Tacit knowledge: you don't know how much you know

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TAKE a long look at the *Mona Lisa*. How do you see her? As blobs of paint or as a woman with an enigmatic smile? Now explain how you came to see those blobs of paint as a smile. For your second mission, think back to learning to form sentences. Your parents never told you "verb in the middle" (if you're English) or "verb at the end" (if you're German) but still you picked it up. And, more remarkable, once you did, have you any idea how come this sentence breaks the rules but read it you still can?

These abilities demonstrate what's known as "tacit knowledge" - something as big and taken for granted as "air", "thought", or "language". Take away tacit knowledge and the human world disappears. Without it, what we think of as knowledge, the "stuff" contained in our books and intellectual artefacts, would make no sense and be no more than noise. The big question is whether, or how far, this tacit knowledge can be made explicit.

The term was coined in the 1950s by the British-Hungarian physical chemist and philosopher, Michael Polanyi. In that era of enormous optimism about what physics and mathematics could achieve, it seemed only a matter of time before science formalised everything. This was to pave the way for computers to acquire all human abilities and run everything. Polanyi wanted to show there was more to scientific creativity than this and argued there was always something unspoken, even at the heart of the exact sciences. His most famous example was riding a bicycle: we can do it but without quite knowing how.

To find a space for his idea, Polanyi made tacit knowledge seem more mysterious than it is. Now we know science is not perfectible we do not have to fight so hard to retain a conceptual space for that which cannot be done by logic and mathematics. This means we can take a calmer look at tacit knowledge and remove some of the mystery.

There are three reasons this is important. First, as part of a project to map what we know about knowledge. Second, to understand in general how the transmission of knowledge and education works. And third, to understand the possibilities and limits of intelligent machines, and where we must either make a breakthrough or abandon our dreams.

Tacit knowledge is knowledge that is not and sometimes cannot be made explicit. In my new book, *Tacit and Explicit Knowledge*, I argue that it comes in three very different kinds, which overlap in daily life. To appreciate some of the difficulties in capturing the idea, consider Polanyi's bicycle-riding example.

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In *The Logic of Tacit Inference*, Polanyi argues persuasively that humans do not know how they ride, but he also provides a formula: "In order to compensate for a given angle of imbalance α we must take a curve on the side of the imbalance, of which the radius (*r*) should be proportionate to the square of the velocity (*v*) over the imbalance $r \sim v^2/\alpha$."

Riding a bike requires a complex mix of different kinds of tacit knowledge

While no human can actually ride a bike using that formula, a robot, with much faster reactions, might. So that aspect of bike-riding is not quite so tacit after all.

That we humans do much of what we do without following explicit rules is no more mysterious than my cat hunting without knowing rules about hunting or a tree growing without knowing rules about forming leaves. We only think it's mysterious if we think explicitness is the norm, but explicitness is a rare thing, restricted to humans, and used only now and again because it is often more efficient to allow causal, neural connections in the brain and body to execute an action with little (or, indeed, no) conscious calculation - after all, cats do pretty well this way. And if you think too hard about how you walk, you may well fall over!

I call this, cat-like, brain-and-body kind of tacit knowledge "somatic tacit knowledge": it is knowledge stored in the muscles, nerve pathways, and synaptic connections. In principle, if not in practice, science could describe all of it. We still wouldn't be able to use it to guide our actions in a self-conscious way because we aren't built for that.

Tacit knowledge can also be "relational". This is the least mysterious as it concerns solely social relations and logistics. With relational tacit knowledge, information could be fully known, exchanged and used, but isn't for contingent reasons. On the edge of this category are secrets, things you might find out by the usual means of acquiring tacit knowledge, "hanging around" with people who have it even if they won't tell you directly.

More impenetrable are things that you cannot explain because you don't know what the other party needs to know. If I am trying to explain how to build a Transversely Excited Atmospheric Pressure CO_2 laser (TEA laser), I may not tell you that the inductance of the top lead is important because I assume you already know it. It is impossible to resolve this kind of problem simply by telling you "everything" you might need to know because "everything" is an open-ended category and the only alternative is to have a faultless picture of what's already in your head and what is not - again, impossible.

Finally, you may not know what you need to know and I may not know what I know. Thus, in the early days of TEA lasers scientists did not necessarily know that the inductance of the top lead was important but by copying existing designs they built in successful short top leads without knowing why. The bottom line is any piece of relational tacit knowledge could be made explicit but logistics prevent it all being made explicit at once. Relational tacit knowledge will also always be with us.

The one real mystery left lies in collective tacit knowledge. This is mysterious because we can't describe it and we don't know in detail how we acquire it. It is mysterious because we can only "borrow it": it is not our property but is social and collective. Take language. What constitutes our constantly changing natural language is not up to any individual, it is a matter of where the collective of language speakers takes it.

This is also why Polanyi missed the full complexity of bike-riding. To balance on a bike we need somatic tacit knowledge, but to ride it in traffic we need collective tacit knowledge. Only by understanding the unspoken conventions of traffic (which vary hugely from place to place, time to time, culture to culture) can you ride in safety. These are impossible to describe in moment-to-moment detail and are unknowable to any entity but humans.

Going back to language, think about what you make sense of when people speak: they mumble, break all the rules of grammar, slur words and so on. This is what stops us having fault-free speech-recognition software on our computers. We humans do huge amounts of "repair work" using a complex and mysterious grasp of "meaning" in order to turn the spoken word into the written. And for "To be or not to be" to represent more than just a haphazard string of words, we must "borrow" rich layers of meaning from our collective history through mechanisms that are not clear to us.

Just as I think there could never be a fully automated editor of my books, I also think the limits to intelligent machines and automation will lie in a much better understanding of tacit knowledge - and especially of collective tacit knowledge. Our human interaction and social life (rather than the mere possession of the bodies once thought necessary for computers/robots to become intelligent) may provide a fundamental limit to the indefinite extension of machine intelligence.

Profile

Harry Collins is at the school of social sciences at Cardiff University, UK. His books include *The Golem* with Trevor Pinch (Cambridge University Press). This essay is based on *Tacit and Explicit Knowledge* (University of Chicago Press), which is part of the Cardiff group's project on expertise (www.cf.ac.uk/socsi/expertise)