Ginger Campbell, MD*

## **Episode #73**

### **Interview with Lawrence Shapiro, PhD, Professor of Philosophy and Author of *Embodied Cognition***

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## **INTRODUCTION**

This is Episode 73 of the *Brain Science Podcast*, and I'm your host, Dr. Ginger Campbell. Today's episode is an interview with [Dr. Lawrence Shapiro](#) from the [University of Wisconsin](#). We will be talking about his book, [\*Embodied Cognition\*](#).

Before we get started I want to remind you to visit our website at [brainsciencepodcast.com](http://brainsciencepodcast.com), where you can find detailed show notes, links, and free episode transcripts. Also, you can send me feedback at [docartemis@gmail.com](mailto:docartemis@gmail.com), or leave voicemail at 205-202-0663.

If you are new to the *Brain Science Podcast* you may be wondering what is [embodied cognition](#). The simplest answer is that embodied cognition is an approach to the study of cognition that regards cognition as something that involves, not just the brain, but also the body and its environment. The dictionary defines "cognition" as, "the mental action or process of acquiring knowledge and understanding through thought, experience, and the senses;"

which means that cognition includes just about everything interesting that our minds do.

Today's episode is intended to stand alone, but it does build on several previous episodes. The subject of embodied intelligence was introduced back in [Episode 25](#) when I interviewed Dr. Rolf Pfeifer about his book, *How the Body Shapes the Way We Think*. Then in [Episode 36](#) I talked with Dr. Shapiro's colleague, Dr. Art Glenberg, who introduced us to the work that psychologists are doing with embodied cognition.

In [Episode 58](#) philosopher, Alva Noë, discussed how embodied cognition could change the way we define the mind. Finally, in [Episode 66](#) Dr. Randy Gallistel gave us an introduction to some of the tools of standard [cognitive science](#). It is definitely not necessary to listen to any of these earlier episodes first, but I mention them mainly so you will know where to go to learn more about this fascinating topic.

I will be back after the interview to summarize the key ideas and to tell you about the next episode of the *Brain Science Podcast*.

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## INTERVIEW

**Dr. Campbell:** My guest today is Lawrence Shapiro, who is a professor of philosophy at the University of Wisconsin, and the author of a new book called, *Embodied Cognition*. Larry, it's great to have you on the *Brain Science Podcast*.

**Dr. Shapiro:** Well, I'm really excited to talk to you today.

**Dr. Campbell:** Before we really get into your book, I thought maybe you might just tell us a little bit about yourself.

**Dr. Shapiro:** I'm a professor at the University of Wisconsin in Madison. I teach in the philosophy department. I've been in Madison since 1993. I moved here from Philadelphia. And I'm interested in issues in [philosophy of mind](#), [philosophy of psychology](#), and [philosophy of biology](#), and I spend a lot of time thinking about thinking.

**Dr. Campbell:** Well, actually it was philosophy of mind that got me interested in neuroscience again; which is why I started this podcast a little over four years ago. So that's why I tend, I think, probably to have more philosophy of mind episodes in this podcast than some of my listeners would expect.

So, how did you come to write *Embodied Cognition*?

**Dr. Shapiro:** I had done graduate work with a guy named [Gary Hatfield](#) at the University of Pennsylvania, who got me interested in [ecological psychology](#), the school of psychology that [James J. Gibson](#) was the father to. Gibson offered an account of the mind and of psychological processes distinct from the reigning [computational paradigm](#).

And just continuing to think about Gibson brought me to think about this other area of psychology—embodied cognition—which is very much indebted, I think, to Gibson's ideas. And it was kind of a natural fit for my interests, since I had been so interested in Gibson as an alternative to computational approaches to psychology.

**Dr. Campbell:** What are the goals of your book?

**Dr. Shapiro:** I'm trying to do a couple things. One thing I'm trying to do is just to provide a fairly even-handed introduction to embodied cognition; which is something not many people have done. It seems to be the kind of research program that has strong devotees or equally bitter enemies. There doesn't seem

to be a lot of neutral ground. And I'm trying to provide that neutral ground, evaluating the arguments in support of and against embodied cognition.

And another thing I'm trying to do is assess the extent to which it's a competitor, or a challenger, to the reigning computational approaches to psychology that cognitive scientists have been pursuing since the '50s and '60s.

**Dr. Campbell:** So, who's the intended audience for your book?

**Dr. Shapiro:** It's written for philosophers and psychologists; but also, I think, any intellectually curious layperson with a little bit of background in psychology, or in biology, or in philosophy should be able to pick up the book and get something out of it.

**Dr. Campbell:** I will say, as a person who's read it, obviously, that anyone who's a regular listener to this show could read your book without any problem, and understand it.

**Dr. Shapiro:** Well, that's good.

**Dr. Campbell:** But why should people who are outside of academics care about embodied cognition?

**Dr. Shapiro:** One thing that strikes me as of great interest to a general audience is how people conceive of their minds. It's always been a puzzle what minds are—how minds are related to bodies. And there's a long history of thinking of minds in different ways, starting with [Descartes](#), moving through the [behaviorist](#) era in the early 20<sup>th</sup> century, and finally most recently the computational framework for understanding minds. And I think embodied cognition, if it continues to make progress and move along, will shape how the ordinary person thinks about minds, just as cognitive science has shaped how the

ordinary person thinks about minds—whether they realize that they’re indebted to this movement or not.

