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THE HIERARCHY OF CONCEPTUAL LEVELS FOR SCIENTIFIC THOUGHT AND RESEARCH

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Abstract

A correct, philosophically neutral definition of science allows scientists complete freedom in what they believe, but requires them to function in accord with rules of the method of science which flow logically from the definition. There are four conceptual levels for scientific thought and research which coordinate and unify the several elements which constitute the practice of science. These conceptual levels are explained and related to the definition of science, to the rules of the method of science and to the freedoms of scientists.

Introduction

In an earlier article (Kofahl, 1986, p. 114) a four-tiered hierarchy of conceptual levels of the practice of scientific thought and research was briefly outlined. The present paper will enlarge on this view of science. The four levels of the conceptual hierarchy are:

*Religious-Philosophical faith or world view,
*Episteme (philosophy of science, epistemology, motivation, goals, etc.) (Gillespie, 1979, pp. 1-18),
*Conceptual frameworks (systems of fundamental concepts, paradigmatic theories and experiments, and assumptions for particular scientific disciplines or areas of research) (Jones, 1971), and
*Scientific hypotheses.

Fundamental to understanding this analysis is the fact that any proper definition of science is philosophically neutral (as delimited in the earlier article) (Kofahl, 1986, p. 112). In addition one must keep in mind the basic rules of the method of empirical science which flow logically from the definition of science. The particular rules pertinent to this discussion are the following:

1. Scientific hypotheses must be so constituted as to be subject to potential falsification by empirical test.
2. Scientific hypotheses may reference only elements of the empirical world and, therefore, may not reference any supernatural entity, activity or influence.

Also pertinent to this discussion are some of the freedoms of scientists which follow from the philosophically neutral definition of science, such as:

1. The definition of science lays no restrictions or requirements on what a scientist may believe.
2. The definition of science has nothing to say about the permissible sources of scientific hypotheses.

I will analyze and explain the four conceptual levels, in conformity with the rules and freedoms just enumerated.

Philosophical-Religious Faith or World View

The all-encompassing conceptual level, that of the scientist's religious-philosophical faith or world view, obviously may incorporate the supernatural—or exclude it. Any restriction to the contrary destroys philosophical neutrality and thus renders science captive to one or another belief system. The absolute freedom for scientists to hold whatever philosophical-religious belief system each one individually may prefer is most important since each person's philosophical view of the world, either consciously or unconsciously, influences everything he thinks or does.

Episteme

The second conceptual level, episteme, includes the scientist's philosophy of science, epistemology, and other such elements as the motivations and goals for his endeavors. It is clear from the history of science that various philosophies of science which have held sway or competed in different periods have related to various theological views of the world. It seems perfectly obvious that a scientist's philosophy of science will reasonably be expected to be logically related to his religious-philosophical world view, whether he be either religious or irreligious in his beliefs. Hence, since science is by definition philosophically neutral, a scientist's philosophy of science may include the supernatural or exclude it, either explicitly or implicitly.

Motivations and goals for one's professional career are likewise commonly meshed with one's belief system. For a Christian engaged in science, one motivation would be the command of God to Adam and to his posterity to subdue the earth and have dominion over

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all of its creatures (Genesis 1:28). And for the Christian one goal would be to pursue science for the welfare of mankind (Matthew 22:39), but the ultimate goal is to glorify God the Creator through scientific endeavor (I Corinthians 10:31).

Epistemology — the science of knowledge and sources and paths to knowledge—is a controversial one for scientists holding differing belief systems. It needs careful consideration. An epistemology for science admits of only one path to scientific knowledge about the natural world, i.e., the method of empirical science. This is established by defining scientific knowledge as knowledge which can be gained by the method of empirical science. This does not mean that science necessarily provides the only path to *true* knowledge about the natural world. Probably most scientists today believe that science is the only means to valid knowledge about the natural order. On the other hand, scientists who as part of their philosophical-religious world view hold the Bible to be divinely inspired revelaton, believe that it contains divinely revealed truth about the natural world. They believe, for example, that God created the universe and everything in it as revealed in the opening chapters of Genesis. They believe that life was created and that the "kinds" of plants and animals were separately created, that they did not evolve through descent with variation from one or a few common ancestral life forms. They accept these truths about the world by faith. This is not scientific knowledge, but Christians believe it nevertheless to be true knowledge. Thus the secularist who rejects divine revelation holds there is only one source of knowledge about the natural world, whereas the Christian holds that there are at least two, science and divine revelation.

