

SUNSETS, SOULS AND SENSES

A Key to the “Science IS / Science is NOT” Overheads

SCIENCE IS...

LIMITED TO THE NATURAL WORLD: Science, by its very nature, cannot seek supernatural explanations to any phenomenon. Even when one seeks to understand “supernatural” phenomena, only explanations complying with natural processes can be considered. Supernatural forces, by definition, can operate outside natural processes, and therefore cannot be reliably subjected to critical testing, in which any result could be expected, and attributed to the vagaries of supernatural forces. We can never expect to reliably disprove a supernatural explanation, whereas natural explanations are all potentially disprovable.

OBSERVABLE: All science is **BASED** on observation, events which can be perceived with our senses, either directly or indirectly. This includes perceivable evidence of unobserved events of the past.

TESTABLE: All ideas (hypotheses, theories) in science must be subject to testing (to being **DIS**proved, **NOT** proven). Every logical means should be attempted to show that such ideas are **NOT** valid. If they survive such tests, they are proportionately strengthened.

MEASURABLE: In order to achieve the highest possible precision, and to reduce subjective judgment as much as possible, all observations should be quantifiable by acceptable and appropriate standards.

REPEATABLE: Any test or observation of a scientific idea should be repeatable by different people, from which one would expect comparable results (unless there are uncontrolled influences or innocent bias). This is why research reports must be as detailed and quantitative as possible.

MODIFIABLE: The concepts (hypotheses and theories), and even the “facts”, the observations of science, are subject to change, as new techniques, new perspectives, and new information comes to light. Nothing in science is to be considered “fixed”, for all time. Science is not based on authority or dogma. Many of its concepts may become generally and widely accepted, because they work, and continue to be confirmed by testing, but even these are subject at least to modification, or even total replacement when new evidence clearly so indicates.

VERIFIABLE: (see **REPEATABLE** and **TESTABLE**).

BUILD UPON TESTABLE PREDICTIONS: Good hypotheses (plausible explanations) should offer or suggest predictable outcomes of carefully controlled and crafted testing or observation if correct, and alternative outcomes if they are **NOT** correct.

BASED ON EXPERIMENTATION: Wherever possible, hypotheses should be tested by experiment. Ideally, such experiments should be “controlled”, which means they are so crafted as to eliminate all variables but one, the one being considered as the critical element of the hypothesis.

OPEN TO CHANGE: (see **MODIFIABLE**).

BIASED: This is not often recognized as a characteristic of science. In fact, every effort is made to counteract the natural tendencies of bias in people. Nevertheless, scientists **ARE** people, and they unwittingly bring whatever biases they may have to their work. Usually this is very subtle, a product of one’s gender, socio-economic status, education, culture, political leanings, age or religion. An open recognition of this is important if one is to design experiments which minimize such bias, or even considers the research of others.

DISPROVABLE: (see **TESTABLE**).

OBJECTIVE: Every effort is made in science to be totally objective about the subject of study. Most of the elements of science are in place precisely to maximize such objectivity. In addition to the items already listed, scientists are expected to report their work and findings, so that other scientists may critically evaluate such work, and even attempt to repeat it, to make sure results are not due to some subjective element which can vary from person to person. All of this recognizes the unavoidable fact that scientists are human, subject to the same influences as anyone else.

STRONG THEORIES INFERRED FROM SOLID EVIDENCE: The most important product of science is its **theories**: the logical constructs of facts and hypotheses that attempt to explain natural phenomena; they are scientific **explanations**. Since a theory is always an explanation, it is always conceptual (as opposed to an observation), and therefore must be inferred as a synthesis from many observations. Ultimately, theories are more important than facts. The more internally consistent are the relevant facts (confirmed observations), the stronger is the theory inferred from those facts.

MADE STRONGER BY DIFFERENT LINES OF EVIDENCE: When evidence comes from different, independent unrelated fields of study, and they all point to the same explanation (theory), this increases credibility and support for the theory immensely. The chances that such agreement would be due simply to coincidence, and not the validity of the theory, are extremely remote.