**Dr. Campbell:** And thinking about our mind really influences how we understand what it means to be human.

**Dr. Shapiro:** Sure it does. It influences our sense of identity. It could have an impact on whether we think non-human species have minds. It could also have an impact on the kind of technology we develop, because there are aspects of embodied cognition that are very influenced by prostheses and other kinds of artifacts that you might end up attaching to your mind in certain ways, which hadn’t been really appreciated before embodied cognition started exploring these claims.

**Dr. Campbell:** Just as an aside, it seems to me like the more we learn about animals, the more I am inclined to attribute at least many mammals to having minds, myself.

**Dr. Shapiro:** Yes, certainly. I was just reading a study today about macaque monkeys expressing uncertainty about certain things. And you think of uncertainty or lack of confidence as a uniquely human trait. But it turns out macaques experience this, as well.

**Dr. Campbell:** Yes. And it turns out that dogs understand pointing, even though wolves and chimpanzees really don’t—which is sort of weird.

**Dr. Shapiro:** I guess they were bred to understand that. But it’s surprising that chimps don’t.

**Dr. Campbell:** Well, I think it’s not that they don’t; it’s that they really just don’t care, because it’s not the way they communicate.

**Dr. Shapiro:** Right. It's sort of like cats don't seem to care about much at all, except other cats and food.

**Dr. Campbell:** Yes.

In getting into this discussion of the difference between the standard cognitive science and embodied cognition we need to start out with a few basic definitions. Would you mind defining what cognitive science is?

**Dr. Shapiro:** Sure. You could think of the mind as consisting of a bunch of different capacities. People have the ability to attend to objects. So, attention is a kind of capacity. Memory is a capacity. Our ability to generate and comprehend language is a capacity, as is our ability to solve problems and reason.

And what cognitive scientists do is they study those capacities, and they think of them sort of like programs that might be run on a computer. And then the approach in cognitive science is—once you are thinking about these various capacities as programs—to try to figure out what that program is.

**Dr. Campbell:** And cognitive science by definition or by history is very interdisciplinary.

**Dr. Shapiro:** Sure. It borrows from computer science; from linguistics. [Noam Chomsky](#), a linguist, is considered one of the foremost cognitive scientists. It also borrows from philosophy, biology, neuroscience. There are a lot of different disciplines that have all been assumed under the cognitive science umbrella.

**Dr. Campbell:** Usually cognitive science is considered separate from neuroscience in the sense, I think, that neuroscience is considered to be more of the nuts and bolts, and cognitive science is more of the—like you said—program approach.

**Dr. Shapiro:** That is right. In fact, some cognitive scientists—most notably [Jerry Fodor](#)—have been a little bit too dismissive about what cognitive science might gain from the study of the brain. On the other hand are neuroscientists who think that everything is neurons and so they don't have need to think about the psychological capacities at a more abstract level of description.

**Dr. Campbell:** I recently started a new [group](#) for my podcast on this website, [goodreads.com](#). Somebody started a thread arguing that neuroscience should replace the need for psychology. And it's kind of interesting to see the kind of response. I don't think he really gets the idea that psychology is at a different level of analysis.

**Dr. Shapiro:** Yes. There are these reductionists out there, and it's hard to see how they can proceed without knowing what it is they're trying to reduce in the first place—which is the business of psychology, to describe and explain these capacities to think.

**Dr. Campbell:** And if it wasn't for the people who had the knack for experimental psychology (I'm thinking of, for example, [Brenda Milner's](#) <sup>1</sup>work with memory) for all those years before we had the MRIs and the CAT scans, then we have all that experimental result that we can now correlate with this more neuroscientific level of analysis, but that does not take away the value of that original work.

**Dr. Shapiro:** No. And in fact, I'd go a little further. Sometimes it's the experimental work in psychology that constrains the kinds of hypotheses about neural organization that neuroscientists are then able to investigate. So, for instance, it's through work on the psychophysics of color vision that the [opponency process theory of color vision](#) was discovered. We've learned a lot

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<sup>1</sup> Brenda Milner was interviewed in [Episode 49](#) of the *Brain Science Podcast*.

about the neuroscience of vision just by doing experimental research on the psychological properties of vision.

**Dr. Campbell:** That's an excellent example.

Moving on to our original topic, which is embodied cognition, how is that different from the standard cognitive science?

**Dr. Shapiro:** Well, let me spend a few minutes, if that's OK, describing what I think of as standard cognitive science. We know that the brain receives inputs from the sensory systems, and we know that the brain has a motor cortex, the job of which is to organize action. So, you can think of the brain as serving a kind of intermediating role between inputs from the sensory systems and outputs to the motor systems.

Thinking about the brain this way makes it tempting for some people to think that what the brain does can be described in isolation from what the body does. Given that the only access my brain has to the world is through the sensory system (although it's just a sort of science fiction imaginative case), you could think of the brain as being removed from the head and hooked up to a computer that just simulates the sorts of inputs that the brain would receive from the sensory systems. And likewise you could then have the brain feeding output to a robotic body if you wanted to.

