MARTIN COHEN

Wittgenstein's Beetle

and Other Classic Thought Experiments

Blackwell Publishing

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I do not want to give the impression that the use of large machines or of elaborate techniques is always justified; sometimes it contributes merely to the sense of self-importance of the investigator, and it is always salutary to remember Rutherford's 'We haven't got the the money, so we've got to think!'

R. V. Jones in the *Bulletin of the Institute of Physics* (1962)
recalling the dictum of Ernest Rutherford

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Forward!

This book is a collection of the 26 most interesting, if not the most useful, thought experiments (although some have indeed been very useful). It is no exaggeration to say that the whole of modern science is built upon the surprisingly modest foundations of half a dozen of the thought experiments included here. They are no more elementary, say, than Einstein's Theory of Relativity, or more complicated than, say, Sherlock Holmes at his most lucid. And in fact, in this collection, science, or natural philosophy, features more prominently than other sorts of philosophy. I make no apologies for that. (Well, maybe a small one.) But too often people have been turned away from science and mathematics and left to pursue interests in other areas denied, as it were, the appropriate equipment for their study. And equally, too many scientists – cosmologists, biologists, theoretical physicists – attempt to make sense of their hard data without the soft tools of philosophy: reflection and imagination. In the language of the writer and scientist, C. P. Snow, the two tribes need to share the same hut, otherwise one lot will get fat and lazy, and the others will freeze to death in the cold. (Which group will suffer which fate he does not say, but I like to think it is the philosophers who are getting fat and lazy.) Certainly blind science is merely technical happenstance, and ungrounded philosophy becomes another religion, something that speaks only of personal belief.

And this book is a history of a very powerful but still mysterious technique used by the great thinkers, philosophers and scientists for thousands of years. A history of theories about the world around us. Thought experiments are that special kind of theory that predicts particular consequences given certain initial starting points and conditions. Like experiments in the laboratory, they are tests devised either to explore intuitions about how the world works – or to destroy them. Actually, many real experiments are more open than that,

from the 'randomly mix two chemicals together' variety favoured in poorly supervised chemistry classes to the unanticipated by-product of very serious but uninspired work. But there is nothing to say thought experiments cannot be similarly opportunistic. The characteristic thing about both real and thought experiments is that you control and limit the circumstances and conditions for the test, so as to pick out just one variable or one unknown. The key difference is that in the latter, everything is set out not in reality but merely in the imagination. The circumstances are described, not created, and the action is imagined, not witnessed. Still, in a strange sort of way, the thought experimenter is just as much a witness (in a well-constructed thought experiment) as any laboratory scientist. As one of the great thought experimenters (Plato) put it – people are put into the peculiar position of discovering things that seemed to have been there all the time, unrecognized or forgotten, in thoughts buried most deeply in the most mysterious recesses of the mind.

What will even the most diligent and attentive readers know at the end of the A–Z? Assuredly not how the universe works, nor even how to transfer brains between two people, let alone what to do if they were trapped in a trolley underground – with Hitler – about to run over either one famous writer or twenty 'Indians' . . . but perhaps they *will* know how to begin to frame such questions, and how to use a different way of thinking to come up with some different answers and certainly many new questions. Perhaps by the end, they will feel that they have cast off the shackles of the Cave (see experiment F) and rediscovered the remarkable power of the human mind. Perhaps, as is claimed for us by Roger-Pol Droit in experiment Q, the world will never be the same again.

On the other hand, perhaps it is time to stop talking about it and instead start thought experimenting. The reader is invited right here to jump straight into the experiments proper, and savour some of the excitement of conducting tests in the laboratory of the mind (as it has sometimes been put). The Introduction, 'Deep Thought' – essentially a brief history of the technique – may be left for later. But for those of a linear frame of mind, and for sure (whatever Edward de Bono might recommend) thought experiments, like all experiments, are necessarily conducted that way, it provides some additional background and ideas.

