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A simple traffic-light semiotic model for tagmemic theory

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Abstract: The complexity and flexibility of tagmemic theory, as a semiotic theory developed by Kenneth L. Pike, can be better understood by examining how it applies to a simple semiotic system like traffic lights. We can then compare the result with how it functions in analyzing a piece of natural language. Tagmemic theory introduces three observer viewpoints – the particle view, the wave view, and the field view. Each view generates a suite of questions to answer. Any one of the views results in a "complete" description of traffic lights, from which the information about the other views can be inferred. And yet each view is distinct in texture from the others, and the existence of such multiple views – each with a claim to emic integrity and each serving as a perspective on the whole – has to be accounted for in a robust semiotic approach. The same phenomena occur when we apply the three views to the analysis of meaning in natural language. The chief illustration is to analyze the meaning of the word *dog* in multiple ways. The multi-dimensional potential for semiotic analysis highlights the limitations of Aristotelian logic and symbolic logic, both of which simplify for the sake of rigor.

Keywords: tagmemic theory, particle, wave, and field views, observer viewpoint, emic, perspective, Kenneth L. Pike

Tagmemic theory (Pike 1967, 1982; Pike and Pike 1977) is really a semiotic theory, not just a theory of language. Can it be formalized? Probably not without losing a good deal of its distinctive strengths. But we can try to build a simplified model for how it works when applied to a small semiotic system other than language – in our case, a system of traffic lights. By illustrating the workings of tagmemics, a model can help us to visualize the character of the theory when applied to semiotic systems that are far more complex, and for which its multiple dimensions of analysis are intrinsically adapted.

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1 Challenges due to flexibility in tagmemics

Tagmemic theory has never enjoyed the popularity of theories like transformational generative grammar, with their combination of rigor and clean formalized representation. The vagueness of some of the categories in tagmemics, and their resistance to pure formalization, have often seemed to be drawbacks. But in a way the weakness can also be a strength. The flexibility in the systematizing categories developed by Kenneth Pike, together with his refusal to eliminate the human participant from the theory, allowed tagmemic theory to be generalized from a theory of language structure to a theory of the structure of human behavior (Pike 1967; Waterhouse 1974: 15). So it became intrinsically a semiotic theory and not merely a theory of natural languages. Moreover, tagmemic theory refused to eliminate meaning. In fact, it emphasized the indispensability of meaning by its insistence on form-meaning composites (Pike 1967: 9, 62–63, 1982: xiv, 16, 115–117). The attention to meaning gives it relevance to all forms of semiotic systems. It has welcomed multiple viewpoints on sign systems, rather than a single monolithic viewpoint.

How then can a multifaceted approach of this kind be formalized? In one way it cannot. It is too complicated. But the complexity can become more tractable if we consider a simple semiotic system to which we apply the theory.

2 A system of traffic lights

Consider, then, a traffic light with three colors, red, amber (yellow), and green. Since there are variations around the world, we will focus on the American system of lights. Red signifies "stop"; amber signifies "caution"; green signifies "go." The presence of signification indicates that the system of lights functions as a semiotic system (Hong et al. 1993: 14; Fontaine 2012; Atkin 2013: § 3.1; Hébert 2016). It can accordingly be analyzed using tagmemic theory. Along the way, we will compare various features of this system to the functions of the word *dog* within the semiotic system of American English, in order to illustrate how the simpler system throws light on functions within a more complex system.

All of our discussion will presuppose the etic/emic distinction introduced by Pike (1967: 37–72; Waterhouse 1974: 6; Headland et al. 1990). Apart from the exceptions noted below, we endeavor to use emic categories in analyzing traffic lights and the word *dog*.

3 Particle, wave, and field views

One of the more fascinating features of tagmemic theory is its explicit inclusion of the observer, and with that inclusion the possibility of attention to the observer's choice of multiple viewpoints (Pike 1976: 91, 1982: 3–4, 10–11). Pike speaks specifically of three distinct "views" that an observer can use in forming a linguistic theory: the particle view, the wave view, and the field view (Pike 1972 [1959]; Waterhouse 1974: 6, 90; Pike 1982: 19–38). But the labels for these views are highly metaphorical. Just what do we mean by them?

