

Body of Thought

Fleeting sensations and body movements hold sway over what we feel and how we think

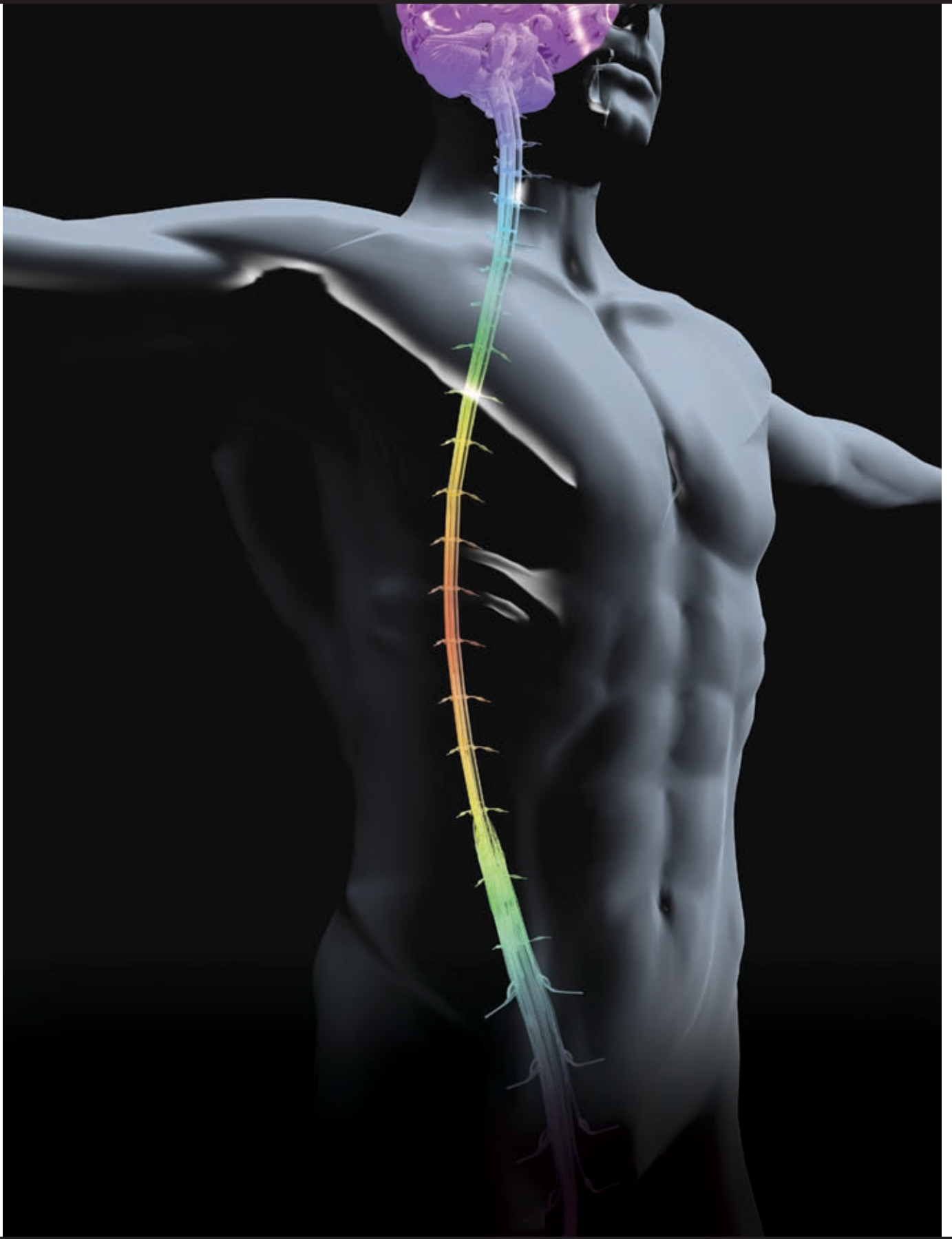
By Siri Carpenter

Why do we look *up* to those we respect, *stoop* to the level of those we disdain and think *warmly* about those we love? Why do we hide *dirty* secrets or *wash* our hands of worries? Why do we ponder *weighty* subjects and feel a load *lift* after we have made a decision? Why do we look *back* on the past and *forward* to the future?