So, the brain, in the standard way of thinking about cognitive science, is isolated from the world, isolated from the body. And it's the cognitive scientist's job to figure out what kinds of [algorithms](#) the brain is using to convert inputs from the sensory systems into motor commands for behavior. Some have referred to this framework for understanding what the brain's job is as involving a sense-think-act cycle: sensing takes place first, then the brain is responsible for the thinking stage, and then the body does the acting.

Embodied cognition, in contrast, imagines not that the brain can be isolated from the body and the environment, but thinks of the body as in some sense shaping, or constraining, or involved in the very processing of the kinds of information that an organism needs to interact successfully with the world. So, it's no longer possible, according to people in embodied cognition, to think about cognition as being the middle stage in the sense-think-act cycle. Instead, thinking involves active exploration—use of the body with things in the environment.

**Dr. Campbell:** OK. So, a key difference is, instead of thinking of the mind as something that's completely separate from both the body and the rest of the world, embodied cognition is going to say that that interaction is a key part of the process.

**Dr. Shapiro:** That's right. And then the tricky business comes with trying to understand in what way the body actually contributes to thinking, and how it contributes to thinking. You can imagine that the body might influence thought in various different ways, and it might simplify certain cognitive processes or it might render certain cognitive processes unnecessary. And then there are additional questions about whether the perspective that embodied cognition theorists take on the role of the body in cognition could be subsumed within a more sort of standard computational framework, or whether it's in fact a revolutionary new idea that requires replacing standard cognitive science with new tools.

**Dr. Campbell:** And we're going to get more into that in a little while. Before we do, could you talk a little bit about how these two different viewpoints will affect how experiments are designed?

**Dr. Shapiro:** Sure. A lot of work in cognitive science—at least traditionally—requires that the subject of the experiments be seated in front of a computer, isolated from the distractions of a noisy environment, focused on the monitor

where stimuli will be presented, and asked to make judgments about the stimuli. Typically what you do is you measure the subject's reaction time in response to stimuli and you try to figure out, given the time it takes the subject to react to a stimulus, what that says about the underlying algorithm that must be employed by the subject's cognition.

But if embodied cognition is the way you want to go, then the last thing you want to do is place the subject in a kind of artificial environment where you're removing all the kinds of what cognitive scientists think of as distractions, but what we embodied cognition people think of as necessary props in the environment that the subject uses to collect or simplify the sorts of information that the subject needs to be performing his or her cognitive tasks.

So, you might say that embodied cognition requires laboratories that replicate the kinds of ecological environments in which subjects have evolved to use their cognitive capacities; whereas more traditional cognitive scientists try to limit the subject's access to the world to just those things that the cognitive scientists think will make a difference to the subject's cognitive capacities.

**Dr. Campbell:** Sort of embedded in your answer there is the difference between the standard view of the subject as just being a passive receiver of information, as opposed to the active acquiring of information that embodied cognition implies.

**Dr. Shapiro:** Yes. Thanks for making that point. I should have made that. Yes, sitting in front of a monitor watching stimuli is a completely passive process, whereas embodied cognition theorists think that cognition, in many cases, requires active exploration of the environment.

**Dr. Campbell:** In Anthony Chemero's new book, [\*Radical Embodied Cognitive Science\*](#), he gives this example—he's talking about this in the context of

[affordances](#), as per Gibson. He talks about how experimenters who don't take into account affordances when they're studying rats, and they put them in these environments and they have new objects, and they don't take into account whether these new objects are things the animal can climb or not, then that can distort their results. Because it turns out that how they behave—how much exploration they do—is directly proportional to that particular thing, because they're more, in general, interested in stuff they can climb than stuff they can't.

**Dr. Shapiro:** Yes. Then, of course, there's the [classic experiment by Hein and Held](#) with the kittens<sup>2</sup>.

**Dr. Campbell:** Yes.

**Dr. Shapiro:** So, you have some kittens moving around their environments pulling carriages with other kittens in them. And the ones in the carriages presumably see everything that the kittens pulling them see, but because they don't actually employ their motor systems to move them around the environment, the claim is that their perceptual systems don't develop properly. The idea there seems to be that part of what's necessary for perception is actual exploration of the environment; not just being a passive recipient, like these kittens conveyed in the carriages are.

**Dr. Campbell:** So, that brings us back again to that key idea that the brain is not alone in its action, it's intimately connected to the body; and that the body has to interact with the environment.

**Dr. Shapiro:** That's right.

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<sup>2</sup> Held, R. Hien, A. (1963) "Movement-Produced Simulation in the Development of Visually Guided Behavior," *Journal of Comparative and Physiological Psychology* 56: 872-6.

**Dr. Campbell:** So, do you think that perhaps vision might be a good way to illustrate some of the key differences between the two approaches? Or do you have a different example that you might like to use?

