Significance

There are two kinds of significance in science: statistical significance and conceptual significance. With the growth of computers, it is now much easier to carry out experiments and to calculate the data to assess statistical significance. This satisfies the career need to publish a large number of acceptable papers, and looks like ‘productivity’—but is it? How much does a lot of statistically significant experiments advance science? After all, only some related events or trends or phenomena have significant interest. If the number of oranges grown in California correlates highly with the birth rate in a Welsh village, this is hardly a promising start or interesting conclusion for a PhD. However strong the statistical significance, some conceptual significance is needed for attracting interest.

As computers are not noted for their thinking ability, knowledgeable intelligent humans are needed for assessing conceptual significance. It is up to us to think what an experiment means. Of course, we consider our own and our colleagues’ findings; but thinking is a slow and difficult business, and, however hard-won, conclusions of years of thinking may be dismissed as mere ‘opinions’—so it is easier, and it often pays, to go for many statistically reliable experiments even if they do look pointless. Yet, aren’t significant concepts the main point and excitement of science?

Isn’t it conceptual issues that dilate our pupils and expand the minds of our student pupils? This is only so for those who have caught the bug of science. Unfortunately, it applies hardly at all to the public. No doubt, the public want more efficient and cheaper vacuum cleaners, and why not? But how do such products of science compare with the power of concepts of science—appreciating how we evolved; where stars come from; how brains work; why we have consciousness—to make living exciting?

Surely the too widespread public distrust of science comes in large part from just what makes science worthwhile for scientists, who (in spite of such low salaries that old vacuum cleaners are hard to replace) see its uncertainties and disagreements as life-enhancing. In short: the controversies of conceptual significance which make science look unreliable to the public, are just what makes it so interesting for scientists. For the astronomer, it really matters that Continual Creation lost the argument against the Big Bang view of the creation and development of the universe. For the brain scientist, it really matters whether the brain is analogue or digital. And just remember the decade-long heat of battle over the significance of Fourier theories of vision. Here statistical significance of experiments was taken for granted; but they were far from sufficient to arouse interest, or charge debate with the excitement of the controversy of those years. Yet this, surely, is what breathes life into science—meanings of observations and experiments. When these are controversial, we get switched on and become creative.

Of course, other things matter to scientists as to everyone else. A clean house is a pleasure, but puzzles of the vacuum of space (whatever happened to the Aether now that space is again supposed not to be empty?) are much more exciting. Pleasures of many kinds are what life seems to be about, but for science we are happy to forego many obvious pleasures to seek significance—conceptual significance. Statistically reliable experiments are a means to this, but they can be horrifiedly misleading without considered conceptual significance.

The important point of statistical significance is to give convincing surprise, such that minds are changed. The greater the surprise, the more, in its technical sense,
is the information it provides. Although statistical significance is necessary for attracting scientific attention, even the most surprising ‘findings’ have little point, without a basis of prior opinions or beliefs. And when assumptions and implications are not clearly stated, the experiment can be even more misleading than when the data are false.

If the reader follows me so far (or has been ahead all the time), he or she might like to take a further step, to ask: What do people coming into science get from lectures, textbooks, and practical classes? What do writers aim for, and readers expect, of science books for those who lack the time for questions or answers to have conceptual point? My hunch is that résumés of experimental results (with warnings of where they may be statistically unreliable) are fine for readers already primed with conceptual understanding; but are disappointing for those who expect direct access to Truth from experimental results, however striking and compelling they may appear. For, conceptual significance of any observation depends on knowledge and assumptions—which always, with enough ingenuity, might be questioned and turn out to be incorrect. Shouldn’t we ask: Do teachers give sufficient help for students to see significance in phenomena and results of experiments? Isn’t living with concepts important for schools and universities? Shouldn’t teachers at least aim towards conceptual significance, even for quite young children, and invite students to play conceptual games for interpreting data and phenomena?

We are fortunate in having writers such as Dan Dennett and Richard Dawkins who spend their productive lives on conceptual significance, and who write so well they attract many readers, including students. Dennett and Dawkins are not as much concerned with statistical significance (which comes to be taken for granted) as with what it means to say, for example, that Charles Darwin got our origins right, or that Benjamin Levit demoted consciousness to a useless chimera. Surely, how data lead to conclusions is just as important as how data are checked for reliability.

