

In the production of knowledge, does it matter that observation is an essential but flawed tool? Discuss with reference to the natural sciences and one other area of knowledge.

Word count: 1593

Observation is a primary route through which we build knowledge in both natural and human sciences. By making preliminary observations, detecting patterns, forming hypotheses, and testing them, humans have reached previously inconceivable scientific milestones. Yet, as essential as observation is, it is flawed. To understand the prompt, we must first distinguish what "essential" and "flawed" signify in practice. Observation is essential because, without it, neither the empirical method nor any systematic inquiry into the world could function. However, it is flawed because human senses have their limits, instruments can be mis-calibrated or misread, and interpretations are inevitably shaped by expectations and bias. However, the nature of these flaws differs across disciplines. In physics, observation is primarily instrument-mediated: knowledge is produced largely through the interpretation of quantitative instrument readings, grounded in mathematical modeling. In psychology, observation can take the form of unaided sense perception through qualitative behavioral studies, or indirect quantification through tools like questionnaires, largely because psychological concepts are more abstract and harder to quantify reliably. If observation is essential but unreliable in these fundamentally different ways, does that undermine knowledge, or does it shape and progress knowledge productively? In this

essay, it is argued that the inherent flaws of observation are important, but rather than making knowledge unattainable, they define how knowledge is produced. Flaws force different disciplines to develop error-control methods, refine concepts, and set clear limits on certainty. To explore this, Galileo's findings and the double-split experiment will be used to examine observation in the natural sciences, while the Hawthorne effect and perceived stress scales in psychology will ground the discussion in the human sciences.

Physics, at its core, builds its understanding of the physical world through systematic, instrument-mediated observation. Unlike unaided sense perception, knowledge in physics is produced largely through the interpretation of instrument readings grounded in mathematical models, a process that expects observational error. Physics is built from the ground up to respond to observational limitations with refinement rather than rejection, meaning flawed observation is often the mechanism through which this area of knowledge advances.

The framework through which knowledge in physics has progressed is exemplified by the trajectory of advances in Astronomy, starting with Galileo Galilei. His contribution to astronomy was methodological: he introduced systematic, evidence-based inquiry to a field previously dominated by philosophical speculation. However, the poor optical quality of his telescope led him to misidentify Saturn's rings as a "triple system" in 1610. This flaw Christiaan Huygens corrected in 1655 using a far stronger telescope (Cajori, 1929). The development of knowledge did not stop there. Issac Newton, building on Galileo's observational and dynamical foundations, developed calculus as a tool precise enough to describe the motion that Galileo could only approximate. Newton's "Principia" then derived Kepler's laws of planetary motion from a single law of universal gravitation (Longair, 2001), knowledge that would have been impossible

without the flawed, iterative observations that preceded it. Each step was made possible because flaws were identified and used as a starting point, the basis of the scientific method. The implication is that in physics, observation error functions as the basis of new research; each acknowledged flaw becomes an invitation to the next observer, meaning the process is inherently self-correcting and cumulative.

However, not all observational flaws in physics are contingent errors that better instruments or more rigorous methodology can resolve. The double-slit experiment, first conceived by Thomas Young in the early 1800s, exposes a different kind of limitation. When photons are fired at a barrier with two slits unobserved, they produce a wave-like interference pattern on the detection screen. The moment a measuring device is introduced, that pattern collapses entirely, and the particles behave as individual objects (Dunning, 2023). The flaw in this case is irreducible and not due to imperfect equipment, as in the case of Galileo. Observation itself disturbs the observed system, meaning that the very fact of trying to know changes what there is to know. This poses a challenge to the idea that observation being flawed is a stepping stone to new knowledge. If the ceiling of certainty is structural rather than technical, it poses the question: has observation not become fundamentally untrustworthy as a tool for knowledge production? Yet even this “flaw” proved to be vital to the production of new knowledge, for instance, in the development of the Heisenberg Uncertainty Principle, formulated in 1927. Knowledge from the double split gave physics a precise mathematical framework for variance, and this framework has shaped the modern understanding of chemistry, cryptography, and many other fields (Hilgevoord and Uffink, 2024). Therefore, even when observational flaws cannot be corrected, acknowledging and formalising them produces new and valid knowledge, even if it requires that the definition of certainty be revised. This example implies that it does not matter

that observation is flawed, because the specific nature of that flaw determined the shape of an entirely new branch of physics, quantum mechanics. However, the fact that observational flaws exist and are important does not undermine the creation of new knowledge; it defines what knowledge in this domain means.