Such turns of phrase, invoking a physical reality that stands in for intangible concepts, might seem like linguistic flights of fancy. But a rapidly growing body of research indicates that metaphors joining body and mind reflect a central fact about the way we think: the mind uses the body to make sense of abstract concepts. Thus, seemingly trivial sensations and actions—mimicking a smile or a frown, holding smooth or rough objects, nodding or giving a thumbs-up—can influence high-level psychological processes such as social judgment, language comprehension, visual perception and even reasoning about insubstantial notions such as time.

The implications seem almost preposterous.

Holding a warm cup of coffee will make me view others more warmly as well? Entering a Wind-scented room will bring out the Good Samaritan in me? Holding a heavy clipboard while responding to a survey will give the issues at hand more gravitas? As far-fetched as such sensory non sequiturs may seem, the evidence for “embodied” or “grounded” cognition is persuasive. “The empirical case is becoming increasingly overwhelming,” says psychologist Lawrence Barsalou of Emory University. “Cognition is emerging, to a significant extent, from all these things—like warmth, cleanliness and weight—that we used to think were irrelevant to cognition.”



AGE FOTOSTOCK



The way you sit or stand can affect how you think, feel and act. An expansive “power” pose leads to riskier decision making. Parking yourself in a hard chair can turn you into a tough negotiator.

Recent research suggests, for example, that the flexing of our facial muscles does not just reflect our emotions but is necessary for our experiencing them. Even less logically, our minds link morality to cleanliness, a connection that underscores just how desperately our processing of abstractions hangs on physical attributes. Even more jarring, people represent the concepts of past and future in a bodily code that includes direction of movement

FAST FACTS

Grasping Concepts

- 1**» The mind uses the body to make sense of abstract ideas. Thus, seemingly trivial sensations and actions—mimicking a smile, holding smooth or rough objects, nodding or giving a thumbs-up—can influence social judgment, language comprehension, visual perception and even reasoning.
- 2**» The flexing of our facial muscles does not just reflect our emotions but is necessary for our experiencing them.
- 3**» People represent the concepts of past and future in a bodily code that includes direction of movement and perception of space.
- 4**» We can now get a grasp of our own feelings and actions by looking beyond our minds to our bodies and the world around us. Such a perspective can point us toward actions that change the way we think and learn.

and perception of space. And our concept of space itself depends on mental simulations of the movements necessary to span that distance.

Such bizarre interactions imply that our brains do not really differentiate between our physical interface with the environment and high-level, abstract thought. The idea that the mind is anchored to the body’s actions and surroundings “gives us a much better way of trying to understand how people work—our social behavior, our emotional lives, our cognitive lives,” says psychologist Arthur Glenberg of Arizona State University. Indeed, armed with this new conception of how thought works, we can now get a grasp of our own feelings, opinions and actions by looking beyond our minds to our bodies and the world around us. Such a perspective can point us toward actions that change the way we think and learn.

Challenging Dogma

Since the 1960s most cognitive scientists have likened the neural machinery responsible for higher cognition to a freestanding computer, separate from the brain areas that are responsible for bodily sensation and action. According to this idea, the brain receives input about sights, smells, sounds, and so on from the body’s sensory and motor systems, but then converts those raw data into disembodied symbols and rules, in much the same way that a computer converts every piece of information—the color red, a photograph of your grandmother, the word “love”—into zeros and ones. On these symbols, stripped of their raw, physical origins, the brain performs the many complex calculations that we call thought.

Beginning in the late 1980s, however, a few scientists challenged the view that the body is just an input-output device for the brain. They suggested that instead, higher cognitive processes are grounded in bodily experience and in the neural systems that govern the body. In this view, the brain’s low-level sensory and motor circuits do not just feed into cognition; they *are* cognition.

Back then the idea had little scientific backing. “We were totally ridiculed—people didn’t take it seriously,” Barsalou recalls. But by the late 1990s the evidence started trickling—then pouring—in. Just in the past few years studies have shown that holding a hot cup of coffee or being in a comfortably heated room warms a person’s feelings toward strangers; that striking an open, expansive “power pose” prompts people to make bolder decisions; that wearing a heavy backpack makes hills look steeper; that a water bottle looks closer when you

are thirsty; that moving objects upward versus downward speeds recall for positive versus negative memories; and that sitting on a hard chair turns mild-mannered undergraduates into hard-headed negotiators.

That the mind relies heavily on the body for information should not be surprising. After all, the body is our only real tether to the world—all the knowledge you acquire, you get through your senses. Close ties between the body and thought make sense from an evolutionary perspective, too. Over millions of years many cognitive scientists believe, our increasingly powerful cognitive abilities piggy-backed on existing neural systems that evolved for simpler, physical tasks such as visual detection or spatial navigation.

