A Good Hypothesis

In order to be of maximum usefulness in acquiring and organizing knowledge, a hypothesis must meet eight conditions:

1. It *must* be *falsifiable;* that is, it cannot be an analytic statement (which will remain true regardless of what occurs). Moliere satirized the doctors who postulated a "dormitive power" in certain drugs to explain why they make you sleepy. But we continue to be offered similarly circular hypotheses: dogs bury bones because they have a bone-burying instinct; human beings fight because they have a violent tendency. These allegedly explanatory hypotheses merely restate that which is to be explained. They are not falsifiable; they are devoid of empirical content. If a hypothesis refers to such entities as bone-burying instincts, which are not manifested in any way other than in the burying of bones (that is, entities which so far as we can tell exist only in the phenomena they allegedly explain), then it is ad hoc and can never be put to the test. If a hypothesis does no more than summarize what is already known, it cannot be disproved.

2. The explanatory hypothesis must of course be *true.* I have read that "lost persons travel in circles because spiral movement is a property of all living matter in motion."

3. The hypothesis must be *simple* "even if," as Nagel maintains, "the simplicity tacitly demanded cannot be articulated precisely, may be almost entirely a psychological matter, and is likely to change as mathematical techniques . . . improve." Simplicity is always relative to a conceptual scheme (compare figuring a 10% tip in American dollars and in English pounds, shillings, and pence). Even in mathematics, simplicity cannot be defined; it may depend on conventional or cultural factors. The simplicity may be in the concepts employed, or in the laws in which they are used. It may be linguistic (in structure or in notation), or ontological (that is, in the extralinguistic entities postulated). Is Copernicus' heliocentrismsimpler than Ptolemy's geocentrism, if Copernicus requires that the earth move? The decision was not easy to make.

4. The hypothesis must be elegant, or *beautiful.* The physicist Dirac says, "it is more important to have beauty in one's equations than to have them fit the experiment . . . fundamental physical laws are described in terms of mathematical theory of great beauty and power." Sometimes the criterion of beauty takes the form of a demand for *symmetry;* it is for this reason that physicists first postulated the existence of so-called antimatter.

5. The hypothesis must be as *general* as possible; it must avoid names and arbitrary or unreasonable restrictions of time and place. Other things being equal, the wider the scope of the hypothesis, and the greater its *range* and *variety* of predictive power, the better. Yet generality and simplicity may sometimes conflict. In economics, for example, "perfect competition" is more simple as an explanatory hypothesis, but "imperfect competition" is more general.

6. The hypothesis, if possible, ought not to be purely *statistical* or probabilistic. There are some areas of science, however, quantum mechanics, for example, and genetics, in which only probabilities can be predicted. No one can state when the next alpha particle will be emitted, but only how many particles on the average will be emitted in a given time interval; no one can state whether the next baby born in a given family will be blue-eyed or brown-eyed, but only what the probabilities are in a large number of births. This is the basis for the dissatisfaction of some physicists with present-day quantum theory, and their search for what they call "hidden parameters." Einstein summarized his opposition to purely statistical hypotheses in a famous remark, "God does not play dice with the universe." In the social sciences, explanatory hypotheses are usually probabilistic. We may explain that there was a riot in Attica prison because confinement and frustration tend to breed aggression, but this hypothesis does not permit us to predict the time and place of the next prison riot.

7. The hypothesis should bring out *analogies* where possible. The scientist may use a model for this purpose (for example, of the atom or of the solar system). The model of course is never an exact replica; it is either much larger or much smaller than, and omits certain features of, whatever it

represents. If the scientist offers a hypothesis that electricity “flows along a wire like water in a pipe,” or that molecules interact “like billiard balls colliding,” this aids us in grasping the hypothesis, as does a diagram drawn to prove theorems in geometry; but the model must not be confused with the hypothesis itself.

8. The hypothesis should, finally, satisfy certain criteria that can best be described as *metaphysical:* that there is no infinite regress of causes; that there is continuity in the world; that the world be regarded as stable

It is interesting in the above list to note the appearance of phrases like simplicity and elegance which are more traditionally the concern of the Arts than the Sciences. Is there some kind of cross over between these two subjects, are their any dangers involved when introducing a subjective measure like ‘elegance’ into science … and what, if anything, does it mean for an equation to be beautiful. Once again science appears not to be as straight forward as we thought.

Adapted from Reuben Abel’s ‘Man is the Measure’ (Chapter 10)