**Dr. Shapiro:** I think that a better example might be a discussion of [Rodney Brooks](#)' work on robotics.

**Dr. Campbell:** OK.

**Dr. Shapiro:** Suppose you wanted to build a robot, and you didn't have big expectations for what you wanted this thing to do; you wanted it to move around an environment—which is actually kind of hard to do, because things fall in front of you and you have to avoid them, or there are walls and doorways you have to pass through, people you need to avoid. One way that this problem—building a robot that can move around a cluttered environment—was tackled decades ago, I think really illustrates the commitments of standard cognitive science.

This was a robot called [Shakey](#), and the idea was simply that you have this robot (it looked kind of like a shopping cart) and it would move around a room. And it had an off-board computer which contained representations of this room; sort of images—of course coded—of this room. And it was the job of this computer to make sure that the robot wasn't going to run into things. It could tell the robot what to explore, which directions to go. But all the processing took place in this off-board computer. The brain of this thing was literally disembodied, because it was connected with cables to this computer. And there was a lot of representation going on, maps created, so that navigation could be plotted.

But now let's think about a different way that you might build a robot to move around an environment. And this is the approach that the roboticist, Rodney Brooks, at MIT, has taken. Rather than requiring that your robot have some sort of representation of the space—some internalized map that it could consult in

order to get around the room—you build a bunch of different kinds of simple modules. And each module receives an input, and on the basis of this input it produces an output.

So, you might have this robot rolling along the floor, and it comes to an obstacle—a big box in its way, or something like that. The robot has sensors surrounding its periphery, and these sensors come in contact with this box. And there's one module within this robot, the only job of this module is to stop the robot when its sensors detect an object dead ahead. Then another module might kick in, which causes the robot to turn, once stopped, and move three or four feet, or move until the sensors are no longer picking up the presence of the object, and then turn again.

So now, rather than having a representation of the environment, all the robot has is a bunch of these little modules that directly connect sensing to acting. And you put all these modules together and the robot ends up doing some pretty versatile things; and to all appearances it's a smart little critter. Rodney Brooks thinks that his robots have the intelligence of something close to an insect. I think insects are actually quite a bit smarter than that. But I hope the contrast is clear. The Brooks robot doesn't contain representations of the environment; it doesn't require the use of an off-board computer to plot routes. Its behavior is all emergent from the excitations and inhibitions of all these independently-running modules.

**Dr. Campbell:** And in terms of the idea of embodiment, I think the things that people have done— like Rolf Pfeifer<sup>3</sup> has done with walking robots—are really interesting, because there they're using some of the qualities of the materials that the robots are made out of that lead to them being able to walk without any algorithms, per se, for walking.

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<sup>3</sup> Pfeifer was interviewed in [Episode 25](#) of the *Brain Science Podcast*.

**Dr. Shapiro:** Yes, it's neat work. One thing you might think about is a contrast between how a [Slinky](#) moves down the stairs and how a robot like — Honda Corporation developed this robot called [ASIMO](#). And ASIMO, to walk down the stairs, requires all sorts of gyros, and sensors, and all sorts of sophisticated equipment. And yet, it doesn't walk down stairs nearly as elegantly as a Slinky does. A Slinky makes it down the stairs just because it's made of this material that is coiled a certain amount, you tip it over, and it works with friction and gravity and gets down the stairs quite proficiently.

So, Pfeifer and some others have realized that if you want to build something that walks, you can't just think about the sorts of algorithms that might go into computing the motions of a leg; you have to think about what legs are made of. And this can actually simplify or constrain the kinds of computational work that you need to do.

**Dr. Campbell:** OK. So, that brings us to the idea of offloading some of the stuff to the world; which I think is really big in the work of people like [Andy Clark](#) and [Alva Noë](#). What do you think about how their work fits in to the conversation?

**Dr. Shapiro:** Different ways. I think that Andy is impressed with offloading as a way of simplifying the cognitive routines that otherwise would require a lot of memory and a lot of reasoning. So, there are a lot of examples of offloading. Typically you can think of offloading as involving structuring your environment in a certain way.

So, I have the books in my library organized by subject matter, and then within subject matter, by author. And this makes it very easy to find my books. If my books were just thrown up randomly, then whenever I wanted to find a particular book it would take me a lot of time. But I've now used the strategy of structuring my environment in a certain way, so that I don't have to remember where every single book on the shelf is, I just have to remember the alphabet.

So, that's one kind of example of offloading. You make the environment do work for you that otherwise you'd have to do yourself.

**Dr. Campbell:** What about the example of—and I think that he mentions this in one of his books—if you're putting together a jigsaw puzzle? I personally am a person who can't put together a jigsaw puzzle without the picture to look at. I mean there is no doubt in my mind that I use the picture.

**Dr. Shapiro:** Well, I don't think that's cheating.

**Dr. Campbell:** No, I don't consider it cheating, either. But he uses this as one of the examples of how people use information that's in the environment, so that they don't have to keep it in their memory.

**Dr. Shapiro:** Right.

**Dr. Campbell:** But I'm not ready to say that that picture or the books on the shelf are part of my mind.

**Dr. Shapiro:** No, I agree. There's a difference there. Let me try my best to defend some of Andy Clark's a bit more outrageous claims. His claims aren't as outrageous as sometimes his critics—in particular, [Fred Adams and Ken Aizawa](#)—make them out to be. But there is this story that Andy and a co-author, [David Chalmers](#), tell in a paper of theirs called "[The Extended Mind](#)."<sup>4</sup> You might have had others talk about this—about Otto and Inga.

