Finding the Art in Science—
An Exploration into the Role of Subjectivity and Imagination in Science

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In many discussions, science has been portrayed as the antithesis of art. Science is the *veritas*, the truth of the natural world. When facts are needed to support arguments, we turn to science, as the objectivity of this established field is beyond the contamination by subjective values and beliefs. It is simply the cold hard truth. On the other hand, what is deemed hindrance in science illuminates the artistic landscape. Human emotions dictate the value of art, which is its ability to touch its audience in a multitude of ways—subjective ways, which opens up to a variety of interpretations.

Such is the opinion of many. But in truth, while the subjectivity of art is well recognized, the objectivity of science remains open to question. Members of the field have each expressed markedly different views towards the issue. While Nobel Laureate Salvador Luria (1912–1991) voiced his support of the affirmative, Nathan Sivin (1931–), the professor emeritus at the University of Pennsylvania, has argued for the contrary.

In his autobiography *A Slot Machine, A Broken Test Tube*, Luria argued for the objectivity of science through a lack of uniqueness in scientific discoveries. In his own words, "[i]f a discovery is not made by X it will be made by Y" (161). There is indeed some truth in his statement. Although Watson and Crick were the ones to come up with the double helix structure of DNA, Luria doubts that they are only one capable of arriving at the same result. The scientific community simply had the right tools, and the right talent for the discovery. Caltech's Linus Pauling, a Nobel Laureate and a "scientific superstar" by Watson's description, not only discovered the α-helix in polypeptides, he also suggested the sugar-phosphate backbone and the importance of hydrogen bonds in the integrity of DNA (Watson 123, 129). Pauling was a mere step away. Rosalind Franklin, a brilliant X-ray crystallographer, even came up with the exact photos that led to Watson and Crick's final answer (129). If it was not Watson and Crick's DNA double helix, it would be someone else's double helix, but the point is the result would still be a double helix. If the contents of a buried chest are fixed, only the identity of its discoverer can change. Such is the objectivity of science, neither Franklin's denial of a helical structure nor Pauling's three-chain model could overturn the truth (129).

This lack of unique knowledge is different to art. If a scientific discovery is likened to the unearthing of contents in a sealed chest, the production of art is best described as the choosing of the contents to put into the chest—it depends on the individual. As elegantly put by Luria, unlike the discovery of DNA structure, "[i]f Michelangelo had not sculpted the Pietà, [it] would not exist" (161). In essence, the objectivity of science stems from discoveries of objective truths, and the subjectivity of art arises from the manifestation of subjective experiences.

Sivin, on the other hand, had other thoughts. Although Sivin recognizes the internal consistency of scientific knowledge, he thinks the objectivity ends there. Once the "technical concepts and models has been translated into the ordinary language", science ceases to be value free (228). The metaphor and analogies that must precede all public discussion are too "value steeped" and susceptible to the ambiguity of everyday language. While Sivin did not present an example, I wish to present one to facilitate his arguments. A notoriously misleading analogy in science is Darwin's term "natural selection". Inspired by selection in breeding, "natural selection" misleads the readers into thinking that some sort of conscious effort is present, but in actuality, evolution relies only on random variations that are preserved or eliminated based on the organisms' ability to survive and reproduce (Darwin 74). Upon realizing his fault, Darwin encouraged people to replace it with "natural preservation" but to no avail (Mckee 29).

Although Sivin's argument from misleading analogies is sensible, it is ultimately founded on the public's inability to grasp the technicalities of a scientific field. Thus it can easily be defeated by drawing a line between the unprofessional discussions of science and the debates between leading scientists of the field.

