

# SUBSTRUCTURE OF SCIENCE AND NEWTON'S FIFTH RULE\*

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## SUBSTRUCTURE

Holton (1973), in his essay on "The Duality and Growth of Physical Science," distinguishes between "private" ( $S_1$ ) and "public" ( $S_2$ ) modes of communication in science. The scientist begins a problem in a personal manner, at a level on which aesthetic and purely individual matters may be involved--sometimes scarcely communicable. This is level  $S_1$  in Holton's terminology. When the scientist reports his work, however, it changes face and becomes a public communication, freed from  $S_1$  obfuscations, and is put forward in as precise and as unambiguous a form as

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*\*Editor's Note:* William Stephenson has produced two book-length manuscripts (as yet unpublished) based on Newton's own unpublished Fifth Rule, suppressed from the third edition of his *Principia* (1726): *Newton's Fifth Rule: An Exposition of Q pro re Theologica* (1975), and the revised and expanded *Newton's Fifth Rule: An Exposition of Q pro re Theologica pro re Scientia* (1975-76). The following is excerpted from pp. 541-556 of the latter.

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possible. This is level  $S_2$ , where the attempt is to become generally understood, at least by everyone in the same field of inquiry. It is the level of public science, of open discussion about phenomena and analytical systems, of codification and the language of textbooks, all indifferent to human frailty, pleasure or enjoyment.

The "private" sector ( $S_1$ ) is where the creative nexus lies, and where communicability is at once speculative, non-rational, ill-structured, and even mystical or religious. Little of  $S_1$  finds its way into published papers, Holton remarks, not because it does not exist but because it is generally neglected: he adds--

The fruitlessness of metaphysical discussions in the sciences has finally brought about a curious case of atrophy; the personal metaphysical tenets of scientists, although sometimes very strong, are in a free society generally so varied, so vague, in fact technically so inept that in a sense they cancel out. We may go one step further, and state that even though a science ( $S_1$ ) without a metaphysical substructure has never been possible, it may be argued that our science ( $S_2$ ) will be healthy only so long as our scientists formally renounce all metaphysics.

One is reminded, inevitably and one hopes not unkindly, of the frailties of perfectionism! It was Hegel who said that another planet couldn't exist the very year Herschel found Uranus. So here, too, without detracting from the metaphysical in  $S_1$ , we go quite a different step forward and state the reverse of Holton's conclusion, that science ( $S_2$ ) will be healthy *only so long as it deals objectively with its subjective substructure*, which includes  $S_1$  but also much more. Applications of Newton's Fifth Rule are always "personal",  $S_1$ .\*

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\*Earlier in this manuscript, Stephenson reformulated Newton's unpublished Fifth Rule as follows:

It depends upon what one means by a healthy state. Our argument will be that  $S_2$  is symptomatic of a certain arrogancy--a stylistic matter in Holton's schema --and that a leavening by way of  $S_1$ , objectively regarded, is essential to a more realistic  $S_2$ .

First, we are not overly concerned, in these opening moves, to try to assist physics at its own game, though, with Holton, we are sure that the newer so-called sciences will benefit from our methodology. In the pages to follow we'll consider an example concerning a general theory of disease and medical care. The point we are now to make, however, is not that Newton's Rule will help the creative scientist to do a more complete job at being creative: Instead, acceptance of subjectivity as a legitimate domain for serious scientific study is of first importance for science, and will "clear the air" in many surprising places in and out of science. Our subjectivity, of course, is Holton's (1973) z-dimension: But it is much more than diagrammatic--it has theory to support it as a place for operations, facts and hypotheses peculiar to it. Because of it, we can introduce thematic discussions into the every-day work of science (and of much else outside it).