**Dr. Campbell:** I think so.

**Dr. Shapiro:** OK. Should I remind people what this is about?

**Dr. Campbell:** Briefly will be fine.

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<sup>4</sup> Clark, A. and Chalmer, D. (1998) "The Extended Mind." *Analysis* 58: 7-19.

**Dr. Shapiro:** Sure. So, Inga is a normal human being who forms the desire to visit the Museum of Modern Art in Manhattan. And she remembers that it's on 53<sup>rd</sup> Street, and so she hops on a subway and goes to 53<sup>rd</sup> Street to see the museum. Otto, on the other hand, has Alzheimer's disease, and carries with him a diary in which he has all the information that he needs to make it around the city successfully. He forms the desire to go to the Museum of Modern Art, looks in his diary, sees that it's on 53<sup>rd</sup> Street, and hops on a subway and goes there.

Clark and Chalmers claim that the information in Otto's diary, if it's integrated in the same way as or in a similar way to the way that Inga's memories in her normally-working brain are integrated, then we should think that, just as Inga has the belief that the museum is on 53<sup>rd</sup> Street—it just happens this belief is in her head—so too, Otto has the belief that the museum is on 53<sup>rd</sup> Street, just as his belief happens to be in his notebook.

It's on the basis of this example that Clark and Chalmers argue for the idea that minds can extend. We can have beliefs in our head, certainly. That's where most of them are. But we can also talk about having beliefs outside our head, so long as these external beliefs meet certain criteria having to do with their availability and accessibility. So this is, I think, a bizarre idea when you first hear about it.

**Dr. Campbell:** But it's very relevant in light of the direction our technology is going, where we can put more and more information on our phone, for example.

**Dr. Shapiro:** Sure.

**Dr. Campbell:** When I was in medical school we used to carry all these notebooks around and call them our peripheral brain. Now medical students have all that stuff on their iPhone. But I don't think most of us think of that stuff as part of our mind.

**Dr. Shapiro:** Yes. And in fact, I offload all the scheduling information about my children in my wife's head. I think of my beliefs about where my children need to be and when they need to be there as my beliefs are in my wife's head—which is a good place for them.

But there are different ways to take Clark and Chalmers' example. And maybe that example is not really helping their case, just because it's so radical. A better way to think about the meaning of the claim that our minds or thoughts might extend beyond our brain is to think about processes that Andy Clark describes as 'loopy'—processes that involve feedback loops.

An example of this is just a turbo engine. A turbocharged engine is an engine that reuses the exhaust it produces. So, it produces exhaust, and this exhaust, rather than simply exiting the engine, spins a turbine which causes air to be compressed more compactly in the cylinders. And with more air in the cylinders the engine is stronger; the explosions are more powerful, it produces more exhaust, which feeds back into the engine, making ever more and more powerful explosions.

And so, there's this kind of feedback loop. What the engine is doing—what it's producing—is then recruited for the purpose of making the engine function even better. And it seems in that kind of case you want to think about the output of the engine—the exhaust—as actually a constituent in the process by which the engine runs.

If you're OK with that idea, then the place to start looking for extended cognition is in those cognitive processes that rely on properties external to the brain in this kind of feedback sort of loop.

**Dr. Campbell:** The traditional approach doesn't really allow for feedback.

**Dr. Shapiro:** That's right. You've got your input, your processing, your output; and that's where the story ends. But here you have input, processing, output

which is input, processing, output. And the processing wouldn't work without the outputs feeding back into the process as inputs.

**Dr. Campbell:** And we know that that's what really happens, just when we do something like pick up a glass.

**Dr. Shapiro:** And also when I sit down to write a paper, or just to write a letter, or to work out some thoughts, I'll be typing on the keyboard and reading what I'm typing as I'm typing it. And in reading what I'm typing, new thoughts are created. I have insights because of what I'm looking at on the screen of my monitor. And so, Andy and others, like [Rob Wilson](#), would think of what you do when you throw thoughts on paper and use these thoughts to create new thoughts, that's a kind of feedback loop; and they would be willing to say that a constituent of this process—this process of, say, problem solving or reasoning—are the actual words on the monitor in front of you.

**Dr. Campbell:** It certainly brings into doubt the traditional idea of the mind as being so easily delineated from everything else.

**Dr. Shapiro:** Yes, exactly. You also see some of this in the fascinating work on the use of gesture. So, it's I think a fairly received view—but I have to be careful here, because I'm not positive—that boys perform better in certain spatial reasoning tasks than girls. And when psychologists have studied this<sup>5</sup> they've noticed something kind of interesting. They've noticed that boys rely on gesture a lot more than girls do when solving spatial reasoning tasks—like how would this shape have to be turned in order to fit with that shape, or something like that.