Thus Christians believe in certain truths about the world which do not constitute scientific knowledge. This, however, does not make them "unscientific." Remember that, provided they function in accord with the rules of the scientific method, scientists are free to believe anything they desire, and have any motivations and goals for their work which suit them personally and individually. The restriction on what Christians may do with divinely revealed truth in science applies at the lowest level of the four-tiered conceptual system.

Conceptual Frameworks

A conceptual framework relates to a particular scientific discipline or to a particular class of problems. It is a collection of fundamental concepts, theories, experimental results and assumptions which establish a scientist's understanding of his work and his perspective for new research programs. Let us illustrate by enumerating some of the elements of a conceptual framework which a Christian might have for the biological science of genetics. Much would be the same as for a secularist. But for the Christian researcher there would be additional elements, including the following:

1. The assumption that species exist in permanently separate groups which correspond to the originally created "kinds," as reported in the first chapter of Genesis in the Bible.
2. The assumption that the basic design features or patterns which distinguish these separate kinds are indeed intelligent, purposeful designs.
3. The assumption that genetic variation is limited within the boundaries of the created kinds.

As a consequence of the differing conceptual frameworks adopted by secular geneticists and Christian geneticists, there would be different questions asked, different expectations, and different choices made for new research problems. For example, the Christian geneticist would be interested in determining the limits of genetic variation. He would be interested in the genetic mechanisms which limit variation. He would seek information which would help identify the created kinds. He would also expect his research results to fit logically with the basic assumptions of his conceptual framework.

Hypotheses

We have seen that the upper three members of our hierarchy of conceptual levels can incorporate elements of the supernatural. The fourth member, that of hypotheses, may not. This is because the supernatural is both immaterial and personal. That which is immaterial is not observable or measurable by our natural senses or by scientific instruments. Furthermore, that which is personal cannot be relied upon to react according to natural laws, to respond always in the same way under controlled conditions. In other words, God cannot be subjected to controlled experimental study. Therefore, because of the requirement that scientific hypotheses must be empirically testable, no supernatural entity, influence or activity may be referenced. This is because a hypothesis which incorporates anything which cannot be observed or measured and which cannot be relied upon to yield reproducible results under controlled experimental conditions will not be an empirically testable hypothesis. It will not be a hypothesis of empirical science.

Can a bonafide scientific hypothesis be constructed under a conceptual framework which incorporates elements of the supernatural? The answer is yes. Under a conceptual framework for genetics which includes the separateness of created kinds, research programs can be designed which comply with the rule that scientific hypotheses may not incorporate any element of the supernatural. For example, a hypothesis in genetics might postulate a genetic mechanism which establishes and/or maintains the genetic integrity of particular groups of related species. Or a hypothesis might postulate certain genetic characters or elements which can be used to identify such groups of species. Or a hypothesis might postulate a means of establishing common inheritance between certain species and denying it between other species. Such hypotheses are logically related to the creation-oriented conceptual framework which I discussed above and can be empirically testable because they do not incorporate any supernatural elements.

Any hypothesis framed under the Biblical creation conceptual framework which has been discussed, if it survives empirical tests, will provide circumstantial evidence for the conceptual framework. The new data resulting from the empirical tests can be incorporated logically into the conceptual framework, as can the surviving hypothesis. And, in appropriate places Christians should be free to point out the logical implications of their results. They should be free to draw conclu-

sions and publish them, conclusions which they offer in support of a created, rather than an evolved world.

The Place of Evolution and Creation in the Hierarchy

The place for such concepts as evolution and creation in the hierarchy is at the level of the scientist's episteme. This would accord with Karl Popper's classification of Darwinism as a "metaphysical research programme" (Popper, 1976). Incidentally, when he came under attack for this idea, even though he made some cautious revisions of his language, Popper never withdrew this designation for Darwinism. We assert that creation, likewise, is a metaphysical research program.

