Let your body do the thinking

So much for abstract thought – even high-concept thinking may be rooted in our physical selves

Anil Ananthaswamy

"I THINK therefore I am," said Descartes. Perhaps he should have added: "I act, therefore I think."

Our ability to think has long been considered central to what makes us human. Now research suggests that our bodies and their relationship with the environment govern even our most abstract thoughts. This includes thinking up random numbers or deciding whether to recount positive or negative experiences.

"Advocates of traditional accounts of cognition would be surprised," says Tobias Loetscher at the University of Melbourne in Parkville, Australia. "They generally consider human reasoning to involve abstract cognitive processes devoid of any connection to body or space."

Until recently, the assumption has been that our bodies contribute only to our most basic interactions with the environment, namely sensory and motor processes. The new results suggest that our bodies are also exploited to produce abstract thought, and that even seemingly inconsequential activities have the power to influence our thinking.

Clues that our bodies may play a role in thought can be found in the metaphors we use to describe situations, such as "I was given the cold shoulder" or "she has an excellent grasp of relativity".

Thirty years ago, such observations led the linguist and philosopher George Lakoff at the University of California, Berkeley, together with philosopher Mark Johnson at the University of Oregon in Eugene, to propose "metaphor theory", the notion that we think of abstract concepts in terms of how our bodies function. Now evidence for the theory has started to trickle in. In 2008, for example, researchers found that people made to feel socially excluded reported feeling physically colder.

Now, Loetscher and his colleagues have linked our ability to think of random numbers – an example of abstract thought – to bodily movements.

His team asked 12 right-handed men to generate a string of 40 numbers, each between 1 and 30, in as random a sequence as possible. The researchers recorded the vertical and horizontal movements of the men's eyes as they spoke the numbers out loud to the beat of a metronome.

The team found that the eye movements could be used to predict the size of the next number before it was spoken. If a volunteer looked left and downwards, he would typically chose a number that was smaller than the previous number, and if he looked up and to the right, he chose a number that was larger (*Current Biology*, DOI:10.1016/j.cub.2010.01.015). What's more, the extent to which he looked in a particular direction correlated with the extent to which the number was larger or smaller than the last. The result strongly suggests that abstract thought is tied to the physical movements of our bodies, says Loetscher.

But why would two seemingly unconnected things – apparently inconsequential eye movements and random numbers – be connected? Lakoff, who calls Loetscher's experiment a "particularly beautiful example" of embodied cognition, says it is to do with how our ability to think develops during childhood.

STEPHEN SIMPSON/IMAGE BANK

Lakoff reckons that the volunteers are making use of two sets of metaphors for imagining numbers: that up is more and down is less, and that right is more and left is less. Such metaphors would have been learned and hard-wired into the brain at a young age. A child watching a glass of water being filled up, or building blocks piled up, will learn that increasing height means greater quantity, for example. Separate brain regions that process quantity and height could then have been linked up in the growing brain, he says, leading to a hard-wired understanding of the metaphor that up is more. Similarly, right-handed people may learn to link right with more because that hand is dominant for them.

"We map our moods onto a vertical, spatial schema, with the good end 'up' and the bad end 'down'"

What's not clear from Loetscher's experiment, however, is if eye movements are driving the number selection, or if the number selection triggers particular eye movements.

To probe whether movements can drive thought, Daniel Casasanto of the Max Planck Institute for Psycholinguistics in Nijmegen, the Netherlands,

WILL THINKING MACHINES NEED BODIES?

If our ability for abstract thought is closely tied to our physical selves (see main story), will intelligent machines also need bodies?

It is a question that is being investigated. Roboticist Josh Bongard at the University of Vermont in Burlington says that the physical bodies of robots and the way that they interact with the environment might be key to creating the capability for intelligent, abstract thought. For a start, Cynthia Breazeal at the Massachusetts Institute of Technology and her team has already created anthropomorphic robots that use knowledge of their own bodies to infer the mental states of humans.

The development of such robots can also further the study of embodied cognition – the idea that even abstract thoughts are rooted in the physical world, says Bongard. "Robots provide a unique perspective on embodied cognition because we can perturb any part of a robot – its body or its brain – and observe the impact on behaviour. This is something that is usually not possible with animals or people."

But Kevin Gold of Wellesley College in Massachusetts is more circumspect about whether machines that think will need bodies. He argues that machines endowed with mathematical models of reasoning and abstract thinking – but not bodies – might still be highly intelligent. "It's still an open question whether we need to cleave closely to human cognition to make human-level intelligence," he says.

turned to the metaphors that we use to speak of our moods. "We can hardly help mapping them onto a vertical, spatial schema, with the good end 'up' and the bad end 'down'," says Casasanto. "We talk of being high on life, or our mood taking an upswing, or feeling down in the dumps."

His team asked 24 students to move marbles from a box on a higher shelf to one on a lower shelf, or vice-versa, while talking about events that had positive or negative emotional significance – such as a time when they were proud or ashamed of themselves.

As it turns out, the students were significantly faster at retrieving and retelling stories that chimed with the metaphor implied by their actions. So if they were moving marbles upwards, they were faster at retelling stories with positive emotional content than those linked to negative emotions, and vice versa (*Cognition*, DOI: 10.1016/j.cognition.2009.11.002).

The results also led to a deeper question: does physical movement have the power to change not just the speed at which people talk, but also what they choose to talk – or even think – about? Casasanto's next experiment found that it does.

As the students were moving the marbles either up or down, they were asked neutral questions, such as "tell me what happened yesterday". In this task, the subjects were more likely to talk of positive happenings when they were moving marbles upwards, and narrate negative stories when moving marbles downwards. "Isn't that somewhat scary?" Casasanto asks.

If bodily motions really are driving our thoughts, Casasanto reasoned that people who use their bodies differently should have different thoughts. To test this, he turned to left-handed people. He asked 286 students, 40 of whom were left-handers, to make judgements about cartoon characters called Fribbles. A page contained 12 pairs of Fribbles and members of each pair looked similar but had distinguishing features. In each pair one member was located to the right and the other to the left of a question.

The questions asked students to circle one of each pair based on their judgement of its personal characteristics, such as honesty, happiness, intelligence and attractiveness. They were either worded positively (which Fribble is the most attractive) or negatively (which Fribble looks less attractive).

"They would talk positively when moving marbles upwards, but negatively when moving them down"

The researchers found that 210 students showed a leftward or rightward preference and, of these, 65 per cent of the left-handers attributed positive attributes more often to the Fribbles on the left, while 54 per cent of the right-handers saw positive attributes in Fribbles to the right (*Journal of Experimental Psychology*, DOI: 10.1037/a0015854). "Righties think right is good, and lefties think left is good," Casasanto concludes.

This bias towards ascribing positive virtues to our dominant side may also be reflected in sayings such as "my right-hand man", or "two left feet", which may have arisen because most people are right-handed.

If the inherent characteristics of our bodies are responsible for our abstract thoughts – what does that mean for bodies that are drastically different to our own?

Lakoff says that if intelligent aliens exist, they may have very different bodies and therefore have developed very different abstract thought – even perhaps a different mathematical system. "People assume that mathematics is objective and that everybody will have the same math," says Lakoff. "But there is no reason to believe that." ■