Why is Metaphor like a Model? Epistemic and Cognitive Uses of Scientific Metaphors

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1. *Big Message*

Metaphors have multiple uses: rhetorical, heuristic, epistemic. Not all metaphors are alike. I am interested in cases where metaphors have epistemic force, albeit often a weak one. I argue that they are best understood as models; note, however, that this has nothing to do with claims about analogy, similarity, etc.

Viewing metaphors as models provides the best way to understand the function of the metaphors I'll discuss. Seeing what viewing them as models entails helps adjudicate differing accounts of what models are. In particular, similarity between a model and the modeled system is required by some accounts of scientific models, but the notion is fraught with difficulties (Goodman; Suarez). Metaphors are typically too ambiguous and open-ended to establish a robust similarity relation. On the alternative account I endorse the relationship between model and system is constituted by the manipulations the model permits. This relationship is one of exemplification of structural (relational) properties (cf. Catherine Elgin) and models themselves are understood to be fictions (cf. Roman Frigg etc.) My account explains why metaphors, even those appropriately understood as models, are typically only weak models.

I will illustrate how metaphors can serve epistemic purposes by showing how Richard Goldschmidt used a metaphor to give a counter-example, refuting the validity of an inference drawn from empirical results (see Lamm, 2008).

I will then show the limits of metaphors as models by showing another Goldschmidtian metaphor, one that is arguably more confusing than illuminating, and comparing it to Bacon's Cupid metaphor of the atom.

Generalizing from this discussion, I will argue that some metaphors have enough structure to serve as models. To support this claim I will say a few things about how structure is established by these metaphors. I will generalize and argue for a structuralist-manipulative account of (some) models as examples (rhetorically) and exemplars (as systems).

2. *Goldschmidt's Violin String Metaphor*

> *If I stop the A string of a violin about an inch from the base, the tone C is produced by the string. This does not mean that the string has a +C body at that point which, when stopped, becomes C.* — Richard Goldschmidt, 1946, p. 252.

The metaphor is clearly used "to think with". It's not just a rhetorical device.

The metaphor *is* the counter example (i.e., the *same argument* properly instantiated applies to the chromosome and to the violin string (and then rejected)).

The metaphor is a model system, to which you can apply the same arguments that purportedly apply to the target system (i.e., the chromosome).

However, the structure of the metaphor [the violin string] is implicit, and emerges from the way the metaphor is used (linear object, localized disruption, functional response). As is the matching between the domains.

3. *Creating Structure by Manipulation / The Sentence Metaphor*

> *Let us compare the chromosome with its serial order to a long printed sentence made up of hundreds of letters of which only twenty-five different ones exist. In reading the sentence a misprint of one letter here and there will not change the sense of the sentence; even a misprint of a whole word (rose for sore) will hardly impress the reader. But the compositor might arrange the same set of type into a completely different sentence with a completely different meaning, and this in a great many different ways, depending upon the number of permutating letters and the complexity of the language (the latter acting as "selection")*. — Goldschmidt, 1940, 248.

Manipulations expose/establish the articulated structure of the metaphor. In this example, it is "language" as mediating between structure and function. The "similarity" (such as it is here) between the domains matched by the metaphor is in the relations between the articulated parts. The relations are identical (not merely "similar") in the two domains, otherwise the matching is rejected. Via the afforded manipulations the metaphors both refer to and instantiate the properties they expose.

This view is opposed to the prevailing naive view of metaphor as a mapping between two independent domains, previously articulated into parts.

Thus, the manipulations of the metaphor tell us about any target that has the identical structure (identifying the parts that match, after the manipulations expose the structure, to get an identical structure, is non trivial).

As this example illustrates, the manipulations a metaphor affords are not limitless; they depend on the latent structure of the metaphoric domain, yet they play a role in constituting the ultimate structure the metaphor exposes.

> *If they be two, they are two so / As stiffe twin compasses are two, / Thy soule the fixt foot, makes no show / To move, but doth, if the'other doe.*
>
> *And though it in the center sit, / Yet when the other far doth rome, / It leanes, and hearkens after it, / And growes erect, as that comes home.*
>
> *Such wilt thou be to mee, who must / Like th'other foot, obliquely runne; / Thy firmnes drawes my circle just, / And makes me end, where I begunne.* — John Donne, A Valediction: Forbidding Mourning.

While clearly not a scientific model or account, the compass and the lovers are presented as having identical structural relationships.

As in literature, where "the emotion evoked by a good conceit is not simply surprise, or, in Dr. Johnson's terms, wonder at the preversity which created the conceit, but rather a surprised recognition of the ultimate validity of the relationship presented in the conceit" (Princeton Encyclopedia of Poetry and Poetics, '65), for a scientific metaphor to serve as successful model, its manipulation should prove to have "ultimate" validity, here judged using scientific rather than aesthetic criteria.