You'll see boys engaged in spatial reasoning tasks using gestures to work out the problem, at the same time they're talking through the problem. And often you'll see that the gestures they're using don't really synchronize with the verbal

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<sup>5</sup> Ehrlich, S., Levine, S., and Golden-Meadows, S. (2006) "The Importance of Gesture in Children's Spatial Reasoning," *Developmental Psychology* 42: 1259-68.

reasoning. It's as if they have two different systems working at once: one a gesture system, and one a verbalization system. And their use of gesture (and here I am gesturing as I tell you this) seems to actually be a part of the process of figuring out these spatial reasoning tasks. And girls, for whatever reason—maybe they've been instructed to keep their hands in their laps, or something like that—don't avail themselves as extensively with the gesturing that boys do. And one idea is that they show a slight deficit in spatial reasoning because—for whatever reason—they're not making use of gesture.

**Dr. Campbell:** That's an interesting idea. I'll have to keep an eye out for more about that.

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**Dr. Campbell:** It seems pretty clear that we need to take into account the body when we look at cognition. But what is the main argument against embodied cognition?

**Dr. Shapiro:** Well, one thing you just said—we need to think about the body when we study cognition—that's obviously true. And this is a problem. So, cognitive scientists have forever known that we have bodies and the kinds of bodies we have make a difference to how we think. So, the idea that somehow

bodies are important to thought shouldn't be what separates embodied cognition from standard cognitive science.

And it's a problem with many efforts to articulate what's interesting about embodied cognition that you always start with the claim that bodies matter. Well, of course bodies matter; and everyone's known that. Even Descartes knew that. (I shouldn't say 'even;' Descartes was no dummy.) So, you have to be clear about the sense in which body matters. And you have to somehow draw out consequences for the fact that we have bodies, that can't be easily accommodated within a standard cognitive science framework.

Let me just give an example: The fact that our ears are on the other side of our head makes it possible to locate the source of sounds. There is something called the 'ITD'—the interaural time difference. So, if there's an object—a dog—to your right, barking, the sound will reach your right ear before it will reach your left ear. And the space and time between when it reaches your right and left ear is very small, of course, but it's enough to help localize the source of that barking.

So this shows that the kind of body we have matters to a particular cognitive capacity—audition. But, of course, this doesn't mean that you can't take a fairly standard computational approach to understanding how it is people are able to localize sound sources. What it does mean is that in whatever sort of algorithm you want to try to devise for understanding how sound is localized, you have to have as a variable in your algorithm the interaural time difference. But that's fine within the standard framework of cognitive science.

Another example: It's because we have eyes separated by a couple of inches that we're able to detect depth. But the sorts of computational vision programs which are paradigm examples of standard cognitive science in action—and very successful examples—accommodate this fact that our eyes are inches apart, and

it's a feature of these algorithms for describing the recovery of depth information that they include this information about the distance of the eyes from each other.

So, one challenge that you face as an advocate of embodied cognition is to say what's novel about embodied cognition—what can't already be incorporated within the more traditional ways of studying the mind.

**Dr. Campbell:** As I understood it from reading your book, one of the criticisms that the standard cognitive scientists might give is that the embodied cognition advocates are just confusing causes for constituents of cognition.

**Dr. Shapiro:** Yes. That's a criticism I make of a particular kind of research program within embodied cognition. It's related to the work of Andy Clark, that I was just talking about, in which he is describing extended cognition. Sometimes Andy will say things like the notebook that Otto carries around with him really contains his belief—it's part of his mind—or the words on the monitor in front of you that are somehow informing your future thoughts are part of your cognitive process.

But there's another way to think about these. Rather than the notebook or the words on the screen as being constituents of a cognitive process, you can think of them as simply external causes that have some sort of influence on the genuine cognitive processes, which are still purely within your cranium.

So, one challenge that folks in embodied cognition have to answer is why should you think of these things that are external to your brain as, in fact, constituents of a cognitive process, rather than as causal influences that might be quite significant, but nevertheless remain distinct from the real cognitive processes that occur exclusively within the brain.

**Dr. Campbell:** Do you think, though, that if you're going to need to include feedback and the description of [dynamic systems](#), which implies feedback, then at

that point do you necessarily have to have the thing causing the feedback to be a constituent? Isn't the very fact that it's feeding back into the system enough to challenge the standard model?

**Dr. Shapiro:** Yes, I agree that that's where I think the proponent of embodied cognition stands the best chance of making clear the sort of difference that he or she has in mind when talking about the extent of cognitive systems; because it does look like when you have these sorts of feedback situations, it's artificial to say this thing is part of the system and this thing is not. So, the description of the turbocharged engine, I think it would just be artificial to insist that the exhaust is not part of the process.

**Dr. Campbell:** But it's not part of the engine. See? That's where you get into it. Right?

**Dr. Shapiro:** Right. It's part of the process of which the engine is also a part; or it's part of the system that produces the horsepowers.

**Dr. Campbell:** So, the embodied cognitive person—I don't know exactly how you'd say that—would say that the brain is part of the system that produces cognition, but it's not the whole process.

