One Epistemological Interfield Relation

Joyce Kinoshita

College of the Holy Cross

1. Introduction

In recent decades, much work has been directed toward clarifying the *logical* relations among various sciences. Because of an emphasis on the logical aspects of interfield relations, the issue of scientific unity often wore a distinctly logical mantle.[1] For example, Robert Causey, a prominent philosopher of this tradition, has linked scientific unity and progress to a project of successive microreductions. He states, "Other things being equal, we tend to feel that our understanding of a class of phenomena increases as we develop increasingly general and intuitively unified theories of that class of phenomena. It is therefore natural to consider the possibility of one very general, unified theory which, at least in principle, governs all known phenomena." (1977, p. 1)

Kinds of unity separable from reductive logical unity have, of course, been proposed; these include reductive and nonreductive unities of method, translation, and ontology. For example, J.A. Fodor (1974) has argued for a broad kind of ontological unity of token physicalism, and against type reduction.

Lately, however, interest has shifted away from the search for unity. For good and varied reasons, it is now not at all unusual to assume that unity is not possible and/or not desirable. I. Hacking, humorously proposing an alternative to the "fantasy" of logical and ontological unity, writes, "I myself prefer an Argentine fantasy. God did not write a Book of Nature of the sort that the old Europeans imagined. He wrote a Borgesian library, each book of which is as brief as possible, yet each book of which is inconsistent with every other." (1983, p. 219)

Still, for two very different sorts of reasons, I would like to redirect attention toward the ways in which various scientific fields are related. First, there is an interesting class of interfield relations, here dubbed *cluster relations*, which appear to be a simple sort of ontological unity; I would like to show that they are not what they appear to be. Second, Causey and other enthusiasts of unity do have an important insight regarding the epistemological importance of relating seemingly disparate fields. Investigation of cluster relations reveals how non-logical, non-reductionist relations among fields might still fulfill part of Causey's desideratum of understanding through unity.

PSA 1988, Volume 1, pp. 48-54

2. Cluster Relations

First a few words about what cluster relations are not. They are not part-whole relations. Scientific fields related by part-whole relations do not simply share in studying one entity or phenomenon; rather, some basic entities of one science are said to be parts of another science's basic entities. For example, organic chemistry and cell biology might be said to be related in this way; organic molecules and reactions might be thought of as the microconstituents of cells and cellular activities. This characterization of part-whole relations is, of course, horribly simplistic.[2] I mention it first only so that part-whole relations are *not* confused with the cluster relations discussed here.

In contrast to part-whole relations, some scientific fields do seem to share the study of *one* important phenomenon or entity. Unreflectively, they are said to study different aspects of this one entity, or they are said to study this one entity by different methods, or with different aims. This one entity is not the only important phenomenon studied by each of these fields, but they do recognize this shared phenomenon as important. For example, the "one" phenomenon of color is studied by many different fields; similarly, the "one" phenomenon of memory is a focus of many different fields. Let us say that these different fields which all share the study of one such entity are *members* of a *cluster*; the members participate in a cluster relation. What is interesting about these clusters is the precise sense in which they both do and do not study one shared phenomenon. On the one hand, they obviously do not share any phenomena. They do not study different parts of one "macro" entity, nor do they apply different methods and interests to the study of one shared entity. On the other hand, neither are they completely unrelated; there is some sense in which they do all share one phenomenon. Let us turn directly to the "color sciences" and the "memory sciences" to investigate this further.

There are at least three different, but related, fields which study the "one" phenomenon of color. We can study light as electromagnetic radiation; different colors of light are studied in terms of their different wavelengths. Here, we consider color to be a matter of the nature of light itself, and we can study light's physical properties without regard to any human sensors or any illuminated objects. We can also consider color to be a property of objects. We can study the physico-chemical properties of an object's surface, in virtue of which certain wavelengths are absorbed and reflected. We can study the physical properties of objects which enable them, under specific conditions, to emit or to scatter light. In this sense, colored objects remain colored even in the absence of incident light; they have a certain surface structure or a certain physical excitation state regardless of ambient light, and regardless of the presence of spectators. We might also consider color to be a sensation of an observer. For example, colorimetry studies color matches (metamers) in terms of the perceptions of a standardized observer. Different spectral energy distributions are, under certain conditions, capable of evoking the same color perception. Without changing an object's chemical surface structure, we can change the color sensation it produces in us by changing the backgrounds against which the object is displayed, or by pre-exposing our eyes to various sorts of light. Color can thus be considered a matter of relations among "tristimulus values" rather than a matter of light's specific wavelength, or the chemical and physical properties of colored objects.

