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Detached Observer – an Anachronism?

The Scientific Method After Next

by Dave Stein

Like the religions and creation myths that predate it, contemporary science provides a framework for attempting to understand the universe. Replacing religious dogma with a new consensus-based scientific authority that is grounded in repeatable experiment and observation, it is itself based on a protocol that we know as the scientific method.

Contemporary scientific protocol is based, among other things, on the notion of the "detached observer" or experimenter, who is separate from – and impartial to – that which is observed. In this sense, it is reductionistic. In other ways, too, science generally attempts to understand the whole in terms of the parts. A classic illustration is the notion of "action-at-a-distance" that underpins the inverse square law equations for gravitational force and electrostatic force.

However, scientific advances are now calling into question the notion of the detached observer. Actually, it is not always the advances themselves that are new; instead, their impacts are now becoming more understood and may well be pervasive in next-generation science. For example, since the advent of quantum mechanics, it has been more readily apparent that the process of observing or measuring something influences the outcome. In a rough sense, this is because the mass-energies used to make the measurements are comparable to the mass-energies of that which is being measured.[1] But the mechanism of influence does not stop here. The act of choosing the experiment itself influences the outcome. Case in point: an electron can manifest as a particle or as a wave, depending on how one chooses to observe it. One can argue that this applies in the social sciences and other walks of life as well, since the answer to a question is often influenced by the way in which the question is framed. So, just how "detached" is the observer or principal investigator?

QUANTUM ENTANGLEMENT – THE END OF REDUCTIONISM?

More generally, the notion of separateness or reductionism itself may need to be re-addressed – specifically, in the context of the Einstein-Podolsky-Rosen paradox and "gedanken experiment" first proposed in 1935 and performed years later by Alain Aspect (1982). As commonly interpreted, the

[1] As a macroscopic analogy, consider using a thermometer with a bulb the size of a basketball to measure the temperature of water in a bathtub. Unless the thermometer bulb and the bathtub water are at thermal equilibrium at the outset, the very immersion of the large bulb into the water itself changes the water's temperature, the "accuracy" of the thermometer notwithstanding.

results of this experiment challenge the reductionistic notion of "action-at-a-distance," as this would require a superluminal signal that violates special relativity. Instead, the results suggest an interconnectedness or "quantum entanglement" that seemingly permits "instantaneous communication" among the particles involved without requiring the forbidden superluminal signal. But the term "communication" (as commonly understood) is a misnomer, and if the particles involved in the experiment are indeed quantum entangled, then how "separate" are they? To a number of physicists, the results of this experiment point to a larger "system" whose properties depend on its entirety and are beyond analysis in terms of its components. If so, how scalable is this notion of larger system, and with what implications to reductionist-based scientific frameworks?

THIS FAR – AND NO FURTHER

Compounding this challenge are the limitations inherent in science and mathematics, and now perhaps even in their foundational deductive logic – limitations that scientists themselves have been among the first to acknowledge. They have long known that science, itself a means to understand the universe, at best only describes and predicts; it does not "explain" except in terms of consistency with other accepted observations and facts. At some point, it rests on fundamental axioms and postulates that are beyond deductive proof and accepted "on faith." To many who ponder this matter, it is self-evident. However, fundamental limits to axiomatic mathematical systems and deductive reasoning are captured in Gödel's theorem. According to mathematician Kurt Gödel, the consistency of a finite mathematical system is provable only at a level external to itself, and this in turn argues against the completeness of the system.[2] This inherently limits what can be known or expressed in terms of a finite system of axioms. Thus, at some point, it's back to "faith" again. In this sense, science differs from religion only in the level of consensus involved.

Today, however, science is now "proving" its own limitations with new discoveries and continual reinterpretations of old ones – even going back as far as Thomas Young's double slit experiment in 1802 and the notion of counterfactuality[3] that emerged from it, a notion with possible implications to logic and to scientific experimentation. For its part, the Heisenberg uncertainty principle[4] supports the contention by some physicists that uncertainty and inconsistency are basic to nature and that beyond a certain point, nature is unknowable in the objective scientific sense. If true, this has profound implications for the predictive capability of science.

Now throw in quantum logic, in which the "law of the excluded middle" (i.e., that everything must be "true" or "false") no longer rigorously applies. Taken to the extreme, this challenges the notion of binary "either-or" thinking.