**Dr. Shapiro:** Right. The system contains the brain, but it also might contain things external to the brain and external to the body. The label 'extended cognition,' I think has as its inspiration [Richard Dawkins](#)' idea of the [extended phenotype](#). Richard Dawkins is an evolutionary biologist who had this idea that it makes sense to think of the [phenotype](#) of an organism—that is, those parts of the organism that are expressed by the [genotype](#)—as often extending beyond what we think of as the body of the organism. So, the spider's web is as much a part of the phenotype of the spider as the spider's eyes or the spider's legs;

because the web is actually a product of the genotype of the spider—the genes that the spider has inherited.

And likewise, I imagine that Andy and Dave chose the name ‘Extended Mind’ with this kind of point that it makes sense to think of what the mind does as extending beyond simply what the brain is doing.

**Dr. Campbell:** One of the things that confuses me, after having read several books about embodied cognition: is it part of the program of embodied cognition to reject computation and representation?

**Dr. Shapiro:** It’s not universally so, but there are certainly very well-known researchers in embodied cognition who have been outspoken in their desire to topple or supplant the traditional methods and conceptual claims of standard cognitive science. [Art Glenberg](#) is an example of this. Art thinks that minds aren’t computational, and the computational framework is a non-starter; because he thinks that the sorts of symbols over which computer programs operate are meaningless, and the only way they can get meaning is through embodiment.

And then you also see people who study embodied cognition with the tools of [dynamical systems theory](#). They think that the mathematics of dynamical systems is the way to study cognition, and using this mathematics means that you don’t have to rely on the idea of symbol manipulation. In fact, people who favor dynamical systems approaches to cognition will sometimes say that you don’t have to think about cognition as involving representations at all—which is, of course, a central notion within standard cognitive science; computational cognitive science.

**Dr. Campbell:** But the equations for dynamical systems are so complicated that don’t they usually end up having to use computation to simulate them?

**Dr. Shapiro:** Yes, they certainly do. But in principle the idea is that we can describe a cognitive task like categorization—so I have [Randy Beer's](#) work in mind here—just in terms of the way that a sensory system, and a body, and an environment all interact. The kinds of interactions between body, world, and nervous system suffice to explain how this agent ends up categorizing objects. There's nothing deeper going on there; no need to talk about algorithms and representations.

**Dr. Campbell:** I guess we could go away from the mind and think about something like, for example, trying to simulate the weather or climate, in which they're taking the principles of a dynamical system; and they do use the—I assume—computation to simulate it. But they're not saying that there's any computation going on in the real world.

**Dr. Shapiro:** Yes, it's just like you can use a computer to simulate a hurricane, but hurricanes don't process symbols.

**Dr. Campbell:** Right.

Looking at computation from a slightly different point of view, I'm thinking back on when [I interviewed Randy Gallistel](#), and we talked about the examples of [dead reckoning](#) and scrub jay caching. Let's just take dead reckoning, because that's a really simple one. That looks like it might be computation.

**Dr. Shapiro:** Yes, it sure does.

**Dr. Campbell:** Even if you don't have symbols.

**Dr. Shapiro:** Right. Although Gallistel does think of these things as having symbols—operating on symbols that might represent things like the angle of the sun, or something.

You're wondering how someone who studies embodied cognition might think about dead reckoning capacities of insects?

**Dr. Campbell:** Yes.

**Dr. Shapiro:** I think that's a really good question—a really challenging question—to ask someone in embodied cognition, because it does seem like such a paradigm of a computational problem. But let me change the context a little bit to suggest how an answer might go.

There is something known as the 'Outfielder Problem,' or the 'Fly Ball Problem.' It's an amazing feat for an outfielder to be able to position himself beneath the ball as it's moving from home plate far into the outfield. It's an amazing feat to be able to do that. And you could approach this problem as one in which the outfielder has to compute the trajectory; compute the speed; figure out, given the gravitational constant, at what rate it will be accelerating as it's falling. And the task sounds very computational.

But it turns out that a lot of work in ecological psychology has shown that there's a simple variable that the outfielder can rely on that, by just attending to this one variable, he doesn't have to actually work through—of course, unconsciously—all these heavy-duty computations. Basically what the outfielder wants to do is position himself so it looks like the ball is rising straight up in the air in front of him, and then it'll come down straight, as well. So, it's this simple sort of variable that enables the outfielder to perform this task that might appear, from a particular bias, to require lots of computation.

**Dr. Campbell:** My husband was an electrical engineering professor. And he had a very gifted student—who actually went on to get a Rhodes scholarship—who did this as a senior design project.

**Dr. Shapiro:** Oh, really!

**Dr. Campbell:** And I think that that's exactly what they came up with, was that trying to do it by formulas didn't work. I mean they literally had a robot that was doing it, and it couldn't catch them doing it that way. It did it exactly like you said.

**Dr. Shapiro:** Yes. Gibson has lots of examples of what appear to be computationally onerous tasks, but it turns out that there are very simple solutions that rely on picking up certain information in the environment.

So, here's a neat example: If you have two telephone poles that are the same height—50 feet tall, let's say—and one of them is behind the other, the question is how do you figure out which one is closer and which one is further. No, sorry; the question is are they the same height—let's make that the question. And in order to answer that, it seems like a computational problem: you have to figure out how far they are from you, and then certain trigonometric relationships will tell you whether they're the same height.

