From Runkel
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Excerpts from the essay "Natural kinds" in W.V. Quine (1969). Ontological relativity and other essays (pp. 114-138). New York: Columbia University Press.

Quine gave earlier drafts of "Natural Kinds" as lectures in 1967.

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Natural Kinds

What tends to confirm an induction? This question has been aggravated on the one hand by Hempel's puzzle of the non-black non-ravens,[1] and exacerbated on the other by Goodman's puzzle of the grue emeralds.[2] I shall begin my remarks by relating the one puzzle to the other, and the other to an innate flair that we have for natural kinds. Then I shall devote the rest of the paper to reflections on the nature of this notion of natural kinds and its relation to science.

Hempel's puzzle is that just as each black raven tends to confirm the law that all ravens are black, so each green leaf, being a non-black non-raven, should tend to confirm the law that all non-black things are non-ravens, that is, again, that all ravens are black. What is paradoxical is that a green leaf should count toward the law that all ravens are black.

[1] C. G. Hempel, *Aspects of Scientific Explanation and Other Essays* (New York: Free Press, 1965), p. 15.

[2] Nelson Goodman, *Fact, Fiction, and Forecast* (Cambridge, Mass., 1955, or New York: Bobbs-Merrill, 1965), p. 74. I am indebted to Goodman and to Burton Dreben for helpful criticisms of earlier drafts of the present paper.

Goodman propounds his puzzle by requiring us to imagine that emeralds, having been identified by some criterion other than color, are now being examined one after another and all up to now are found to be green. Then he proposes to call anything *grue* that is examined today or earlier and found to be green or is not examined before tomorrow and is blue. Should we expect the first one examined tomorrow to be green, because all examined up to now were green? But all examined up to now were also grue; so why not expect the first one tomorrow to be grue, and therefore blue?

The predicate "green," Goodman says,[3] is *projectible;* "grue" is not. He says this by way of putting a name to the problem. His step toward solution is his doctrine of what he calls entrenchment,[4] which I shall touch on later. Meanwhile the terminological point is simply that projectible predicates are predicates ζ and η whose shared instances all do count, for whatever reason, toward confirmation of ⌜All ζ are η⌝.

Must be an error here—PJR.

Now I propose assimilating Hempel's puzzle to Goodman's by inferring from Hempel's that the complement of a projectible predicate need not be projectible. "Raven" and "black" are projectible; a black raven does count toward "All ravens are black." Hence a black raven counts also, indirectly, toward "No non-black things are non-ravens," since this says the same thing. But a green leaf does not count toward "All non-black things are non-ravens," nor, therefore, toward "All ravens are black"; "non-black" and "non-raven" are not projectible. "Green" and "leaf" are projectible, and the green leaf counts toward "All leaves are green" and "All green things are leaves"; but only a black raven can confirm "All ravens are black," the complements not being projectible.

[3] Goodman, *Fact*, pp. 82 f.
[4] *Ibid.*, pp. 95 ff.

If we see the matter in this way, we must guard against saying that a statement ⌜All ζ are η⌝ is lawlike only if ζ and η are projectible. "All non-black things are non-ravens" is a law despite its non-projectible terms, since it is equivalent to "All ravens are black." Any statement is lawlike that is logically *equivalent* to ⌜All ζ are η⌝ for some projectible ζ and η.[5]

Having concluded that the complement of a projectible predicate need not be projectible, we may ask further whether there is *any* projectible predicate whose complement is projectible. I can conceive that there is not, when complements are taken strictly. We must not be misled by limited or relative complementation; "male human" and "non-male human" are indeed both projectible.

To get back now to the emeralds, why do we expect the next one to be green rather than grue? The intuitive answer lies in similarity, however subjective. Two green emeralds are more similar than two grue ones would be if only one of the grue ones were green. Green things, or at least green emeralds, are a kind.[6] A projectible predicate is one that is true of all and only the things of a kind. What makes Goodman's example a puzzle, however, is the dubious scientific standing of a general notion of similarity, or of kind.

A sense of comparative similarity, I remarked earlier, is one of man's animal endowments. Insofar as it fits in with regularities of nature, so as to afford us reasonable success in our primitive inductions and expectations, it is presumably an evolutionary product of natural selection. Secondly, as remarked, one's sense of similarity or one's system of kinds develops and changes and even turns multiple as one matures, making perhaps for increasingly dependable prediction. And at length standards of similarity set in which are geared to theoretical science. This development is a development away from the immediate, subjective, animal sense of similarity to the remoter objectivity of a similarity determined by scientific hypotheses and posits and constructs. Things are similar in the later or theoretical sense to the degree that they are interchangeable parts of the cosmic machine revealed by science.

This progress of similarity standards, in the course of each individual's maturing years, is a sort of recapitulation in the individual of the race's progress from muddy savagery. But the similarity notion even in its theoretical phase is itself a muddy notion still. We have offered no definition of it in satisfactory scientific terms. We of course have a behavioral definition of what counts, for a given individual, as similar to what, or as more similar to what than to what; we have this for similarity old and new, human and animal. But it is no definition of what it means really for *a* to be more similar to *b* than to *c;* really, and quite apart from this or that psychological subject.

Did I already suggest a definition to this purpose, metaphorically, when I said that things are similar to the extent that they are interchangeable parts of the cosmic machine? More

literally, could things be said to be similar in proportion to how much of scientific theory would remain true on interchanging those things as objects of reference in the theory? This only hints a direction; consider for instance the dimness of "how much theory." Anyway the direction itself is not a good one; for it would make similarity depend in the wrong way on theory. A man's judgments of similarity do and should depend on his theory, on his beliefs; but similarity itself, what the man's judgments purport to be judgments of, purports to be an objective relation in the world. It belongs in the subject matter not of our theory of theorizing about the world, but of our theory of the world itself. Such would be the acceptable and reputable sort of similarity concept, if it could be defined.