According to this view, thinking is reliving: I cannot reflect on last summer's trip to the Grand Canyon without recruiting some of the same brain cells that recorded the sight of its majestically striped walls. I cannot process the plot of a novel without simulating the sensations the text describes nor judge the height of the hill ahead of me without mentally climbing it. "The brain simulates real experience in order to make sense of the world," Barsalou says.

Facial Feedback

Anyone who has sweated a job interview or clenched a fist in anger knows that living an emotional experience is a physiological event. This phenomenon is reflected in the idioms we call on



An injection of Botox that paralyzes the muscles needed for frowning can also jam the neural circuits responsible for processing negative emotions, making sad and angry sentences harder to understand.

Results of a now classic study led by psychologist Fritz Strack, now at the University of Würzburg in Germany, show that the simple act of making a facial expression affects both how we feel and how we interpret emotional information. Strack and his colleagues found that people rated *Far Side* cartoons as funnier when they were holding a pen between their teeth, without allowing it to touch their lips (a pose that activates muscles used for smiling), than when they were holding a pen between their lips (which prevents smiling). Those findings indicate that the face sends important

Words that evoke disgust stimulated increased activity in the muscles that curl the upper lip and wrinkle the nose.

to describe our feelings: your heart sinks, your stomach flips, you jump for joy, you are mad enough to spit nails. "Emotional states are associated with a tendency to action," says psychologist Paula Niedenthal of Blaise Pascal University in France. As a result, people do not say, "I was so mad that I just ... sat there."

In addition to the physiological systems that regulate heart rate, sweating and body movement, the triggering of emotions involves the activation of at least some of the 20 or so muscles of the face that control emotional expression. That fact raises the question of how that peripheral physiology affects thought: Can merely changing the configuration of a person's facial muscles affect how that person thinks about emotion?

feedback to the brain, which it then uses to interpret information about the world.

Many researchers, including Niedenthal, believe that the brain cannot fully think about emotion without reenacting, or physically simulating, that feeling. In a 2009 study she and her colleagues used electromyography to measure facial muscle activity and found that reading emotional words while considering their meaning triggered the same subtle muscle activity that people show when expe-

(The Author)

SIRI CARPENTER is a freelance science journalist specializing in behavioral science topics. She holds a Ph.D. in social psychology from Yale University and lives in Madison, Wis.



side whether that is an experience I want to seek out or avoid. Otherwise, how could I know?”

What happens when people’s ability to simulate specific emotional expressions is blocked? In 2009 neurologist Bernhard Haslinger and his colleagues at the Munich University of Technology gave participants Botox injections to the forehead, temporarily paralyzing the muscle that is responsible for frowning. The treatment muted activity in the amygdala, a key emotion center, while participants were attempting to mimic unhappy expressions but not when they were mimicking happy faces. The results suggest that by thwarting muscle activity, Botox treatment somehow jammed the neural circuits needed to fully process negative emotion. A 2010 study led by Glenberg and University of Wisconsin–Madison graduate student David Havas bolsters that conclusion, showing that participants who underwent Botox treatment for frown lines were subsequently slower to comprehend sad and angry sentences but not happy ones.

Clean Hands, Pure Heart

The body plays an equally important role in reasoning about abstractions. Consider, for example, the link between physical cleanliness and moral purity—the relation that Shakespeare’s Lady Macbeth felt so desperately as she tried to scrub away her sins. In a 2006 study psychologists Chen-Bo Zhong of the University of Toronto and Katie Liljenquist of Northwestern University gave research participants the same opportunity (though under less murderous circumstances). They first asked participants to recall doing ethical or unethical deeds, then gave them an ostensibly unrelated word-completion task. Those who had remembered unethical behavior were more likely than those who had summoned up ethical behavior to generate cleansing-related words such as “wash” and “soap,” rather than words such as “wish” and “step.” In a follow-up experiment, 75 percent of people who had recalled unethical deeds later selected an antiseptic wipe (rather than a pencil) as a parting gift, compared with only 37.5 percent of people who had brought to mind ethical deeds.