Building on work in information theory (Poythress 2013a), I suggest that we can make the three views more rigorously defined by thinking of each view as selecting out particular *kinds* of questions that it uses in querying semiotic data. The particle view prefers questions that ask about the occurrence or nonoccurrence of "particles," which are mutually exclusive. A green light, an amber light, and a red light are mutually exclusive. Each is "particle-like." In England I have seen red and amber lights on at the same time, functioning as a signal that the light is about to turn green. But even then, the red and amber lights do not occur at the same time *in the same place*. To be rigorous, a question about occurrence or non-occurrence must be asked specifically concerning one location and one time at that location.

3.1 A particle view of traffic lights

Using a particle view, we come up with an emic list of particle-like lights: plain green, plain amber, plain red, green arrow (left, right, or up), amber arrow (possibly pointing left, right, or up), and red arrow. (Red arrows are not common, but do exist. I have seen a left-pointing red arrow, which was used to indicate that a left turn was prohibited even when at the same time there was a plain green light for moving straight and turning right. A right-pointing red arrow has an analogous function.) Each of these types of light is to be associated with a specific question: "Does a plain green light occur at time *t* and location *L*?" Answering the question "yes" for a plain green light implies that the corresponding answer for a green arrow or a plain amber light will be "no." The answers are mutually exclusive, and this exclusion is characteristic of the particle view.

As in many cases of semiotic systems, a particle view is closest to how a naive observer would usually produce a classification. The wave view and the field view are less intuitive, and more likely to be produced by observers who are not naive, but are involved in a theoretical analysis.

3.2 A wave view of traffic lights

What would a wave view of traffic lights be like? A wave view prefers questions that ask about wave-like motion, whether it be literal motion in time or something analogous to motion in the form of a transition. While particles exclude the simultaneous occurrence of other particles at the same time and location, waves focus on questions where the answer to one question may lead almost certainly to a conclusion about another, related question. For example, if event B customarily accompanies or follows event A, the probability of B given A is high. In the usual temporal cycle of traffic lights, amber customarily follows green. Red follows amber, and green follows red. A wave view asks questions like "At time t and location L, is amber following green?" It is more complicated, in a way, to ask questions about one thing following another. But we can nevertheless eventually represent all the significant information about the behavior of a traffic light by including questions about all the combinations for one color following another, and by including a few umbrella questions like "does green follow (any light at all) at time t?"

3.3 A field view of traffic lights

Finally, what does it mean to use the field view? From the standpoint of information, the field view prefers to ask a group of questions that include questions that can be answered affirmatively at the same time. This kind of situation characteristically occurs when we start with particle-like units, and then analyze the units using multiple dimensions of description. For traffic lights, there are two obvious dimensions – the dimension of color and the dimension of shape. The color can be red, amber, or green. The shape can be a solid disk of color (what we earlier called "plain"), an up arrow, a left arrow, or a right arrow. (I do not recall seeing a down arrow.) Less commonly, there can also be arrows that point up and to the left, at an angle, or up and to the right. If for simplicity we ignore the less common directions, we have a two-dimensional grid (Table 1).

Table 1: Grid classification of traffic lights.

	Red	***Amber***	***Green***
Solid disk	red disk	amber disk	green disk
left arrow	red left arrow	amber left arrow	green left arrow
up arrow	red up arrow	amber up arrow	green up arrow
right arrow	red right arrow	amber right arrow	green right arrow

We can add a third dimension if we allow a distinction between a light that is constantly on and a light that is blinking.

The distinctive characteristic of the field point of view is the preference for questions that can be affirmed as “independent axes.” For example, “Is a solid disk of light occurring at time t and location L?” can possibly be affirmed simultaneously with “Is a green light occurring at time t and location L?” The two questions represent two independent axes, because the light can be green or not-green, and then, independent of which of these two options is true, the light can be a disk or a left arrow or an up arrow or a right arrow. Field-like questions are typically questions that ask about particular *features* characterizing particle-like units. In the usual case, including the case of traffic lights, the particular features are themselves emic units of a sort. But they are not “particle-like” units in the same way that a red solid-disk light is. They can occur simultaneously with other features belonging to several distinct dimensions or axes.

A summary of the atomic units for the field view might therefore include the natural labels within each axis, but nothing more. On the axis for color, we have the choices: red, amber, green. On the axis for shape, we have the choices: solid disk, left arrow, up arrow, and right arrow. There would be questions about the occurrence of any one feature – let us say the feature “red” – for each distinct time t and location L.

