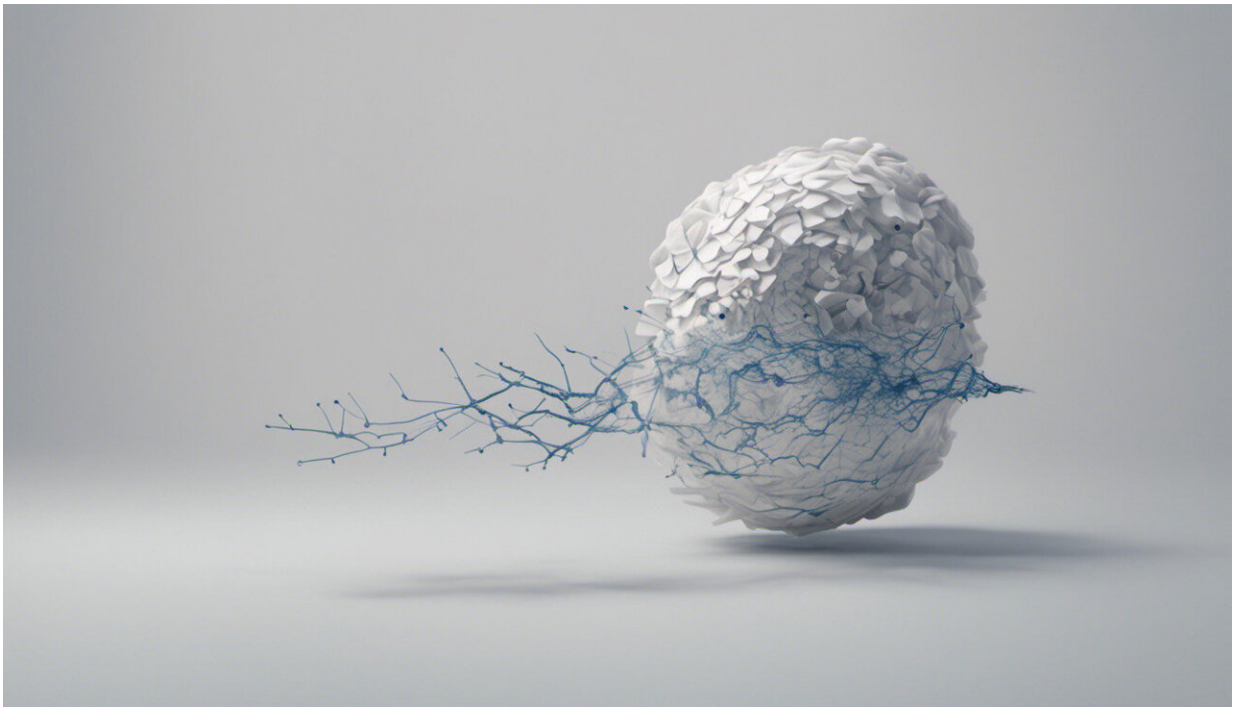
Why the best problem-solvers think with their hands, as well as their heads

November 10 2016, by Gaëlle Vallée-Tourangeau And Frédéric Vallée-Tourangeau



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During a lab meeting, one of our PhD researchers recalls how her father would forbid her from using paper to help solve maths homework problems by writing them down. Another admits that she sometimes still uses her hands to make small calculations, although she does so while

hiding them behind her back. When we realise that all of us use our fingers in order to answer demands for the "third, fifth, and seventh digits" of our secret online banking password, we laugh in relief. We are not so daft after all, or at least we are not alone.