4. *Structure of Metaphor*

Note the tension between:

1.Manipulations depend on (are relative to) structure.

2.Manipulations constitute/establish structure.

The tension can be resolved by distinguishing between the *latent structure* that exists in the description and the *ultimate structure* that comprises the actual metaphor or model. Thus:

1.Manipulations depend on (are relative to) *latent* structure.

2.Manipulations constitute/establish *ultimate* structure.

5. *Models as Examples and Exemplars*

Models are fictions (see Frigg, 2010). But what kind of fictions? My answer in a nutshell: Manipulable fictions. The principle of generation (a la Walton) is that appropriate manipulation of the prop maintain truth about the modeled system. The richer the set of allowed manipulations and the larger the subset of them that maintain the fit of the model to the modeled system the better the model. The manipulations are make-belief. The identity of the relational properties is not part of the pretense that produces the structure, however, it is noted "after we leave the pretense" or "by oscillating" in and out of pretense (cf. Camp, 2009, p. 115). There is no need to "translate facts about the model to facts about the system"' (cf. Frigg, p. 126); once constituted in pretense, the (relational) properties are the same.

Which properties are exemplified, the "telling properties" (Elgin, 2009, p. 7), of the metaphor? Those structural properties that are (legitimately) established and those that can be (legitimately) manipulated. While this may not be a good way to identify them a priori, we are often shown which manipulations are appropriate (e.g., in the sentence metaphor). Another possibility, of course, is to use the metaphor to explore this question (i.e., we stipulate the exemplar relation, and see which manipulations are appropriate in the sense of being faithful to it, rather than destroying it).

Q: Is the metaphor a model specification (description) or the model?

I am drawn to saying that these metaphors (i.e., the metaphoric content) shouldn't be understood as model descriptions, but as the models per se (keeping in mind that not all metaphors are models). The model is constituted by the metaphors and the legitimate manipulations. On this account charges of vagueness or imprecision often attributed to "analogical models" evaporate. This does not mean there is no difficulty in using these models, but we need to be more careful in pinpointing why and how this happens. It rests on the type of systems metaphors are and the way inferences about them are translated to conclusions about the target system.

6. *Does this account have legs?*

Here is an example that can be taken as undermining the tolerant view of metaphors as models.

> *[Cupid] is described with great elegance as a little child... for things compounded are larger and are affected by age; whereas the primary seeds of things, or atoms, are minute and remain in perpetual infancy.... [He is] represented as naked... there is nothing properly naked, except the primary particles of things...The blindness... [For] it seems that this Cupid, whatever he be, has very little providence; but directs his course, like a blind man groping, by whatever he finds nearest... His last attribute is archery: meaning that this virtue is such as acts at a distance* — Francis Bacon, Of the Wisdom of the Ancients (1857), Cupid Or the Atom.

Bacon lists properties, but does not really manipulate the metaphor. There is very little structure or relationships between the properties.

7. *What types of conclusions can be drawn from these models?*

Ultimately a question for the community. But I want to highlight two interesting cases from the examples discussed earlier.

(1) Negative conclusions based on using the models as counter examples.

(2) Conceptual possibilities (e.g., language as selection).

As Elgin notes (p. 13), fiction can exemplify the grounds for conclusions. This is what happens here. The grounds are structural (relational), and reflect the constitutive manipulations.

Simply put, here's the account of models/modeling I propose: modeling involves studying one system — primarily via the ability to manipulate it — as a means for studying another. I argued that manipulability is the hallmark of models which are meant to provide a way for studying modeled systems via the manipulations of their models (rather than by manipulating the original system). The type of manipulability that is required makes use of the model having an organized, ideally well-specified, articulated fine structure (latent structure). Literary metaphors, as well as scientific metaphors invoked merely to rhetorical effect, need not exhibit the structure required in order to support internal manipulability. But sometimes they do, and potentially serve as models.

Does the parenthetical remark about language as selection really provide any insight about the biological system presumably being modeled? In other words, what is the point of modeling, if it offers so few guarantees? I agree with Cartwright (see her 2010) that the lessons drawn form a model depend on practices of interpretation; these are inherently social. There is no fixed "translation key", either in time or among the various inferences the model supports (cf. Frigg, 2010). Note that in my account the "key" is used for the matching (string/chromosome; mutation/stopping; sound/function), not translation of conclusions; the relevant facts are grounded in the exemplified relations. Models as such, and also some kinds of metaphors, expose and make salient relevant structure and manipulations. Elgin talks more generally about representations exposing features.

These factors affect the epistemic strength of models and explain why metaphors, even those appropriately understood as models, are typically weak models. They are particularly effective as how-possibly explanatory models (phenomenological models) that suggest how a complex notion or behavior manifests itself in a familiar context, without warranting strong inferences about the modeled system.

In conclusion: Viewing these metaphors as models provides the best way to understand the function of the metaphors. Seeing what viewing them as models entails helps adjudicate differing accounts of what models are.