3.4 A suite of questions for each view

In sum, the particle view naturally leads to a suite of questions about semiotic data, such that the distinct questions are mutually exclusive (Poythress 2013a: 72, 79). If the questions are denoted A and B, this can be represented in terms of probabilities by $P(A \,\&\, B) \sim 0$, where “~” indicates approximation. The probability that A and B occur simultaneously at the same location is approximately 0. Answering one question A affirmatively implies answering others negatively with respect to a single time and location.

The wave view leads to a suite of questions in which answering some questions leads to high probabilities for the answers to other, related questions. If A denotes the question whose affirmative answer leads to high probability for B, we are saying $P(A \,\&\, \neg B) \sim 0$ (the probability of A and not-B [$\neg B$] is approximately 0) or (equivalently) $P(B \mid A) \sim 1$ (the probability of B given A is approximately 1 [certainty]). Finally, the field view leads to a suite of questions, in which at least some pairs of the questions can be simultaneously answered either yes or no. A and B are approximately independent (Poythress 2013a: 79).

When we take together the whole suite of questions arising from the particle view, we can obtain a full description of the situation once we have answers to all the questions within this one suite. The same is true if we take the complete suite of questions belonging to the wave view alone. And the same is true for the suite of questions arising from the field view. Each of the views, by itself, is in a sense "complete." We can picture everything about the system if we have the answers to *one* suite of questions – let us say the suite for the field view. At the same time, one suite of questions as a whole belongs to one view, and is distinct from the suite belonging to either of the other views. The suite is "complete" in the sense that it enables us to deduce answers to the questions in another suite. But in another sense it is *not* complete: no one suite, by itself, includes all possible questions directly within it.[1]

One point to notice here is that even with a simple semiotic system, multiple views are possible. And none of the views is artificial. They all notice things that are emic realities, realities that native participants in a culture know without self-consciously knowing that they know. The possibility of multiple viewpoints shows that not everything is being captured by a typical semiotic analysis that occupies only *one* of the three viewpoints. This conclusion holds true even though a description of traffic lights from the particle view alone locates in space and time every piece of relevant light. By analogy, the same principle could be illustrated with more complex semiotic systems, whether in music, dance, architecture, film, or Morse code. We now choose to illustrate the principle with natural language.

4 Particle, wave, and field views of *dog*

The clear distinction that we can make between three views of traffic lights helps to clarify what it would mean to apply these three views to natural language as a semiotic system. Of course, we must be studying a language *as a system*, rather

1 Mathematically, the questions can be represented as belonging to a Boolean algebra. Any one suite of questions, out of the three suites, will serve as a set of generators for the entire algebra (Birkhoff 1948: 163). The possibility of multiple choices for generators corresponds to the possibility of human observers choosing a particular view out of the three main possible views. Mathematical transformations allow a transition from one set of generators to another. Pike (1972 [1959]) acknowledges that the initial inspiration for his terms *particle, wave*, and *field* came from interacting with quantum theory. Interestingly, particle and wave views within quantum theory correspond roughly to different choices of basis (generators of a vector space) within the infinite dimensional Hilbert space representing the theory.

than only one piece of it, like the English word *dog*. But even a single word can serve illustratively if we use it as a starting focus, without pretending that we can actually rip it out of the larger system of the English language.

4.1 *A particle view of* dog

A particle view of *dog* treats it as a particle, a word, with its own exclusive integrity. Suppose the word *dog* occurs at a particular moment in time, location, and articulation by a particular person. Its occurrence *excludes* in a particle-like manner all the alternative words that could be used. This exclusion holds whether we focus on sound, grammar, or meaning-content (Pike's "lexemic" hierarchy and later "referential" hierarchy, Waterhouse 1974: 52–54; Pike 1982: 97–106). Meaning is particularly interesting, because it is particularly complex, and also crucially important. Using the word *dog* excludes other meanings – horses, pigs, sheep, and so on.