A SEARCH FOR UNDERSTANDING: This is indeed the goal of science: an understanding of our natural universe, how it works, and why it is the way it is.

SCIENCE IS NOT ...

BASED ON PROOF: A common misconception, perhaps based on the use of mathematics in science, and that mathematical concepts ARE subject to “proof”. “Proof” carries with it the connotation of finality and certainty which is NEVER a proper feature of science. All too often, seemingly foolproof explanations have, upon closer scrutiny or new techniques, been shown to be wrong. In science, every effort is made, in fact, to DISPROVE concepts, to subject such ideas to severe critical analysis to find any weaknesses or flaws. If none are found, we simply say the concept is strengthened. Someday, someone may indeed discover a fatal flaw (as has happened numerous times), so we can never say a concept is “proven”, a closed case.

BASED ON BELIEF: Belief typically implies merely a feeling (perhaps a strong feeling, but nevertheless a feeling). One may believe something simply as a result of being told of this in a very compelling fashion. One may even have an experience which could be interpreted as the result of some abstract cause, not something one can actually see. In other words, a belief does not require objective evidence for confirmation. In contrast, scientific concepts DO require such objective evidence.

BASED ON FAITH: (see BASED ON BELIEF).

BASED ON AUTHORITY: Scientific facts or theories come from observation, and can change with new observations. Individual scientists might become “experts” with experience, and considered world proponents of certain established scientific concepts “authorities”. But time and again, some of those concepts have eventually been found to be in error, often shifting the “authority” label to another. Again, critical observation and analysis is primary, not any one authority or dogma.

DECIDED BY DEBATE OR LAW: Scientific concepts are properly decided on the basis of critical observation and analysis, not by any compelling oratory or selective twisting of facts.

SEARCH FOR TRUTH: “Truth” can mean different things to different people. It can apply to what one believes, what someone has said, what is said in a highly revered document, or what is “right” or “best”, none of which need be based on observation and critical analysis. Science is more properly a “search for understanding about the natural world”, seeking as objective a perception of reality as our subjective minds will allow, providing us with a picture of how the natural world works, which can enable us to live in harmony within that natural world.

CERTAIN: Because well-established, highly acclaimed concepts (explanations) can be (and have been) found to incorrect, we must recognize that nothing in science is certain or absolute. Science has given us many excellent explanations (theories) which work beautifully, and to the extent that they **DO WORK**, and have practical applications, they are properly accepted. But sometimes, given changing circumstances, those theories must be modified, or replaced entirely, giving us an even better (more useful) insight to the real world.

FAIR: There is nothing in science which guarantees “fairness”. Whatever is, **IS** (for the time being, at least), as indicated by the critical analysis of careful observations. Again, fairness is a very subjective trait, something science tries to avoid.

ABLE TO SOLVE ALL PROBLEMS: Science is equipped only for solving questions (or problems) dealing with natural phenomena. Problems or questions involving supernatural forces or events cannot, by their very nature vs. the nature of science, be effectively examined. Neither can science reach conclusions involving judgment or opinion. Science can offer information (observations and explanations) which may provide some criteria for such decisions, but cannot produce the decisions. (See **SCIENCE IS ... LIMITED TO THE NATURAL WORLD**).

A COLLECTION OF FACTS: Although scientific facts (critically confirmed observations) are the basis for science, they are **NOT** the focus of science. The primary goal of science is the understanding (explanation) of natural phenomena, ultimately in the form of theories (the closest thing to scientific facts that concepts can be).

DEMOCRATIC: Scientists do not vote on which theory is best. Competing theories are not considered of equal standing, and are not selected on the basis of what (or who) is most popular. There are specific objective criteria to which competing theories must be subjected, and which ultimately determines which theory survives. Such criteria include the “Fair Test”, “Multiple Independent Lines of Evidence”, absence of conflicting lines of evidence, and the overall weight of evidence.

ABSOLUTE: (see **CERTAIN**).