In the human sciences, observation takes a fundamentally different form to that seen in physics. Observation in psychology often involves watching and interpreting human behaviour directly, or collecting data indirectly through tools such as questionnaires and self-report scales. Both these methods are flawed, as they are prone to biased interpretation or measure abstract concepts that can not yet be quantified. This distinction matters because the flaws that emerge are interpretive rather than technical. Therefore, the same question needs to be asked: does it matter that observation is flawed, or does the discipline absorb and correct for those flaws productively?

A well-documented example of this is the Hawthorne effect, a concept in psychology describing the tendency of individuals to modify their behaviour when they are aware of being observed. Named after a series of studies conducted at the Hawthorne Works factory in the 1920s and 1930s, the effect highlights a flaw unique to the human sciences: a human participant is aware of the experimental context, and that awareness itself contaminates the data. However, the identification of this flaw proved generative. Psychologists developed methodological responses, including blind and double-blind experimental designs, where participants and sometimes researchers are kept unaware of key aspects of the study, specifically to neutralise reactive behaviour. The flaw, once named, became a design constraint that improved the reliability of psychological knowledge broadly. The real-world implication of this is direct: clinical trials,

pharmaceutical testing, and behavioural studies now routinely employ double-blind designs as a standard of rigour (Nikolopoulou, 2022), a methodological norm that would not exist without the prior identification of observational bias. On this basis, it does not matter that the observation is flawed. However, it is worth noting that the Hawthorne effect itself has since failed to replicate reliably (Shepard, 1971), reminding us that in psychology, corrections to methodology can remain subject to interpretive uncertainty, much like the original findings.

The deeper problem in psychology is fundamental to the area of study; the concepts are often abstract, subjective, and conceptually contested in a way that has no direct equivalent in physics. Stress, for instance, cannot be observed in a quantifiable and objective way at present. Personally, using the Perceived Stress Scale in a research project on stress and academic performance brought this limitation into focus. The PSS, developed by Sheldon Cohen in 1983, asks respondents to rate how overwhelmed they have felt over the past month, an inherently subjective self-observation method, as questions can be interpreted differently depending on cultural background, personal threshold, and social desirability bias, where respondents may under- or over-report stress to appear a certain way. Psychologists, aware of this, have attempted to quantify stress using physiological markers such as cortisol concentration in the blood, which correlates with perceived stress more objectively. Yet even cortisol does not map cleanly onto subjective experience; it fluctuates with physical activity, sleep, and time of day, meaning it captures a biological signal rather than the lived construct of stress itself (Sanogo, 2024). Here, the flaw is in the nature of what is being measured, and this does matter. The real-world consequences of this are tangible: In clinical or research settings, two clinicians using different instruments may diagnose the same patient differently, as the conclusion depends as much on the tool as on the patient. Observational flaws here do not set a hard mathematical

ceiling as in physics; they set a ceiling on construct validity, on how confidently any single observation can claim to capture the object it promises to measure. Psychology does not abandon inquiry; however, it remains explicit about the limits of each method and focuses on reproducibility.

In conclusion, across both natural and human sciences, observational flaws have been structurally necessary to the production of knowledge. To answer the question of whether it matters if observation is a flawed tool: in natural sciences, specifically physics, observation error is quantifiable, quantum variance, and the uncertainty principle allow precise definitions of what can and cannot be known, building knowledge productively within those limits. In human sciences, specifically psychology, what is being measured itself can be contested, making observation flaws inseparable from conceptual uncertainty. Observation is inseparable from interpretation, and interpretation happens to be inseparable from the construct itself. In physics, observation sets mathematically bounded limits that drive theory forward; in psychology, it sets limits on construct validity that modern methodology has not been able to pass. In both cases, the confrontation with imperfect observation is what makes the knowledge more reliable and creates new avenues for research and new knowledge.

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