**Your Brain on Metaphors**

By Michael Chorost

It sounds like a question that only a linguist could love. But neuroscientists have been trying to answer it using exotic brain-scanning technologies. Their findings have varied wildly, in some cases contradicting one another. If they make progress, the payoff will be big. Their findings will enrich a theory that aims to explain how wet masses of neurons can understand anything at all. And they may drive a stake into the widespread assumption that computers will inevitably become conscious in a humanlike way.

*The player kicked the ball.
The patient kicked the habit.
The villain kicked the bucket.*

*The verbs are the same.
The syntax is identical.
Does the brain notice, or care,
that the first is literal, the second
metaphorical, the third idiomatic?*

The hypothesis driving their work is that metaphor is central to language. Metaphor used to be thought of as merely poetic ornamentation, aesthetically pretty but otherwise irrelevant. "Love is a rose, but you better not pick it," sang Neil Young in 1977, riffing on the timeworn comparison between a sexual partner and a pollinating perennial. For centuries, metaphor was just the place where poets went to show off.

But in their 1980 book, *Metaphors We Live By,* the linguist George Lakoff (at the University of California at Berkeley) and the philosopher Mark Johnson (now at the University of Oregon) revolutionized linguistics by showing that metaphor is actually a fundamental constituent of language. For example, they showed that in the seemingly literal statement "He’s out of sight," the visual field is metaphorized as a container that holds things. The visual field isn’t really a container, of course; one simply sees objects or not. But the container metaphor is so ubiquitous that it wasn’t even recognized as a metaphor until Lakoff and Johnson pointed it out.

From such examples they argued that ordinary language is saturated with metaphors. Our eyes point to where we’re going, so we tend to speak of future time as being "ahead" of us. When things increase, they tend to go up relative to us, so we tend to speak of stocks "rising" instead of getting more expensive. "Our ordinary conceptual system is fundamentally metaphorical in nature," they wrote.

What’s emerging from these studies isn’t just a theory of language or of metaphor. It’s a nascent theory of consciousness.

Metaphors do differ across languages, but that doesn’t affect the theory. For example, in Aymara, spoken in Bolivia and Chile, speakers refer to past experiences as being in front of them, on the theory that past events are "visible" and future ones are not. However, the difference between behind and ahead is relatively unimportant compared with the central fact that space is being used as a metaphor for time. Lakoff argues that it is *impossible*—not just difficult, but impossible—for humans to talk about time and many other fundamental aspects of life without using metaphors to do it.

Lakoff and Johnson’s program is as anti-Platonic as it’s possible to get. It undermines the argument that human minds can reveal transcendent truths about reality in transparent language. They argue instead that human cognition is embodied—that human concepts are shaped by the physical features of human brains and bodies. "Our physiology provides the concepts for our philosophy," Lakoff wrote in his introduction to Benjamin Bergen’s 2012 book, *Louder Than Words: The New Science of How the Mind Makes Meaning.* Marianna Bolognesi, a linguist at the International Center for Intercultural Exchange, in Siena, Italy, puts it this way: "The classical view of cognition is that language is an independent system made with abstract symbols that work independently from our bodies. This view has been challenged by the embodied account of cognition which states that language is tightly connected to our experience. Our bodily experience."

Modern brain-scanning technologies make it possible to test such claims empirically. "That would make a connection between the biology of our bodies on the one hand, and thinking and meaning on the other hand," says Gerard Steen, a professor of linguistics at VU University Amsterdam. Neuroscientists have been stuffing volunteers into fMRI scanners and having them read sentences that are literal, metaphorical, and idiomatic.

Neuroscientists agree on what happens with literal sentences like "The player kicked the ball." The brain reacts as if it were carrying out the described actions. This is called "simulation." Take the sentence "Harry picked up the glass." "If you can’t imagine picking up a glass or seeing someone picking up a glass," Lakoff wrote in a paper with Vittorio Gallese, a professor of human physiology at the University of Parma, in Italy, "then you can’t understand that sentence." Lakoff argues that the brain understands sentences not just by analyzing syntax and looking up neural dictionaries, but also by igniting its memories of kicking and picking up.