Holton was impressed by the small number of themes, not more than a hundred or so in all physics, such as assumptions of symmetry, continuum, methodological preference, and the like, of which complementarity and chirality are recent examples. The importance of these is not denied. But there is more "personal" structure in every scientific field of endeavor that

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"These things which neither can be demonstrated from the phenomena nor follow from them by argument of induction, I hold as subjective hypotheses. Their resolution is possible by way of operant factors relevant to these hypotheses. In this manner new testable hypotheses arise from the subjectivity at issue" (p. 261). Newton's own version, translated from the Latin, is provided by Koyré (1965: 272).  
[Ed.]

is unrecognized, not because it doesn't exist or is unimportant, or because it is metaphysical, but because no one really accepts it--and it should be made public, for a healthy state of science.

An example will introduce the matter, involving medical research professors who expressed interest in problems of hypertension.

### HYPERTENSION

Some years ago hypertension was not among the most highly regarded diseases in medical circles, but at the time this study was undertaken at a large medical center there was a growing awareness that "hi-blood" was not only a common condition, but important especially in the welfare of thousands of black adults in the region of the medical center. There was a considerable weight of interest and involvement in the matter amongst many medical professors at the center, and one of the earliest studies on medical care for hypertension was being conducted in the neighborhood. Many facts about the condition were on record. Women, for example, were said to fare better than men under treatment. Mortality increases with increasing levels of blood pressure. It wasn't known why some people develop malignant episodes of the disease. The "psychological factor" was an important feature in the malignancy of some patients--but no one knew why. There had been a conference on hypertension, under the auspices of the Council for High Blood Pressure Research of the American Heart Association, and many of the professors were apprised of its conclusions.

These matters are mentioned to make the point that most of the professors who took part in the Q study volunteered because of an expressed or explicit interest in hypertension; all knew of the author's communication research projects vis-a-vis hypertension and the like, and regarded the study as in relation to his communication or informational interests.

As concourse we put together a list of known facts and conjectures about hypertension, as reported in the literature. A Q sample of 46 "statements" was chosen, a few of which are given below to exemplify their character:

Everybody has a variable pressure, but some are more variable than others. Different kinds of stress tests will cause greater pressor response in individuals who have a family history of hypertension.

Mortality ratios increase progressively with increased levels of blood pressure.

The administration of glucose has a very significant lowering effect on average blood pressure.

We should recognize that the on-going studies on blood pressure reveal that the systolic blood pressure and the blood lipids seem to be the strongest available determinants of overall excess mortality and excess coronary mortality.

We teach our students that the diastolic pressure is the thing.

If you put together the question of the elevated uric acid and diabetes and hypertension, the combination is a real poor risk.

... and so on.

These are mainly matters of fact, accepted as supportable about hypertension. We are confident that the professors, for the main part, were knowledgeable about the subject. Our concern, of course, was not with the matters of fact but with how the professors would judge them for their relative "importance" or "significance" in the disease entity.

Each of 17 professors was personally introduced

to Q technique by the author, and performed a Q sort with the statements to represent what in his judgment was most important in the disease. The data were factored and rotated by varimax procedure, providing four operants, which we can sufficiently represent as shown. The four factors are in "simple structure"

Professors	Factors			
	A	B	C	D
1	x			x
2	x			
3	x			
4	x			
5	x	x		
6				x
7	x			
8			x	
9		x		
10		x	x	
11				x
12				
13			x	
14				
15			x	
16		x		
17			x	

(x = significant loading)

except for Q sorts 1, 5, 10 which are "doubled". Factor A is represented by four clear-cut Q sorts, B by two, C by four, and D by two. Only Q sorts 12 and 14 are not in the structure. The data clearly indicate that the staff members were far from of one mind about the relative significance of the facts.

The factors are not idiosyncratic positions, however, taken differently by each scientist. Six of the physicians are on factor A, four on B, five on C and three on D, pointing to systematic matters. Some of Holton's thema are undoubtedly present implicitly, as in all scientific work. But what is directly involved, we may be sure, is that the professors have projected their particular interests upon the Q sample, without being aware of doing so. If a physician is in daily contact with diagnostic testing for purposes of life insurance, he is likely to project that interest, and this is what happened with respect to factor C, as the following statements suggest:

Factor Scores			
A	B	C	D

23. Many factors combine to pro-

1	3	5	2
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duce an irregular, non-normal distribution of blood pressure readings found on insurance examinations, and a probable bias in the mortality data.