Conclusions

The four-tiered hierarchy of conceptual levels for the practice of science provides each participant in the scientific enterprise with guidelines for exercising his or her freedoms while at the same time abiding by the rules of the method of science. It helps to categorize correctly the various intellectual elements involved in the practice of science so that they are not confounded one with the other. It promotes clarity of thought with respect to the relationship of such concepts as evolution and creation to science. Finally, it provides a basis for mutual understanding and respect between scientists whose belief systems and professional commitments may be diametrically opposed.

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PANORAMA OF SCIENCE

Small Comets May Mean A Young Solar System

An interesting astronomical controversy has raged since 1986 that, when resolved, may show the solar system is young. Louis Frank and two graduate students discovered dark spots on ultraviolet images of the earth's high atmosphere taken by the Dynamics Explorer I satellite (Frank, Sigwarth and Craven, 1986a). The spots, which appear similar to flies on a TV screen, were found on virtually every one of over 10,000 images taken over a six-year period. The spots, which last two to three minutes, are estimated to cover an area of 2-3,000 km^2. Frank interprets these spots as water vapor absorption of ultraviolet light from disintegrated small comets (Frank, Sigwarth and Craven, 1986b). From the size of the spots, Frank deduced that the comets average 12 meters in diameter with a mass of 10^8 grams of ice and bombard the earth at a rate of 20 per minute. He has been very careful and has analyzed the data for other possibilities, like instrument problems, statistical errors, and ultraviolet absorption by oxygen. The results are said to be "startling" and "its influence in several fields of science will be profound" (Eberhart, 1986). However, Frank has drawn sharp criticism. He was even urged to withdraw his interpretation of the data, and both Frank and *Geophysical Research Letters* (the journal that published his research) were warned they would lose their credibility.

Frank's interpretation is not without physical difficulties. Scientists naturally ask: "Why these comets have not been detected before?" Comets are not pure water ice and therefore astronomers should see a flash of light when the comet hits the atmosphere. Also the comets should be seen by radar. Comets should be striking other heavenly bodies also. When they hit the moon, the sensitive seismographs placed on its surface should have detected them (Anon. 1986a). Small comets should be vaporized rapidly by the sun (Anon., 1986b). Hydrogen should escape from the small comets, but the amount of atomic hydrogen in interplanetary space is too small (Beardsley, 1988; Kerr, 1988a). Frank explains these and other problems by what seems to be strange properties for comets. The small comets are supposed to be fluffy aggregates with a density of only 0.1 gm/cm^3 and covered by a mantle of black dust. A comet with these properties would last a considerable time in interplanetary space and could remain undetected. The coating of dust on the comets keeps them from vaporizing, so that little hydrogen escapes. Observations of Halley's comet support the hypothesis that these small comets could be coated with black dust. As the comets approach the earth at less than 20 km/sec, they disintegrate by tidal and other forces about 1,000 miles from the earth, vaporize by sunlight, and "softly" strike the upper atmosphere as a moving cylinder of water vapor and do not produce a flash of light. An analogous process on the moon, according to Frank, would allow them to go undetected by the moon seismographs.

A number of objections to the small comet hypothesis are mainly based on the presumed old age of the solar system. Frank is quoted as saying: "If you accept these [tiny comets], your concept of the solar system has to be entirely different from what's in the literature today" (Monastersky, 1988). The most obvious problem is that the ocean would have an extraterrestrial origin and would have been very small when the earth was young, which would have far-reaching consequences for origin of life theories. If the earth has been bombarded by small comets at the rate observed, over three times as much water should have collected in 4.6 billion years, even considering photodissociation of water and the escape of hydrogen from the upper atmosphere. Moreover, Mars and the moon should be covered with a deep ocean. The rings of the outer planets should have been torn apart. According to some scientists, football-field sized craters should be punched all over the moon, whereas too few craters exist for the presumed age of the moon. If the comets are real and the rate of bombardment has been constant, then these objections to the small comet theory would be solved by assuming a young solar system. Although the small comet hypothesis is outrageous to most scientists, Frank claims the hypothesis is not a