Let’s look at Benjamin Levit’s claim that brain activity initiating a movement, of say the hand, precedes awareness of the movement, suggesting that consciousness is not causal, so free will is a delusion.

The statistical result is not in doubt. But is the conceptual conclusion, that subjective consciousness lags behind physical brain activity, justified by these intriguing experiments? We must look at what they involve. Levit got his subjects to look passively at a dot moving quite fast around a clock face. The subjects (of course, many were needed to ensure statistical significance!) were asked to move a hand spontaneously at any moment, while watching the moving dot. A subject was not allowed to respond to some predetermined position of the dot, for it must be a spontaneous movement, so to say ‘from within’, and not a response to a stimulus. This is not a familiar reaction-time experiment, so must be considered differently. Each subject was asked to remember where the dot had been at the moment, as he remembers, he willed the movement. It turned out that the memory of the dot position corresponded to a time about 500 milliseconds after the remembered initiation of the hand movement. So the brain acts before consciousness. So consciousness cannot be causal. So free will is a delusion. Or is it?

This is, to Levit’s great credit, an unusual situation demanding special consideration. The claim demands strong reasons for believing it, as it goes against our preconceptions and challenges pet beliefs. Statistical significance is necessary to arrive at this even as a question; but it is naïve to suppose that it, or indeed any experiment, directly provides an answer. One has to think with special care of the assumptions behind this unusual experimental situation, with its remarkable claim. This is what the few philosophers—such as Dan Dennett, Pat and Paul Churchland, and Sue Blackmore, who are versed in the necessary knowledge—to our great gain do. Of course, some brain scientists are in this league. They are truly and nobly experimental philosophers, taking time from their
experimental work to look beyond statistical to conceptual significance, to give point and purpose to experiments.

Presumably it is because Levit’s conclusions violate common sense—denying conscious control of our destinies—that these experiments have received unusual philosophical attention. Their conceptual significance as originally conceived is neatly summarised by the neuroscientist Susan Pockett (2002):

> “These conclusions are important to consciousness researchers precisely because they seem to deny to consciousness any major role in our day-to-day affairs. If we cannot become conscious of external stimuli until half a second after they happen, then even mildly fast reaction to a stimulus has to be unconsciously generated. Worse, not only are reactions necessarily unconscious, but even proactive or ‘voluntary’ actions must be unconsciously generated. So if consciousness is important at all, it can only be in the generation of long-term plans, which are then carried out unconsciously” (page 144)

A distinguished physicist has even suggested that, in the light of these experiments, time may need to be reconsidered. If brain and perception studies illuminate physics—fine—especially as all physics depends on the senses for observations, and brains to make sense of them. Time would not even be a mystery without our various interests and abilities to question and seek answers. Effective debates between ‘objective’ physics and ‘subjective’ psychology must be of special interest both to the physical sciences and to psychology.

But conceptual thinking is hard work, and few of us are trained for it or can find the time. Isn’t essay writing, with individual challenge by enthusiastic and not overworked teachers, essential in universities for creating effective experimental philosophers? Doesn’t the present emphasis on exams suggest, wrongly, that simple unambiguous answers are given by experiments? For descriptions of experiments are easy to trot out in exams and quick to mark, while following the conceptual worlds of students (however important) is tortuous and can be torturing.

Thinking on the Levit experiment reveals that neither the memory of the positions of the dot nor the memory of initiating the hand movement are in clock time. What is reported, is relative remembered times for motor initiation and vision. This raises many possibilities, and casts doubts on the original claim that the motor acts precede conscious initiation. It could be that the brain needs time to compare these memories, perhaps switching from one to the other. Perhaps it is necessary to ‘wait for the ink to dry’ to make the comparison (cf Dennett 2003). Does this comparison across brain processes suggest a divided self—the motor and visual brains being separate, needing time to cross-communicate?

There are many other possibilities that allow this experimental result without implying that brain activity precedes consciousness of willed movement, so not demonstrating backwards or no causation from consciousness. The situation is very different from that of the EEG Expectancy Wave discovered by Grey Walker, as this is in clock time, and is ‘objective’. Though showing that special brain activity precedes planned action, it makes no claim for the timing of consciousness.

We owe to Benjamin Levit a very intriguing discovery which undoubtedly has significance. But as usual, this is not given directly by the experiment. Its significance must be found, by difficult, generally unfamiliar, but very important work: switching the computer off—thinking.

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