4.2 *A wave view of* dog

What happens with a wave view of *dog*? In a wave view, we look at the word *dog* not as if it were isolatable, but as participating in some literal or figurative motion or transition. When people use the word *dog*, they are in their intention going somewhere with it. They are intent on saying something about a particular dog or dogs in general. The meaning of *dog* does not in fact occur in isolation from a larger purpose, and the mental and auditory and grammatical and semantic aspects all *flow* from "dog" to "the dog" or "my dog" or "dogs bite" or "a dog needs food." The larger language units do not function just as grammatical constructions but as comments about a world, real or imaginary. Given that the meaning of *dog* occurs, it sets up a situation where a movement in some direction of meaning is probable: from the meaning *dog* to specification by a determiner, "a dog" or "the dog" or "my dog," and then out towards making the meaning of *dog* participate in some larger complex of meaning about my dog or dogs in general in the world.

4.3 *A field view of* dog

Next, how does a field view look at the word *dog*? A field view focuses on multiple intersecting features that can simultaneously apply to a particular particle-like unit such as the word *dog*. When we focus on the meaning of *dog*, we can have dimensions such as (1) the dimension of classification that distinguishes domesticated animals from wild animals and plants; (2) the dimension of technical taxonomical classification, where domestic dogs belong to a larger canine family (Canidae) that includes wolves, foxes, jackals, and coyotes; and (3) the dimension of food preferences, carnivore or herbivore or omnivore. The last of these classifications applies primarily to animals, but there can be carnivorous plants! The distinctions between domesticated and wild, between canine and non-canine, and between carnivorous and non-carnivorous, cut across each another. A "yes" answer to one does not exclude a "yes" answer to a question in another dimension, nor does it exclude a "no" answer.

5 Unit, hierarchy, and context

Let us next apply to traffic lights another triad of conceptions related to the particle, wave, and field views, namely the triad of unit, hierarchy, and context (Pike 1982: 39–136).

5.1 Units for traffic lights

Units are characterized preeminently by being distinguishable as wholes in relation to what is *not* the same unit. Units are naturally in focus with the particle view. But the field view also leads to units in the form of distinctive emic features (like "green" for the color of a light). But even in the context of a field view, the units still show a yes-no distinction from what is not the same unit.

In the case of traffic lights, the units are most naturally identified with the distinct kinds of lights, where we treat a red solid disk as distinct from an amber solid disk, which is distinct from an amber arrow.

5.2 Hierarchy for traffic lights

The next focus is *hierarchy*, which Pike associates with a wave view. It is naturally associated with the wave view because hierarchy focuses on the inclusion of smaller units within larger wholes. The presence of the whole generally implies the presence of certain pieces making it up, though the converse is less likely to be true. *W* for whole implies *P* for pieces. The probability of the occurrence of *P* given *W* is high. This kind of probability relation is characteristic of a wave view.

What is hierarchical about traffic lights? Some traffic light boxes have four or five rather than three disks, in order to have room for arrows of various kinds. But the most common traffic light has a box with three lights, red, amber, and green, from top to bottom. The box is a larger whole in which are embedded the three lights. The structure consists of two levels functioning in a hierarchy. The lower level consists in individual lights. The higher level consists in the box with its standard vertical arrangements of the three lights.

At a typical intersection between two streets, there will be at least four boxes, one facing in each of the four directions in which the streets stretch out. Or, at some intersections, there may be two, three, or more boxes facing in the same direction. One box may be positioned at the right-hand side of the street as seen by a car approaching the intersection. Another (or sometimes two or more) may be hung vertically above the area through which a car travels as it enters the intersection. The subsystem of boxes that face in a single direction can be considered as a single unit, constituting a third layer of hierarchy. Then we can take the total system of boxes facing in all four directions, and see that they constitute an organizational whole that is an emic unit. This level constitutes a fourth level in the hierarchy of lights. Certainly the traffic engineers who plan for the lights at the intersection are aware of the functional unity of the whole system. But even the casual driver knows – without being aware that he knows – how a number of traffic boxes function together to provide a system for controlling the movement of the traffic. He counts on the fact that when the lights facing him turn green, he can safely pass through the intersection, because the lights facing in opposite directions along the cross street will be red.

Thus we have at least four levels of hierarchy: (1) an individual light, which is either red, amber, or green; (2) an individual box with three lights in the box; (3) a subsystem of lights facing in a single direction; and finally (4) all the boxes belonging to a single intersection. In some instances, the traffic lights at any one intersection fit into a still larger system of lights that are designed to control the flow of traffic at a more comprehensive level – for example, a whole inner city area.