Note that the locus of color differs for each of these fields. Moreover, some concrete situations may arise where color exists for one field but not for another.

The study of memory provides us with a similar example. Memory can be studied chemically; we might (e.g.) study the precise molecular structure of neural phosphoproteins. Here, memory is studied as a chemical phenomenon. Memory can

https://doi.org/10.1086/psaprocbienmeetp.1988.1.192968 Published online by Cambridge University Press

also be studied in terms of whole brain processes and brain systems; similar brain processes and systems may involve different chemical or brain phenomena. In addition, memory can be studied in terms of whole organism behavior. Indeed, species with vastly different brain processes and systems may produce investigatable memory behavior.[3]

In the case of the various color studies, there is no entity, color, which is variously studied by electromagnetic studies, chemical optics, and colorimetry. These fields "find" color in different places: in light, in objects, in sensations. The three sciences study different phenomena. Although in some sense they are all studying color, there is no entity, color, which has these three different aspects to study. Similarly, although neurochemistry, neuropsychology, and behavioral psychology somehow all study memory, there is no common object of inquiry, memory, which has chemical, structural/functional, and behavioral aspects.

The color sciences may have some explanatory relations; for example, electromagnetism explains what the radiation emitted by a red-hot iron is. But this is not the only way that they are related, for they are also somehow related in all studying color. Yet, electromagnetism does not explain what color sensation or chemical surface structure are. Similarly, whatever other logical or explanatory relations the memory sciences may have, they are related in all studying memory.

What is the sense in which all of the members of a cluster study one phenomenon? A cluster of sciences is a cluster in virtue of a shared *unifying case*. For example, the *unifying case* for the color sciences might be,

> Light (radiant electromagnetic radiation) strikes an object, which absorbs some and reflects some; and the reflected light is sensed by an observer.

The unifying case for the memory sciences might be,

> A stimulus, presented to a person, causes certain chemical syntheses in the brain, certain brain processes, and certain overall behavior patterns.

The situation described by a unifying case is not itself an intrafield basic entity of any of the member fields. For example, the total complex phenomenon described by the unifying case for color is not basic to electromagnetism in the way that electromagnetic radiation is basic; it is not a basic intrafield entity. Nor is the unifying case some kind of extra-scientific phenomenon; it is not non-theoretical. Rather, the unifying case is an *interfield conceptual paradigm of how the fields are related.* It is indeed quite theoretical, for it draws on the theories of all its member fields. It describes one complex sort of interfield phenomenon, and includes basic intrafield sorts of phenomena from each of the member fields as important elements within its complex nexus. There may or may not be an articulated interfield theory, a theory for which the unifying case is basic in the way that electromagnetic radiation is basic for electromagnetism.

It is the unity of the interfield unifying case itself that enables each of the member fields truly to be sharing a phenomenon. The interfield phenomenon is not basic to any of the member fields; thus, the members do not study a shared intrafield phenomenon. The member fields do not investigate different aspects of one intrafield phenomenon. Nor do they simply investigate different aspects of the interfield phenomenon, for the case described by the unifying case is merely paradigmatic; the paradigm shapes the interfield organization of the various fields, but does not shape the internal, intrafield organization of any member field. Each member field investigates *all* of the aspects of its intrafield entities it deems important. For example, electromagnetism studies the

https://doi.org/10.1086/psaprocbienmeetp.1988.1.192968 Published online by Cambridge University Press

nature of light without regard to the presence or absence of color observers. It would not quite be accurate to say that it studies an aspect of a situation in which light is perceived by observers.

The unifying case displays a situation as epistemologically privileged, but it is not necessarily descriptive of the all of the kinds of situations which the member fields investigate. The situation it does describe is, however, displayed as typical, central. It displays a conception of how the member fields cohere, a way of seeing the relation of their various objects of study. It does this by giving special epistemological status to a situation where some phenomena of each of the member fields are mutually related. In each of the two examples considered here, the relation is causal. Because the relation is causal, the unifying case unifies in two ways. First, two seemingly disparate phenomena are shown actually to be causally related, disparate no longer. Second, the causal connection enhances the possibility of fruitful interchange among member fields. For example, if two different phenomena are different sorts of effects of a shared cause, then knowledge of one effect may be useful in the investigation of the other. Similarly, if one sort of phenomenon typically causes another sort of phenomenon, then the respective studies of each sort may usefully cross-fertilize the other.