9. You can provoke a drop in blood pressure with two or three very deep breaths, presumably on some neurogenic reflex basis. -3 -4 5 0

11. Blood pressure falls quite spectacularly in most people during sleep. 0 1 5 -2

6. There are several lines of evidence suggesting that effective reduction in blood pressure may have a salutary effect on the incidence of stroke. 1 2 4 3

14. Where there is adverse mortality in family history, particularly under the age of sixty, this fact is of considerable prognostic significance. 2 1 4 1

The five physicians on factor C give primary emphasis (relative to other statements of the Q sample and to other factors) to blood pressure as such--its irregularities (23), dropping (9), spectacular (11), effect in relation to stroke (6), and family history (14). Their interest is in relation to medical examinations for insurance policies, as indeed was the case.

Factor B is distinguished by preoccupation with patient care, as the following statements bear witness:

	Factor Scores			
	A	B	C	D
35. I think virtually all of us	3	5	-2	4

would agree that it is almost malpractice to deny therapy to a patient with malignant hypertension.

37. I would suggest at the moment that what we don't know (but desperately need to find out) is the effect of therapy in early hypertension. 2 5 4 -4

45. We know that almost any kind of hypertension, of whatever etiology, can progress into a malignant phase, but we don't really know the factors which lead to this. -3 4 -2 1

19. There is no clear dividing line between normal and abnormal blood pressures as measured by excess mortality. -2 4 -1 -4

40. Many anti-hypertensive drug side effects are worse than the disease. 3 3 -1 0

34. The sophistication of the examiner plays a very important role in the kind of blood pressures he reports. -5 3 -3 0

18. I do not believe there is a good correlation between causal blood pressure and mortality, certainly not as close relationship as there is between basal blood pressure and mortality. 3 4 -3 0

44. Everybody agrees that high blood pressure is bad, but then again it is not all bad. -4 0 -2 -4



Therapy is uppermost in the mind (35, 37), and concern for treatment (40); caution, also, in diagnosis, with the patient in mind (19, 34, 44, 18).

Factor A is given by professors whose main involvements at the center are in teaching, as indicated by the following:

	Factor Scores			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
29. We teach our students that the diastolic pressure is the thing.	4	1	-1	-1

Everything for the factor bears in this didactic direction: The center, after all, is a teaching institution.

Factor D is most cognizant of the facts, as the following attest:

	Factor Scores			
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
7. Antihypertensive therapy has little effect on the atherosclerotic complications associated with severe hypertension.	0	0	2	5
30. If you put together the question of the elevated uric acid and diabetes and hypertension, the combination is a real poor risk.	4	2	2	5
32. Stress elevation of blood pressure is often a dangerous sign and a doctor who tries to excuse blood pressure on this basis is not a friend of the patient.	0	0	1	5
36. I know of no convincing proof as yet, that therapy ad-	0	0	-3	-5

ministered to the early hypertensive has modified his course.

37. I would suggest at the moment that what we don't know (but desperately need to find out) is the effect of therapy in early hypertension. 2 5 4 -4

Note that these physicians, who perhaps were most directly involved in research respects, were alert to the importance of early therapy (36, 37): At the time few doctors were so concerned.

In our free society it does not surprise us that professors are not of one mind. Yet do they not live by the axiom that facts are facts? We take it for granted, or never raise the matter, that scientists, with the same information, come to hold quite different positions about it: Few ever question the matter. Shouldn't facts speak for themselves without "personal" attachments? Isn't even a little fact, as Emerson put it, worth a whole limbo of dreams?

It is the purpose of our work to answer no to Emerson, and to say that we have to go beyond facts, not to merely look them in the face, but behind them. The matter is of significance, perhaps beyond all measure.