5.3 Contexts for traffic lights

The final focus among the three kinds of elements – unit, hierarchy, and context – is the focus on context. Context is intrinsically field-like or relational in character. Various contexts are present simultaneously with the piece that exists within the context. Answering one question leaves open both a yes and a no answer to a question about some other piece within the total context. As we could show in a more detailed analysis, the contexts include (1) the context of traffic that the lights are supposed to support; (2) the context of specific timing, which indicates *when* cars move where; and (3) the specific semiotic *system* of meaning presented by the complete complex of all the lights with their meanings (Poythress 1982: 290–293; compare Jakobson 1960: 353–358).

6 Contrast, variation, and distribution of units

Now we can consider in more detail what happens when the particle, wave, and field views are applied to the analysis of a single unit, such as a green disk light. Pike's tagmemic theory advocates that we analyze a single unit in three aspects or modes: contrast, variation, and distribution (Pike 1982: 41–65).

6.1 Contrast for traffic lights

Contrast is a particle-like aspect of the analysis, in that it separates a particular unit from other units that are distinct from it. Green is not red, nor is it amber. A yes to one question "Is it green" means a no to the other two related questions. It is important that the three colors chosen for the semiotic system of traffic lights be distinguishable easily. They are *also* distinguishable in most cases by vertical position within a box of lights. The *contrastive-identificational* features of a unit are those features that identify it positively ("green") and also distinguish it (contrastively) from other units (e.g. red and amber).

6.2 Variation for traffic lights

Variation is manifested in different kinds of green lights. A green light can be recognized as green even it is lighter or darker green, depending on the ambient light, and whether it is formed by a smaller or larger disk of light (red lights are sometimes made extra large for the sake of increasing visibility). The variations are wave-like, in the sense that a particular lighter or darker or brighter or dimmer green implies the presence of the semiotic meaning "go," but "go" need not imply the particularities of one shade of green. (*A* implies *B* but not vice versa.)

6.3 Distribution for traffic lights

Third, there is distribution. Distribution means distribution within a larger context. It is innately "field-like," because the context is there simultaneously with the piece on which we are focusing, and the two (the piece and the context) can often vary independently. Distribution includes distribution in class (the green disk light is one of a class of traffic lights, and the class includes the others colors and shapes), distribution in sequence (green comes before amber and after red in the normal sequence seen at intersections), and distribution in system (as we saw from the field view, a green disk light is identifiable in terms of a two-dimensional system, the dimension of color and the dimension of shape [solid or arrow]; Pike 1982: 62–65).

To describe in detail the variations in size and hue of a green or red light involves traveling beyond the emic awareness of the casual auto traveler. The manufacturers of traffic lights and the traffic engineers who design the systems have their own universe of discourse in which they make fine-tuned distinctions. Within this universe of discourse, or multiple universes, many of the fine-tuned distinctions would be emic. When the inquiry is about contrast, the main focus will be on those features that reliably distinguish a green disk from a green arrow or a red disk. The focus is on defining the boundary between a green disk and everything else. If the focus is on variation, the main concern is to define the inner "region" in which we find the entire range of variation in green disk lights. But if we were to define the boundary carefully enough, we could infer the inner region enclosed by the boundary. Conversely, if we were to define the inner region carefully enough, we could infer the position of the boundary at the edge of the inner region. (See Figure 1.)

Where does distribution fit? Distribution focuses on how a particular unit sits within a larger environment. If the environment were to be described

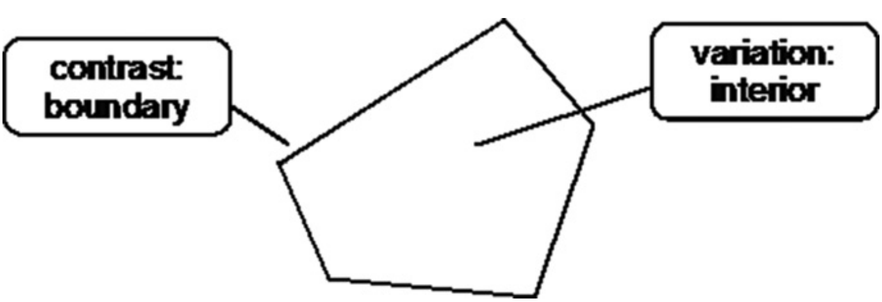

Figure 1: Contrast and variation together.

thoroughly, such a description would include a description of the distribution of the environment – the environment of the environment, if you will. And that description would include the original unit or units from which we started. Thus a thorough description of distribution intrinsically includes contrast and variation of the unit with which we started.