The unifying case for memory displays chemical synthesis, extended brain processes and behavior all as effects of some unspecified stimulus. The unifying case for color displays the causal interaction of light, object, and sensation. We may go on to study light in itself, or objects in themselves, or sensations in themselves; and *each instance of color need not involve the causal interaction of these three kinds of phenomena*. But the unifying case gives the fields an interfield perspective, a perspective external to the intrafield basic entities, aims, and interests constitutive of an individual field.

Cluster relations, like interfield explanatory relations, may be extremely helpful to the progress of the individual fields, but they are not necessary for much of their individual normal research. Cluster relations are also piecemeal. The member fields may cluster about a given unifying case, but each field also goes beyond it. Neurochemistry studies molecules and reactions other than those involved in memory. Behavioral psychologists extend their studies beyond memory behavior. Moreover, a given field may be a member of several different clusters. The unifying effect of a unifying case is thus far less than that of "completed" logical or ontological reduction.

3. Two Virtues of Piecemeal Relations

Unifying disparate scientific fields has at least two (related) sorts of virtue, pragmatic and epistemological. Pragmatically, the paradigmatic unifying case can help propel the progress of each of the member fields by increasing communication and cross-fertilization. (See Maull (1977) and Darden and Maull (1975).) In order for the unifying case to play this role, however, it must be accepted by the members. The members mutually understand each other as members, if they all accept the same appropriate unifying case. Membership can thus be disputed in two ways. A cluster may accept a unifying case which legitimizes (e.g.) the study of sensations as related to it, but may reject a particular science of sensations as nonscientific. On the other hand, members of a cluster may refuse membership to a field because it does not fit their unifying case. A field seeking membership may be promoting a unifying case which the other fields will not accept. In such a case, the lone field may see itself as unified with the others, even though the others may not accept the unity. Ideally, acceptance is mutual, for this facilitates communication and cross-fertilization. But the pragmatic benefits of the unifying case are available, if at all, to all and only the fields which accept the unifying case. And, like explanatory relations, cluster relations may change; once-accepted unifying cases may, over time, be changed or rejected.

Acceptance or rejection of a unifying case is not always clearcut. One indication of acceptance is interfield communication and cross-fertilization (Maull 1977). Another indication of acceptance is outright statement of the unifying case in monographs and textbooks. But because it is possible to carry on much of the normal intrafield research of a science independently of interfield commitments, it is possible for individual scientists to reject a unifying conception shared by others.

An example of such disagreement is reported in *The Science of Color* (Optical Society of America (OSA) 1953). In 1922, the OSA formulated a standard definition of color in this way: "Color is the general name for all sensations arising from the activity of the retina of the eye and its attached nervous mechanisms, this activity being, in nearly every case in the normal individual, a specific response to radiant energy of certain wavelengths and intensities." (OSA 1953, p. 6) In the 1930's, however, a bitter controversy arose over the issue of whether color should be defined as a sensation. The battled was fought for nearly twenty years. It threatened the interfield unity among those who worked with sensations and those who studied the physics of light, but it did not halt the normal intrafield research of each of the fields. By 1953, the Committee on Colorimetry was able to secure enough agreement on the interfield relations to publish a new standard definition of color: "Color consists of the characteristics of light other than spatial and temporal inhomogeneities; light being that aspect of radiant energy of which a human observer is aware through the visual sensations which arise from the stimulation of the retina of the eye." (OSA 1953, p. 221) By 1983, a monograph on the physics and chemistry of color could blithely specify three loci of color: objects, light, and sensations. In *The Physics and Chemistry of Color*, Kurt Nassau states, "The term *color* is properly used to describe at least three subtly different aspects of reality. First, it describes a property of an object of an object, as in '*green* grass.' Second, it describes a characteristic of light rays, as in 'grass efficiently reflects *green light* while absorbing light of other colors more or less completely.' And, third, it describes a class of sensations, as in 'the brain's interpretation of the specific manner in which the eye perceives light selectively reflected from grass results in the *perception of green*." (1983, p. 3)