It does get defined in bits: bits suited to special branches of science. In this way, on many limited fronts, man continues his rise from savagery, sloughing off the muddy old notion of kind or similarity piecemeal, a vestige here and a vestige there. Chemistry, the home science of water-solubility itself, is one branch that has reached this stage. Comparative similarity of the sort that matters for chemistry can be stated outright in chemical terms, that is, in terms of chemical composition. Molecules will be said to *match* if they contain atoms of the same elements in the same topological combinations. Then, in principle, we might get at the comparative similarity of objects *a* and *b* by considering how many pairs of matching molecules there are, one molecule from *a* and one from *b* each time, and how many unmatching pairs. The ratio gives even a theoretical measure of relative similarity, and thus abundantly explains what it is for *a* to be more similar to *b* than to *c*. Or we might prefer to complicate our definition by allowing also for degrees in the matching of molecules; molecules having almost equally many atoms, or having atoms whose atomic num-

bers or atomic weights are almost equal, could be reckoned as matching better than others. At any rate a lusty chemical similarity concept is assured.

From it, moreover, an equally acceptable concept of kinds is derivable, by the paradigm-and-foil definition noted early in this paper. For it is a question now only of distilling purely chemical kinds from purely chemical similarity; no admixture of other respects of similarity interferes. We thus exonerate water-solubility, which, the last time around, we had reduced no further than to an unexplained notion of kind. Therewith also the associated subjunctive conditional, "If this were in water it would dissolve," gets its bill of health.

The same scientific advances that have thus provided a solid underpinning for the definition of solubility in terms of kinds, have also, ironically enough, made that line of definition pointless by providing a full understanding of the mechanism of solution. One can redefine water-solubility by simply describing the structural conditions of that mechanism. This embarrassment of riches is, I suspect, a characteristic outcome. That is, once we can legitimize a disposition term by defining the relevant similarity standard, we are apt to know the mechanism of the disposition, and so by-pass the similarity. Not but that the similarity standard is worth clarifying too, for its own sake or for other purposes.

Philosophical or broadly scientific motives can impel us to seek still a basic and absolute concept of similarity, along with such fragmentary similarity concepts as suit special branches of science. This drive for a cosmic similarity concept is perhaps identifiable with the age-old drive to reduce things to their elements. It epitomizes the scientific spirit, though dating back to the pre-Socratics: to Empedocles with his theory of four elements, and above all to Democritus with his atoms. The mod-

I think this is the point you made in an earlier letter about copper wires?

But is the question not begged? Is it not we who still choose the criterion of similarity or kind or "mechanism" from our own perceptions and our categorizing of them?

ern physics of elementary particles, or of hills in space-time, is a more notable effort in this direction.

This idea of rationalizing a single notion of relative similarity, throughout its cosmic sweep, has its metaphysical attractions. But there would remain still need also to rationalize the similarity notion more locally and superficially, so as to capture only such similarity as is relevant to some special science. Our chemistry example is already a case of this, since it stops short of full analysis into neutrons, electrons, and the other elementary particles.

A more striking example of superficiality, in this good sense, is afforded by taxonomy, say in zoology. Since learning about the evolution of species, we are in a position to define comparative similarity suitably for this science by consideration of family trees. For a theoretical measure of the degree of similarity of two individual animals we can devise some suitable function that depends on proximity and frequency of their common ancestors. Or a more significant concept of degree of similarity might be devised in terms of genes. When kind is construed in terms of any such similarity concept, fishes in the corrected, whale-free sense of the word qualify as a kind while fishes in the more inclusive sense do not.

Different similarity measures, or relative similarity notions, best suit different branches of science; for there are wasteful complications in providing for finer gradations of relative similarity than matter for the phenomena with which the particular science is concerned. Perhaps the branches of science could be revealingly classified by looking to the relative similarity notion that is appropriate to each. Such a plan is reminiscent of Felix Klein's so-called *Erlangerprogramm* in geometry, which involved characterizing the various branches of geometry by what transformations were irrelevant to each. But a branch of

science would only qualify for recognition and classification under such a plan when it had matured to the point of clearing up its similarity notion. Such branches of science would qualify further as unified, or integrated into our inclusive systematization of nature, only insofar as their several similarity concepts were *compatible;* capable of meshing, that is, and differing only in the fineness of their discriminations.

Disposition terms and subjunctive conditionals in these areas, where suitable senses of similarity and kind are forthcoming, suddenly turn respectable; respectable and, in principle, superfluous. In other domains they remain disreputable and practically indispensable. They may be seen perhaps as unredeemed notes; the theory that would clear up the unanalyzed underlying similarity notion in such cases is still to come. An example is the disposition called intelligence—the ability, vaguely speaking, to learn quickly and to solve problems. Sometime, whether in terms of proteins or colloids or nerve nets or overt behavior, the relevant branch of science may reach the stage where a similarity notion can be constructed capable of making even the notion of intelligence respectable. And superfluous.

In general we can take it as a very special mark of the maturity of a branch of science that it no longer needs an irreducible notion of similarity and kind. It is that final stage where the animal vestige is wholly absorbed into the theory. In this career of the similarity notion, starting in its innate phase, developing over the years in the light of accumulated experience, passing then from the intuitive phase into theoretical similarity, and finally disappearing altogether, we have a paradigm of the evolution of unreason into science.