On the face of it, that the human psyche would tie physical cleanliness and moral purity defies logic—any rational person knows that a bar of soap will not absolve wrongdoing. Yet clearly, the bond runs deep. Water-purification rituals, for example, are a part of most of the world’s major religions. Zhong and Liljenquist speculate that the connection may stem in part from a basic cognitive need to root abstract qualities in bodily experience and in

Our minds tie physical cleanliness to moral purity. The link shows up in our speech: we “wash away our sins” and “keep dirty secrets.” But this visceral connection to morality is embedded deep within our psyches.

riencing those emotions. Words that typically evoke disgust, such as “vomit” and “foul,” stimulated increased activity in the facial muscles involved in curling the upper lip, wrinkling the nose and frowning the brow. Words that connote anger, such as “murder” and “enraged,” also provoked activity in the muscle that furrows the brow. And words that connote joy, such as “smile” and “delighted,” set off the muscles responsible for raising the cheeks and crinkling the eyes into a smile.

In other words, the researchers concluded, when people reasoned about emotional concepts it caused them to simulate a bodily experience of the emotion, evidence that the reasoning and the muscle activity are linked. “If someone asks me to go see a scary movie,” Niedenthal says, “I can reexperience the feeling of fear I have had while watching such movies and de-

ANDREA BRICCO Corbis

part from an evolved disgust toward unclean foods. That primal disgust, some researchers believe, has expanded to take on broader cultural meanings, so that moral violations pose the same kind of threat as physical impurity.

The presence of that connection is obvious in the language we use to describe moral violations—we speak of keeping dirty secrets and yearning for a clean conscience. Our language further suggests that moral cognition is tightly bound to the specif-

lands and his colleagues found that the same left-right association infiltrates not only our visual spatial sense but also our hearing. In the study participants donned headphones and heard time-related words such as “yesterday” and “tomorrow,” along with neutral words such as “identical” and “closet.” The experimenters told them to report whether each word presented was louder in their left or their right ear. When words were presented equally loudly to both ears, listeners nonetheless perceived past-

People rated hand sanitizer highly after lying via e-mail; mouthwash got higher scores after a voicemail fib.

ic body parts responsible for ethical transgression—say, the mouth for swearing or the hands for groping. “In natural language, when people swear, we say they have a dirty mouth,” observes Spike (Wing Sing) Lee, a psychology graduate student at the University of Michigan at Ann Arbor. “If someone steals something, we might say that they have sticky fingers.”

The specificity of such sayings led Lee and psychologist Norbert Schwarz, also at Ann Arbor, to wonder whether people actually project immoral behavior onto specific body parts. In a 2010 study they asked research participants to role-play a scenario that required them to tell a malevolent lie using either voicemail or e-mail, then rate the desirability of several consumer products. Lee and Schwarz found that people rated hand sanitizer more highly after lying via e-mail rather than voicemail and rated mouthwash more highly after lying via voicemail rather than e-mail. Thus, people did seem to make a subconscious, nonverbal connection between a part of their body and the specific type of unsavory deed.

Just as moral reasoning rests, however illogically, on bodily sensation and action, so does our concept of time. In a 2010 study using motion sensors to detect tiny movements, psychologist Lynden Miles of the University of Aberdeen in Scotland and his colleagues found that thinking about the past caused people to sway about two millimeters backward, whereas thinking about the future caused them to sway imperceptibly forward.

Other research reveals that people think of time as occupying physical space, with the past on the left and the future on the right, a finding consistent with the fact that people in Western cultures write from left to right. In a 2010 study psychologist Gün Semin of the University of Utrecht in the Nether-

related words as louder in the left ear and future-related words as louder in the right ear.

The idea that we process time as flowing from left to right with our ears as well as our eyes is “mind-blowing,” Semin says. “On the surface, there is no reason for this to happen.” Yet, he speculates, the cultural experience of writing from left to right somehow changes our brain architecture, so that the brain represents the past in its right hemisphere, which takes input from the left eye, ear and side of the body, and the future in its left half, which interprets sensory stimuli from the right half of the physical world.

Taking Measure

Even basic visual perception is susceptible to the whims of the body. In a 2008 study, for example, psychologists Dennis Proffitt of the University of Virginia and Jessica Witt of Purdue University found that participants judged out-of-reach objects

Even the concept of time has a physical presence in our thoughts. It moves from the past, on our left, to the future on our right.



to be closer when they were told they would be able to use a 39-centimeter conductor's baton to reach the objects, compared with participants who had no baton.