The above factors are not metaphysical, but in other studies they can be, and metaphysics isn't far away in any of them. None of Holton's thema is evident, though many are undoubtedly involved. The question to be asked, even so, turns on Holton's assumption that the metaphysical tenets of scientists cancel one another out, leaving science purely factual, and this we doubt. "Personal" involvements are ubiquitous in science, and it is hard to believe that something of them doesn't rub off on the way.

Can we really overlook the massive subjectivity of such involvements? From the high regard for pres-

tige and fame (Hagstrom, 1965), to the values of eponymy (Merton, 1957), to the fads and fashions in science which put it in competition with the marketplace (Dunnette, 1966), and to the "playfulness" as communication-pleasure, that keeps tens of thousands of scientists busy, doing little good and little harm, but enjoying the problem-solving process (Stephenson, 1972)--and on to other indications of irrationalities in happenstance and serendipity (Paisley, 1965), there are indications in plenty that much is "not really scientific" in the process of science-making. It is easy to suppose that all such, and the personal tenets, attitudes, and human foibles to which attention is being drawn, are so varied, so contradictory, that they must cancel one another out, leaving science with only its pristine facts to consider. The assumption, however, can now be tested.

Holton, indeed, finds reason to doubt the canceling out process, at least on broad historical levels, in the persistence of "stylistic" modes. His essay on "Thematic and Stylistic Interdependence" (Holton, 1973) is very interesting in this respect.

What, he asks, guides the scientist to study what he does? He answers that it is more than the "facts of nature". The "style of thought" of the (historical) period enters. Plato's preselection was in relation to moral education--one studied the "preliminary sciences" as a stage on the way to "the forms of soberness, courage, liberality and high-mindedness" (*Republic*, Bk. 3), that is, in relation to Plato's theory of the soul. And is the situation any different today? Holton has to answer that it isn't, and that science cannot exist "for its own sake". The criteria for preselection change, but a stylistic relationship remains constant for a particular period. And what of today? According to Holton it is a style imbued with decay--decay of particles, fission, nuclear disintegration, indeterminacy, time reversal, negative states of entropy, particle annihilation,..a science of disintegration, radioactive decay and discontinuities!

Consider the physicist, basically interested in the orderly structure of subnuclear particles: He strips away an atom's outer shield of electrons and forces the nucleus through a particle accelerator to bombard a target with enormous force. The nucleus, and perhaps the target as well, disintegrate, and the fragments go off with energies, spins, and momentum fascinating to the researcher, and madness or dangerous destruction to the uninitiated. But isn't modern art stylistically in this same mode? It, too, is fragmentary, disintegrative, indeterminate. Holton gives as an example the French painter Arman's *Allegro Furioso*, a painting in which two violins are shattered, splintered, tossing in space in violent disarray, to represent an instant of furious musicality. Moreover, it is orderly disarray! Is this, then, not reaching a new simplicity? Might it not be heralding a return, Holton proceeds, to a new, more sophisticated stylism? In science as well as art?

... The simple harmonies, the simple symmetries, have been found out. How much more satisfying it will be if we can discern harmonies and simplicities directly, through a more highly trained vision, in complex, apparently broken and deranged configuration. It may be that we are beginning to train new sensibilities which will set a new style (Holton, 1973: 98).

Is it not ironical that our own theory follows the same destructive style? That we desiccate poems, paintings, science to provide concourses, with the end in sight of simple operant factor structures? At least we are in step with the historic style!

But it is also of much greater interest that we can call Holton's artistry to task. We should perhaps place a *Guernica* where he put *Allegro Furioso*, broken mankind where he reached only for a violin. For though there may be some truth in the interdependency of stylistic modes, we can put a finger on the modern scientific style, and it is different from

Holton's optimistic aspirations for new sensibilities.

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*It is not only possible but necessary that mathematics be applied to psychology; the reason for this necessity lies briefly in this: that by no other means can be reached that which is the ultimate aim of all speculation, namely conviction. (J.F. Herbart)*