Sivin's second argument argued that the progress of science is dictated by values of the society. He pointed out that "subjective judgments come to bear on every activity situated within a society," and science is no exception (228). The difference in subjective judgement has led to a variety of research focus in different countries. For example, citizens of Hong Kong place a relatively high demand on traditional Chinese medicine, which might have driven medical researchers to merge traditional wisdom with modern science. Sivin's view that scientific advancement is determined by subjective judgements is echoed by French mathematician Henri Poincaré (1854–1912). In *Science and Method*, Poincaré argued that scientists cannot possibly know the infinite number of facts in the world, rather they must come up with a criterion to select their scope of study (161). And to Poincaré, that is the subjective sense of beauty present in scientific discoveries (166). I must alert the readers to the fact that Poincaré was discussing the motivation of scientists rather than the subjectivity of science when he presented the argument. Nonetheless, the argument indeed demonstrated the subjectivity and personal values involved in scientific advancement.

Upon reading arguments from both sides, readers might have noticed the problem in the way Luria and Sivin tackle the objectivity of science, and come up with the way to reconcile their views. The two are arguing under different definitions. When Luria argues for objectivity, it is apparent that his use of "science" is limited to the body of knowledge gained through the scientific method, whereas Sivin, a historian, has used the word to describe the entire social process of scientific advancement. The body of knowledge is indeed objective through verifiability, but the process in which the knowledge is gained is influenced by subjective factors. Ultimately, the objectivity of science depends on how broadly readers define it.

While subjectivity might not be shared across art and science, the role of imagination surely is. I find myself agreeing with Luria: scientific discovery is not a just a deductive procedural process (158). Of course, there are mechanical processes in doing science, with data measurement and verification as obvious examples. However, beyond this and science traverses into a realm of creativity and imagination. From the formation of a hypothesis to the design of an experiment, these scientific activities all require an outburst of creativity.

The great imaginative efforts of scientists can be seen throughout history. English chemist and meteorologist John Dalton was the first to propose the atomic theory (Smith 230). His use of creativity has allowed him to see what lies behind chemical reactions and molecules—particles with varying sizes and masses known as atoms. An even better example is Darwin's triumph in his theory of evolution. Darwin's stretch of imagination allowed him to consider the evolutionary process in the scale of thousands of generations, a phenomenon that cannot be actively experienced in a person's lifetime (Darwin 88).

Imagination lies behind the design of elegant experiments as well. This is exemplified by the Meselson-Stahl experiment, in which semi-conservative DNA replication is verified. The imagination and ingenuity of the experiment lies in the use of nitrogen isotopes to grow bacteria, and the confirmation of semiconservative replication via density measurements (Watson 138–139). This stroke of genius is by no means a result of a deductive approach, but a genuine demonstration of creativity.

Although imagination plays a pivotal role in science, it is important to appropriately restrict it. Empirical data helps draw the line between science and fiction. No matter how imaginative or aesthetically pleasing a hypothesis is, if it is at odds with empirical data or is unfalsifiable, then it should not be accepted. It should be noted that string theory, among many imaginative frameworks, has been criticized for making no testable predictions (Cockshott 98).

Put simply, imagination is necessary for forming hypotheses and designing the experiments to test them. However, whether these hypotheses are ultimately accepted is dependent on the objective empirical data.

The process of scientific discovery is more humanistic than it appears. Subjective forces are at work—socioeconomic factors steer the course of a country's scientific research, and individual style dictates how a scientist might approaches a problem (Luria 159–160). It is the subjectivity of the thought process, with imagination lying at the heart of it, and the objectivity of the empirical verification that result in the modern science we know today. Effective, multi-approached, and most importantly, worthy of the highest trust.

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Teacher's comment:

Science is sometimes delineated as a "tough and objective" subject for its empirical and tentative nature. Learners are asked to memorize some hard facts and train to follow rigor reasoning in the process of discovery. In "Finding the Art in Science—An Exploration into the Role of Subjectivity and Imagination in Science", Tinwing tries to unveil the subjective nature of science. On top of the process of help satisfy natural curiosity and acquire the body of knowledge through scientific method, science could also be perceived as a complex social activity. In this perspective, values and subjectivity will be inevitably embedded in science. Tinwing further argues that despite the subjective nature of hypothesis, empirical verification ensure objectivity and validity for scientific enquiry.

Tinwing provides convincing arguments for the thesis. I enjoy reading his paper for its creative insight and empirical examples on how different areas of study apprehend science. (Yip Lo Ming Amber)