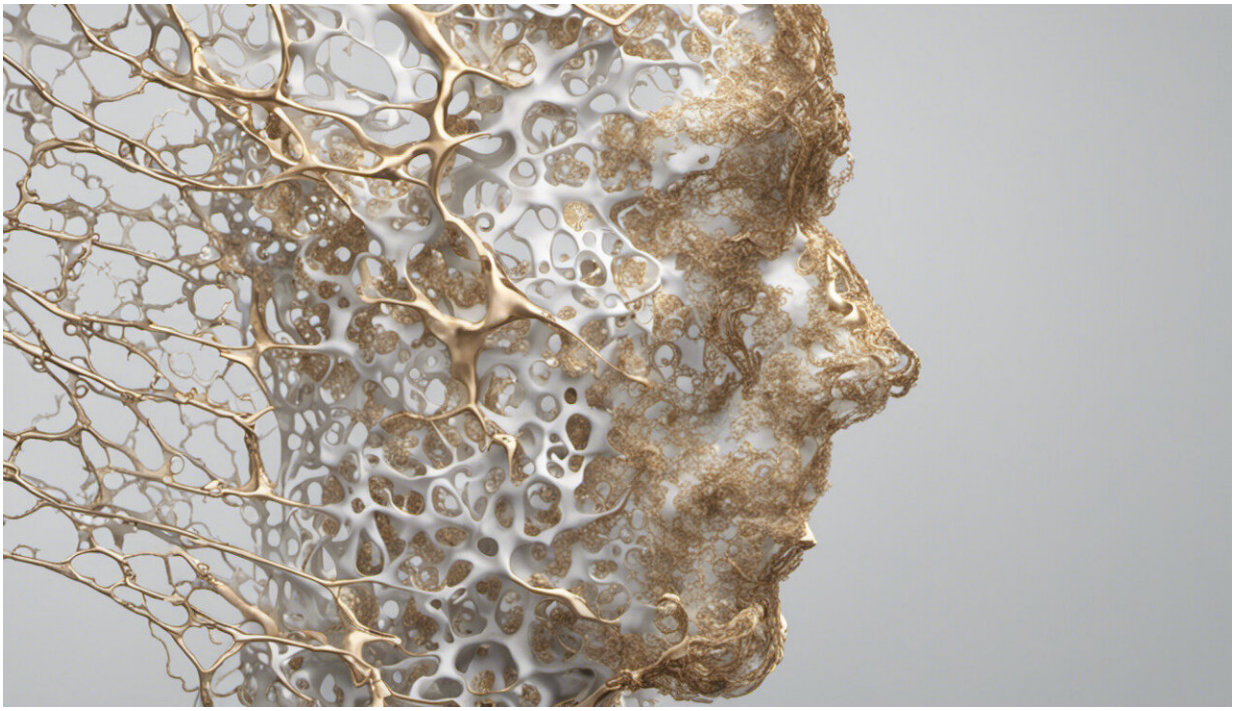
Our ability to think and reason has been trained and tested in real world situations that restrict our ability to use our hands. At school, children quickly learn to count "in their heads", without using their fingers as props. At university, we ask our students to take "closed-book" exams, relying only on that information committed to memory. Job applicants take intelligence tests during which their interaction with the world is limited to a tick-box (or computer key-press) to mark their selected answers. The implicit assumption that underpins these practices is that truly intelligent behaviour originates from the inner parts of the brain, and the brain alone.

Of course educators are well aware that props are a great help in teaching young children to reason with numbers and solve problems. Likewise, neuropsychologists use props to assess memory loss in the elderly. In other words, it's acceptable to engage with the material world to support your thinking if your mental abilities are still developing or if you are losing your cognitive powers. For the rest of us, however, it's seen as a sign of cognitive weakness.

It is this view we aim to challenge, rejecting the metaphor of mind as computer according to which thoughts ultimately emerge from the brain's processing of information from the outside world. The insidious consequence of this metaphor is that it implies that simulating a situation in your head while you think is equivalent to living through that situation while you think. In both cases, your answer will depend only on how (well) your brain processes the information.

Our research strongly challenges this assumption. We show instead that

people's thoughts, choices and insights can be transformed by physical interaction with things. In other words, thinking with your brain alone – like a computer does – is not equivalent to thinking with your brain, your eyes, and your hands – as humans frequently do.



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The mind in the world

In the course of problem solving, we naturally tend to recruit artefacts and manipulate them to augment and transform our ability to think and to explain ourselves. Consider a game of Scrabble: players naturally touch, move and re-arrange the tiles they receive. If thinking were simply done "in the head", what's the purpose of these moves?

In fact, these moves are integral to the process of generating words. As players reconfigure the physical properties of their environment, they are not simply making it easier for them to think; they *are thinking*. Moves can be deliberate or serendipitous. This suggests that thinking is fundamentally relational: it unfolds along a series of physical changes in the environment that at times affects, and at times is affected by, a series of biological changes in the brain.

To put this to the test, we design thinking tasks under laboratory conditions during which people can physically interact with the properties of the problem. Interactivity inevitably benefits performance. In part this is because changes in the physical environment makes it easier for people to remember what information they are considering. But also dynamically changing the problem's configuration prompts new possibilities for action, or unveils new ways of solving problems. People are more creative and more efficient when solving problems with their hands: thinking is an embodied activity embedded in a physical environment.

We recently applied this approach to a study of creativity and insight. While posing a problem presented using a classic pencil and paper format never led to a breakthrough, those who could use physical artefacts to build a model of the problem were much more likely to reach some insight, no matter the difference between the partipants' cognitive abilities.

We also applied this approach to the study of complex statistical reasoning. Previous research had found that, depending on the ease of mentally representing the statistical information presented, between 11% and 40% of people succeeded in solving these reasoning problems using just pen and paper.

We presented the same information on a pack of cards which reasoners

were free to spread out and rearrange in any way they like. Not all participants fully engaged with the cards – perhaps unwilling to be judged as poor thinkers for doing so. Yet the success rate for those who made the most of this opportunity to use the material world to boost their thinking leapt to a 75% success rate.

So next time your child counts using her fingers, or you see your employees spread out information over their desk and walls, be reassured: they are not limited in their capacity to think well, nor are they handicapping their ability to do so. In fact, they are enhancing their ability to think. Your mind does not think like a computer, it thinks with the objects (including computers) and people around you. And our capacity to think and reason well at any given moment depends as much on our cognitive abilities as it does on the richness – or paucity – of material things with which to support our thinking and decision-making.

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