Moreover, a thorough description of contrast includes a description of the ways in which the distribution of a green light *contrasts* with the distribution of other kinds of light. So description of contrast, if it is thorough, includes information about distribution. The same holds true if we start with variation, because, as we have seen a thorough description of the "inner region" that is encompassed by variation would suffice to make inferences about contrast, and therefore also about distribution, which is encompassed by contrast.

Thus, contrast, if it is thoroughly analyzed, encompasses both variation and distribution. And the same is true of variation as a starting point, or distribution as a starting point. It might seem paradoxical that each encompasses the other. But they *start* with attention to different questions and different kinds of description. So the hierarchical organization of the entire description is different.

7 Contrast, variation, and distribution of *dog*

By analogy, we may extend the same type of analysis to the word *dog* within the semiotic system of the English language. Again, it is useful to focus on the meaning of *dog* rather than grammar, phonology, or graphology. The meaning contrasts with the meaning of other, related words – for example, words for other domestic animals and words for other members of the dog family, like wolves and coyotes. If we undertook a thorough description of the meaning boundary, with a focus on contrast, we would from this description be able to infer the "inner region" of meaning – all the particular kinds of dogs to which the word would fittingly apply. We could do such a description with respect to the common meaning of *dog*, in which it refers to domestic dogs of the canine family. Or we could do a similar description with respect to the dictionary word *dog*, which includes other meanings. The word *dog* can also be used to refer to describe "a worthless or contemptible person" or an andiron, or a hot dog.[2]

2 *Merriam-Webster Dictionary*, s.v. "dog." http://www.merriam-webster.com/dictionary/dog (accessed 8 August 2016).

8 Broader implications

These illustrations make it clear that observer viewpoint has a role in the analysis of many semiotic systems. Two different observer viewpoints need not be seen as competing with each other, so that the only question is "which is right?" Properly understood and properly executed, one observer viewpoint can in principle encompass all the "data" about the semiotic system, and from this one viewpoint a diligent and careful analyst may infer everything visible from the other viewpoints. The difference is in the choice of a starting basis. More than one basis is possible that makes good contact with the insider's point of view – emic awareness. Or we can have a basis used in preliminary etic contact with an unknown semiotic system, or a basis in a universal etic system used to classify phenomena from multiple emic systems across languages and cultures (Poythress 2009: 150–152). From the standpoint of tagmemic theory, as a semiotic theory about theories (Poythress 2013b), all the alternatives can be affirmed as legitimate, because they all represent natural observer interpretations of signs.

We can suggest that there are implications for the limitations of Aristotelian logic and symbolic logic. Formal logic offers a model that attempts to make rigorous the kind of reasoning that ordinary people are accustomed to do in thinking anchored in natural language. It is no doubt valuable in certain respects to have impressive rigor. But the rigor is bought at the cost of having minisystems of logic that emphasize contrast and the particle view (Poythress 2013c: ch. 19).

Consider, for example, the classic syllogism,

All men are mortal.
Socrates is a man.
Therefore, Socrates is mortal.

The validity of a syllogism depends on the key terms having univocal meaning: "man/men," "mortal," and "Socrates" must have the same meaning all the way through. And indeed in this particular case the stability of meaning within ordinary language is considerable. But there is fuzziness at the edge, for instance if we ask whether "mortal" means "will actually die" or "has the possibility of dying, is able to die." The working of formal logic depends on pretending that the contrasts, the edges of meaning as it were, are infinitely sharp. It is a simplification, as we can see if we undertake to use a multi-viewpoint approach such as semiotics can supply.

Because of the promise of rigor, it is tempting for some observers to make a permanent commitment to the “superiority” of formalism. Such observers might easily attempt to reduce semiotics to logic. But the situation can be reversed merely by changing our choice with respect to point of view. Semiotics can analyze mathematics (Poythress 1976, 2015: 158–159) and logic (Poythress 2013c: 73–79).

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