THE SOCIAL AND CULTURAL CONFLUENCE

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[2] (Actually, this is one of his theorems.) In 1931, mathematician Kurt Gödel proved that no axiomatic mathematical system can prove its own consistency and completeness through deductive reasoning. In fact, it has been argued that paradoxes or pseudo-paradoxes – for example, the legendary barber who shaves himself "if and only if he does ***not*** shave himself" – are inevitable consequences of finite axiomatic systems.

[3] Counterfactuality can be regarded as the effect, on an observable outcome, ***of the mere existence or potentiality*** of an alternative that did not actually occur. Macroscopic analogy – imagine that you are driving from point A to point B and can choose from among several possible routes. Even if your vehicle is the only one on the road at the time (such that traffic volume is not a factor), the existence of routes that you do not choose influences your experience of the route that you do choose! The implications of the double slit experiment, and of the more elaborate experiments that followed it, continue to be subjects of study.

[4] The Heisenberg uncertainty principle prohibits ***simultaneous*** knowledge of two ***conjugate*** quantities – e.g., position and momentum (mass multiplied by velocity) for the same coordinate – with arbitrary precision.

Although the limitations of detachment, reductionism, and science itself may herald profound changes in the scientific method (albeit not immediately), social and cultural factors may well magnify the impacts of these limitations. With the increased interaction among the cultures of the world – for example, via travel, communications, commerce, and education (including self-development) – there is an increased cross-flow of ideas, philosophies, and perspectives among peoples, cultures, and regions. In comparison with cultures generally characterized as "Western," Asian cultures are generally more holistic and less reductionistic in their approach to nearly everything including philosophy, religion, medicine, business relationships, and even warfare. This is underscored by the fact that in contrast with the individualism that characterizes the United States and parts of Europe, Asian cultures tend to be more group and personal relationship oriented. A confluence of Asian cultural influences and advances in particle physics may pave the way for a scientific method that is less reductionistic than the present one, and in fact the term "particle" itself has a reductionistic connotation.

Futures studies and the organizations that enable and support them might well be a third player in this confluence. By their very nature, futures studies are holistic and interdisciplinary as they examine the cross-cutting implications of technology advances, social trends, and policy decisions.

Another impetus is the continual quest for answers, for understanding – and with it, increased interest in personal experience. Although many regard science as a rebellion against religious dogma and the authority of religious establishments, it substituted its own authority, scientific consensus, for the authority that it sought to supplant. In doing this, it has tended to marginalize and even repress the role of personal experience, especially experience that cannot be replicated under controlled conditions. Like many religions, especially the "revealed religions," contemporary science is consensus-based. However, in the coming years, it is reasonable to expect increased interest in personal experience at the individual level, especially as people seek answers that are seemingly beyond both contemporary science and mainstream religion.

This does not necessarily herald a return to creation myths that "explain" that which is beyond objective knowledge, to be experienced only at the personal or subjective level. Interestingly, however, physicists as eminent as Stephen Hawking have suggested that a thorough understanding of the "Big Bang," the modern scientific counterpart to ancient creation myths, might be forever beyond our reach. Once again, "this far and no further." Meanwhile, the anthropic principle[5] reverberates, in essence reminding us that it is not only our choices of what to measure or observe that limit us; indeed, the universe cannot be known to us in a scientific sense independently of human measurements or observations. This again begs the question, albeit at an even more fundamental level that is beyond our present purposes, "What is a detached observer?"

NOT THE FINAL FRONTIER

In the meantime, science marches ever forward, joining forces with other fields of study in ways that sometimes lead to new areas of investigation. Case in point: research on "physics of consciousness," where one can envision that the role of personal experience will only be magnified. This may present an interesting dilemma for peer-reviewed journals (already facing other challenges) – as such journals are grounded in "objective," consensus-based science and repeatable results, and generally they are not designed to accommodate anecdotal evidence, at least not outside of large statistically-significant population samples.

One can even be sure that there will be scientific advances that are not yet envisioned. Like many scientific laws and findings before them, the Heisenberg uncertainty principle, quantum logic,

[5] As often expressed, "The universe is as it is, because otherwise we would not be here to notice."

counterfactuality, and even Gödel's theorem may themselves be overturned someday, as scientific principles, laws, and discoveries are rarely final. As scientists continually push back the so-called frontiers of ignorance, "this far and no further" itself recedes with time. It would be premature to characterize the new scientific method that will emerge from the seeming irreconcilability of personal experience and the entangled observer with the scientific method and consensus-based science. Equally premature would be speculation on the remaining "tenure" of the scientific method as we presently know it. Less disputable is the growing possibility for substantial changes in scientific protocol.

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