But what about metaphorical sentences like "The patient kicked the habit"? An addiction can’t literally be struck with a foot. Does the brain simulate the action of kicking anyway? Or does it somehow automatically substitute a more literal verb, such as "stopped"? This is where functional MRI can help, because it can watch to see if the brain’s motor cortex lights up in areas related to the leg and foot.

The evidence says it does. "When you read action-related metaphors," says Valentina Cuccio, a philosophy postdoc at the University of Palermo, in Italy, "you have activation of the motor area of the brain." In a 2011 paper in the *Journal of Cognitive Neuroscience,* Rutvik Desai, an associate professor of psychology at the University of South Carolina, and his colleagues presented fMRI evidence that brains do in fact simulate metaphorical sentences that use action verbs. When reading both literal and metaphorical sentences, their subjects’ brains activated areas associated with control of action. "The understanding of sensory-motor metaphors is not abstracted away from their sensory-motor origins," the researchers concluded.

Textural metaphors, too, appear to be simulated. That is, the brain processes "She’s had a rough time" by simulating the sensation of touching something rough. Krish Sathian, a professor of neurology, rehabilitation medicine, and psychology at Emory University, says, "For textural metaphor, you would predict on the Lakoff and Johnson account that it would recruit activity- and texture-selective somatosensory cortex, and that indeed is exactly what we found."

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Nonetheless, the work supports a radically new conception of how a bunch of pulsing cells can understand anything at all. In a 2012 paper, Lakoff offered an account of how metaphors arise out of the physiology of neural firing, based on the work of a student of his, Srini Narayanan, who is now a faculty member at Berkeley. As children grow up, they are repeatedly exposed to basic experiences such as temperature and affection simultaneously when, for example, they are cuddled. The neural structures that record temperature and affection are repeatedly co-activated, leading to an increasingly strong neural linkage between them.

However, since the brain is always computing temperature but not always computing affection, the relationship between those neural structures is asymmetric. When they form a linkage, Lakoff says, "the one that spikes first and most regularly is going to get strengthened in its direction, and the other one is going to get weakened." Lakoff thinks the asymmetry gives rise to a metaphor: Affection is Warmth. Because of the neural asymmetry, it doesn’t go the other way around: Warmth is not Affection. Feeling warm during a 100-degree day, for example, does not make one feel loved. The metaphor originates from the asymmetry of the neural firing. Lakoff is now working on a book on the neural theory of metaphor.

If cognition is embodied, that raises problems for artificial intelligence. Since computers don’t have bodies, let alone sensations, what are the implications of these findings for their becoming conscious—that is, achieving strong AI? Lakoff is uncompromising: "It kills it." Of Ray Kurzweil’s singularity thesis, he says, "I don’t believe it for a second." Computers can run models of neural processes, he says, but absent bodily experience, those models will never actually be conscious.

On the other hand, roboticists such as Rodney Brooks, an emeritus professor at the Massachusetts Institute of Technology, have suggested that computers could be provided with bodies. For example, they could be given control of robots stuffed with sensors and actuators. Brooks pondered Lakoff’s ideas in his 2002 book, Flesh and Machines, and supposed, "For anything to develop the same sorts of conceptual understanding of the world as we do, it will have to develop the same sorts of metaphors, rooted in a body, that we humans do."

But Lera Boroditsky wonders if giving computers humanlike bodies would only reproduce human limitations. "If you’re not bound by limitations of memory, if you’re not bound by limitations of physical presence, I think you could build a very different kind of intelligence system," she says. "I don’t know why we have to replicate our physical limitations in other systems."

What’s emerging from these studies isn’t just a theory of language or of metaphor. It’s a nascent theory of consciousness. Any algorithmic system faces the problem of bootstrapping itself from computing to knowing, from bit-shuffling to caring. Igniting previously stored memories of bodily experiences seems to be one way of getting there. And so may be the ability to create asymmetric neural linkages that say this is like (but not identical to) that. In an age of brain scanning as well as poetry, that’s where metaphor gets you.

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