Cluster relations may also provide epistemological benefits. That is, Causey has argued that the reason interfield unity is desirable is that it promotes understanding. He states, "We increase our understanding mainly by constructing explanations of previously discovered knowledge, and by organizing the knowledge and explanations into systematic and general theories." (1977, p. 17) Later, he adds, "although most understanding results from explanations, I believe that our understanding is also increased to some extent by the systematic organization of our knowledge." (1977, p. 167) Causey has an important insight: we have a gain in understanding when we are able to see how two seemingly unrelated bodies of knowledge are actually related. Some bodies of knowledge may indeed be systematized by logical and ontological relations, but lack of derivational and/or ontological systematization needn't imply lack of interfield organization. There may be other, non-reductive, ways to organize bodies of knowledge that display how they are related. Perhaps Causey could argue that logical and ontological reduction provide a better sort of understanding. Perhaps such a case could be made; I will not argue here the relative values of kinds of understanding. But there is some middle ground between reductive understanding and no understanding at all. Cluster relations are not themselves reductions, and yet they are means of seeing how seemingly disparate sciences are related.

In order for cluster relations to provide this epistemic benefit, however, the unifying case must satisfy an anti-Protagorean criterion. While the unifying case need not be descriptive of every instance of the shared phenomenon, it must be central and it must at least be warrantedly assertable by the member fields. Believing in a unifying

https://doi.org/10.1086/psaprocbienmeetp.1988.1.192968 Published online by Cambridge University Press

case does not make it warrantedly assertable any more than simply believing it true will make it true. The events or entities cited as causally connected by the unifying case must in fact be causally connected, at least in the important central cases. A group of scientific fields could mistakenly hold that they were related by a unifying case; these fields might even derive pragmatic benefits of communication and cross-fertilization while having only an apparent gain in interdisciplinary understanding.

This investigation of cluster relations, though cursory, still indicates that interfield relations are complicated, multifaceted. Fields may not only be logically, theoretically, and/or ontologically related, but also *epistemologically* related. Moreover, even piecemeal interfield relations may provide pragmatic and epistemological benefits. Without embracing the desideratum of reduction, we can still reaffirm the importance of investigating interfield relations of all sorts.

Notes

[1]I borrow the term "interfield" from Maull (1977) and Darden (Darden and Maull, 1977). Their two important papers also focus on the non-logical relations among the sciences. They present valuable insights on how some explanatory relations may come about and how terms may undergo transformation. While I do not at all discuss relations and transformations of *terms*, the interfield relation I do discuss is intended to supplement, not replace, Maull's and Darden's insights.

[2]Sklar (1967) and Nickles (1973) have long ago pointed out some of the complexities of logical and ontological relation. In these two articles, they concentrate on reductive relations, but many of their points hold for partial logical and ontological relation as well.

[3]A recent article in *Science* discusses the neuropsychological approach to memory (Squire 1986). In this article, Squire urges that all three approaches are important for understanding memory.

References

Causey, R. (1977). *Unity of Science*. Dordrecht: Reidel.

Darden, L. and Maull, N. (1977). "Interfield Theories," *Philosophy of Science* 44: 43-64.

Fodor, J. (1974). "Special Sciences (Or: The Disunity of Science as a Working Hypothesis)." *Synthese* 28: 97-115.

Hacking, I. (1983). *Representing and Intervening*. Cambridge: Cambridge University Press.

Maull, N. (1977). "Unifying Science Without Reduction." *Studies in History and Philosophy* 8: 143-162.

Nassau, K. (1983). *The Physics and Chemistry of Color*. New York: L. Wiley and Sons.

Nickles, T. (1973). "Two Concepts of Intertheoretic Reduction." *Journal of Philosophy* 70: 181-201.

Optical Society of America (1953). *The Science of Color*. New York: Crowell Co.

Sklar, L. (1967). "Types of Inter-Theoretic Reduction." *British Journal for the Philosophy of Science* 18: 109-124.

Squire, L. (1986). "Mechanisms of Memory." *Science* 232: 1612-1219.

https://doi.org/10.1086/psaprocbienmeetp.1988.1.192968 Published online by Cambridge University Press