But what Gibson realized was that objects at the same height will have the same proportion of themselves below the horizon and above the horizon. So, two telephone poles that are 50 feet tall, if one is 100 feet away and the other is 50 feet away, they'll still be cut by the horizon with the same proportion beneath the horizon and above the horizon. And that tells you that they're the same height. You don't have to do any sort of computations.

**Dr. Campbell:** And then he had a lot of examples where you figured it out by moving your head.

**Dr. Shapiro:** Yes—parallax kinds of examples, where the intermediate object will move the opposite direction of your head, and the distant object will move the same direction as your head. It's kind of interesting.

**Dr. Campbell:** Well, I think we're kind of running out of time, so is there anything else you would like to talk about before we close?

**Dr. Shapiro:** I think we've covered a lot of interesting stuff. I'm happy to rest.

**Dr. Campbell:** You don't feel like I've left any big loose ends?

**Dr. Shapiro:** No, I don't think so. No. I've had a lot of fun chatting with you about this.

**Dr. Campbell:** Great! I've enjoyed it, also.

[music]

I want to thank Dr. Shapiro for taking the time to be our guest on the *Brain Science Podcast*. While his book, [Embodied Cognition](#), is not aimed at casual readers, it does give an excellent balanced introduction to embodied cognition. Obviously, it goes into much more detail than we could in our brief conversation.

I think it goes without saying that I think that the embodied cognition approach has a lot to offer. But I don't necessarily see it supplanting the traditional tools of cognitive science. I'm not convinced that the use of representation and computation can be totally abandoned. If you want to learn more about the traditional approach to cognitive science, I refer you back to [Episode 66](#) with Dr. Randy Gallistel.

In my introduction I did mention that there were several other episodes that do relate to today's discussion of embodiment. Thinking back on these older interviews, I am struck by the fact that embodiment is influencing the work in a wide variety of fields. Rolf Pfeifer, who I interviewed in [Episode 25](#), is working in the field of robotics and artificial intelligence; Art Glenberg, who was interviewed in [Episode 36](#), is a psychologist; and Alva Noë, who was featured in [Episode 58](#), is

a philosopher. So, I think it's clear that embodiment, and its implications for intelligence and cognition, is an important research approach that is influencing a wide range of areas within cognitive science and neuroscience.

Also, as Dr. Shapiro pointed out, it is important to the rest of us because it has implications for how we see ourselves as humans, how we regard other species, and how we relate to technology. Our brains are an essential part of who we are; but we are not just our brains.

Now for a few closing announcements: I want to remind you that if you go to [brainsciencepodcast.com](http://brainsciencepodcast.com) you will find detailed show notes for today's episode—including links to the other episodes that I mentioned, as well as free transcripts. You can also get episode transcripts on your [iPhone](#) or [Android](#) device if you buy the *Brain Science Podcast* app.

On the subject of money: I want to thank everyone who helps support my work with donations and by buying these apps. If you are interested in helping to support the *Brain Science Podcast*, just go to [brainsciencepodcast.com](http://brainsciencepodcast.com) and click on the tab at the top labeled '[Donations](#).' Your donations help to keep the podcast, the transcripts, and the website free.

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Now that the *Brain Science Podcast* is coming out every other month, I've had several listeners ask me to announce the upcoming books. The best way to keep up with what books are likely to be featured is to join our new Discussion Forum at [goodreads.com](http://goodreads.com). I took down the old forum, so you can get to this easily by

going to [brainscienceforum.com](http://brainscienceforum.com). Or, if you're already a member of goodreads, just search for 'brain science podcast' in goodreads.

Over the years, many of you have asked me to interview [Antonio Damasio](#); and I'm happy to report that he has finally agreed to come on the podcast to discuss his new book, [Self Comes to Mind](#). But his schedule is very tight, so it might be several more months before this actually becomes a reality. However, his new book is now available on [Audible](#), for those of you who like that format.

Meanwhile, don't forget to listen to my other podcast, [Books and Ideas](#). It's coming out in the months in between the *Brain Science Podcast*. And if you sign up for the free [Brain Science Podcast newsletter](#) you can automatically get show notes for every *Brain Science Podcast* episode, as well as announcements in between.

Finally, for those of you in the UK, I will be in London May 11<sup>th</sup> through 13<sup>th</sup> and I will be speaking at the Skeptics in the Pub on May 11<sup>th</sup>. You can get more details at their [website](#); or send me email at [docartemis@gmail.com](mailto:docartemis@gmail.com)—especially if you want to meet up somewhere else while I'm there.

If you're interested in hearing the live stream of my talk, make sure that you are following me on [Twitter](#)—where I'm Doc Artemis, of course—because that is where I will post the real-time links. I plan to post the information on the main [Brain Science Podcast](#) website, but since I'm going to be outside the United States, I'm not sure that it will be practical to do that in real time. I will also try to put the links on the *Brain Science Podcast* [fan page](#) on Facebook.

As always, I love to hear your feedback. It's hearing from you that keeps me going. You can send me feedback at [docartemis@gmail.com](mailto:docartemis@gmail.com), or leave voicemail at 205-202-0663.

Thanks again for listening. I look forward to talking with you again very soon.

[music]

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