Why would simply having a tool with which to reach objects make the objects seem closer? Proffitt argues that when you view an action and your in-

To test whether judging distance actually requires that people simulate the act of spanning that distance, in a second experiment Proffitt and Witt gave participants a baton for reaching out-of-range objects but asked half to squeeze a rubber ball with their reaching hand while making their distance judgments. Results showed that the ball squeezers

Could surrounding ourselves with smooth and soft textures help smooth our personal relationships?

attention is to reach for it, the extent of your body's reach is your "action boundary"—the limit of your potential action. Having a tool that extends your reach allows you to mentally simulate using that tool for reaching. This causes your action boundary to shift, making you perceive the target as closer. "The only measuring stick that we really have is the body, so what we do, measuring the environment, is to use our bodies," Proffitt says.

perceived the objects as farther away than did those without a ball, indicating that compressing the ball had interfered with their ability to mentally simulate a different action—reaching.

Acting Out

If bodily states infiltrate cognition so often, why are we so seldom aware of this phenomenon? How is it possible that the temperature of a room could

Having a tool that enables us to nab out-of-reach objects makes the objects seem closer. We estimate distance by our ability to span it using our bodies or extensions of them.



KARIN SMEDS Getty Images

affect how I feel about my companions, or that the hardness of my chair could affect my negotiating ability, or that a disgusting smell could provoke me to behave immorally, all without my knowledge? Sometimes our physical sensations and movements are probably too fleeting or trivial for us to notice their effect on our mental lives. Other times, our failure to recognize the connection between our bodily experiences and our thought processes may arise from the simple fact that it seems preposterous. If I have to perch on a hard chair for a salary negotiation, I may be uncomfortable, but I am unlikely to pay much attention to my discomfort, focused as I am on negotiating. Under those circumstances, if I drive a hard bargain, I am unlikely to credit the chair.

But the weight and expanse of data on embodied cognition suggest that making subtle adjustments to our actions or our physical environments could yield big rewards. Yale University psychologist John Bargh and his colleagues' research shows, for example, that rough textures tend to make social interactions seem rough, too, and that touching hard objects leads us to judge others as more rigid. Could surrounding ourselves with smooth and soft textures help smooth our personal relationships? If I choose to have hot coffee rather than a Coke with a new acquaintance, will I end up feeling more warmly about that person? Will spritzing my home with clean, pure fragrances help me meet my charitable ideals? Embodied cognition theories indicate that such environmental adjustments, along with related attention to the ways in which we hold or shift our bodies, can make a surprising difference in our mental and emotional lives.

Embodied cognition might also have important implications for education. Gesturing while doing math problems helps children learn and retain what they have learned [see "Hands in the Air," by Susan Goldin-Meadow; *SCIENTIFIC AMERICAN MIND*, September/October 2010]. Physical action is equally valuable for children learning to read. In a number of recent studies, Glenberg and his colleagues have shown that elementary school children who, while reading, manipulate toys or pictures on a computer screen to simulate the action in what they are reading demonstrate better reading comprehension and more vocabulary growth.

Building on those findings, Glenberg's team has further learned that simulating action helps kids solve math story problems more efficiently. In one scenario, children read a story problem involving a robot's movements and were asked to calculate the total number of steps the robot took. The catch was



that the text also provided irrelevant numerical information, such as the number of people the robot greeted. The study found that children who were instructed to physically manipulate images on a computer screen to mimic the robot's actions were better able to ignore the irrelevant information. What is more, after learning the physical-manipulation procedure, children got the same benefits just by imagining how they would move images to simulate the action in the story—a technique that may be more practical in classrooms, which are likely to lack props to match every story.

"The idea that language comprehension requires simulation is something that is not taught," Glenberg says. "We're counting on children to make this leap from the written word to the simulation, but some children are not making that leap—they're just saying words." Teaching children to simulate action while reading, he says, may give those who are struggling the boost they need to keep up with their peers. "In my fondest dreams," Glenberg adds, "I see teaching a large number of people to read as my real contribution." **M**

The temperature of what you drink could influence your social interactions. Clutching a cup of hot coffee makes you feel more warmly about the people around you than does holding a cold beverage.

(Further Reading)

- ◆ **Embodying Emotion.** Paula Niedenthal in *Science*, Vol. 316, pages 1002–1005; 2007.
- ◆ **Grounded Cognition.** Lawrence Barsalou in *Annual Review of Psychology*, Vol. 59, pages 617–645; 2008.
- ◆ **Embodiment as a Unifying Perspective for Psychology.** Thomas Schubert and Gün Semin in *European Journal of Social Psychology*, Vol. 39, pages 1135–1141; 2009.
- ◆ **Embodiment as a Unifying Perspective for Psychology.** Arthur Glenberg in *Wiley Interdisciplinary Reviews: Cognitive Science*, Vol. 1, pages 586–596; 2010.