But for those of us with non-linear, downright disorderedly minds, an equally acceptable thing is to pick up the book and just read the odd experiment every now and then, preferably leaving a moment's pause between the description and the discussion. Because thought experimentation is about imagination, and harnessing its anarchic power in the service of understanding.

Introduction

Deep Thought: a brief history of thought experiments

On the face of it, thought experiments are a useful way to gain new knowledge about the world, by means of 'armchair philosophy' only. And, whether they are called thought experiments or not, the approach has had an important role in not only theoretical philosophy, but in practical science over the centuries.

The ancient Greeks particularly liked to explore using the technique. Not that they had no concept of more conventional experimentation too. Empedocles (495–435 BCE), who wisely divided the world between two forces, 'love' and 'strife', also founded one of the first medical schools, from which source a fragment of writing records a very practical investigation of the circulatory system. But Heraclitus (c.500 BCE), who liked to write in riddling epithets like the famous one about it being impossible to step into the same river twice, decided that as 'all is flux', it is ultimately by the power of the mind, which can contemplate 'what is not', rather than by senses forever limited to examining merely what is, that the truly important things can be found.

Ptolemy (87–150 CE), the inspiration of future mathematicians and geometers, as well as geographers and cosmologists, describes his homely view of the universe in the first book of the *Almagest*, and gives various arguments that sit somewhere between 'thought experiments' and real experiments. In particular, Ptolemy argues that since all bodies fall to the centre of the universe, the Earth must be fixed there at the centre, otherwise falling objects would not be seen to drop towards the centre of the Earth. Now his listeners could at this point have conducted their own 'real' experiments but it was clearly enough to reflect on their own underlying assumptions of

reality to agree with Ptolemy. Only the fact that the first assumption is rather a big (and rather a dubious) one stands between them and true knowledge, a fact that is certainly a reminder of the dangers of the thought experiment technique. But then again, it is also a reminder of the dangers of the 'thoughtless' experiment technique too. It was not the lack of testing that was a problem with Ptolemy's theory; it was the assumptions underlying it.

Another of Ptolemy's experiments is designed to show that the Earth must not only be at the centre of the universe, but completely motionless – steady as a rock – too. To do this, Ptolemy asks us to consider the fact that that if the Earth moved, as some earlier philosophers had suggested, then certain bizarre consequences would have to follow. In particular, if the Earth rotated once every 24 hours, was it not intuitively obvious that an object thrown vertically upwards would not fall back to the same place, but would fall back slightly to one side?

Ptolemy's record is not encouraging, but then his experiments were not truly thought ones. For Plato, as for Heraclitus, those wishing to understand phenomena in the natural world should recognize that experience of events is a poor guide. Plato's dialogues are littered (for want of a kinder term) with thought experiments. Alongside Gyges with his magic ring exploring the nature of morality is the 'mad friend' hunting for his knife; elsewhere there is Plato himself conducting the (less well known) 'breeding experiment' in which he advances the case for eugenics for the good of society; and over there is the much repeated but little agreed upon metaphor of the prisoners in the cave, that seems to be telling us something about the nature of knowledge. Less often appreciated, but still very influential, is that the entire process of the development of society outlined in the *Republic* is actually a carefully crafted thought experiment, built on the assumption that people will not be content with all the fruits of nature – but will want to eat meat, leading to a struggle for land and resources.

But it is in Plato's account of Socrates leading the slave boy, Meno, to develop the Pythagorean principle that new knowledge appears to emerge from introspection in the best manner of the technique. Many of the Ancients valued such 'pure' knowledge, quintessentially mathematical, more highly than any that relied on actually going out and looking at real things, and the notion of 'truths' waiting to be discovered by contemplation is appropriately sometimes dubbed 'Platonist'. Thought experimenters are his fellow travellers.

Even Aristotle, who like a certain kind of scientist usually maintained the supremacy of observation, tried one or two thought experiments. In his *Metaphysics* (Book VII, iii) for instance, he offers