CHAPTER 12

TOWARDS A STANDARD TERMINOLOGY
FOR (BIO)SEMIOTICS

MARCEL DANESI

Department of Anthropology, Victoria College University of Toronto, Toronto, Ontario M5S 1K7
Canada

Abstract: Semiotic theory has often been burdened by terminological inconsistencies and especially
by the use of concepts and definitions in idiosyncratic ways. This paper aims to provide
a framework for eliminating such inconsistencies and idiosyncracies by putting forward
a simple system of terms based on Modeling Systems Theory, as developed by the
late Thomas A. Sebeok, that takes into account semiotic behavior across species. The
four basic forms proposed here (singularized, composite, cohesive, and connective) are
defined, illustrated, and defended as solutions for standardizing semiotic terminology and
for bringing general semiotic theory more in line with the biosemiotic movement

Keywords: Semiotic terminology, biosemiotics, semiotic theory, modeling systems theory

INTRODUCTION

When all is said and done, the fundamental goal of theoretical semiotics is to
figure out how signs are constituted and what kinds of functions they encompass.
The terminological frameworks developed by Ferdinand de Saussure (1857–1913)
and Charles Sanders Peirce (1839–1914) stand, to this day, as the standard ones
for pursuing this objective. But over the last five decades, a perusal of the major
writings in semiotic theory and practice reveals that terminological inconsistencies,
partisan factions (Saussurean vs. Peircean), and a host of *sui generis* neologisms
have sprung up that currently tend to tarnish the image of semiotics as a true
scientific enterprise. Even the fact that there is still no real agreement as to what the
science itself should be called—*semiology* or *semiotics*—is a symptom of the general
vagueness and terminological inconsistency that has beset the field throughout its
recent history (Deely 2003). Aware of this state of affairs and of the historical factors

that brought it about, the late Thomas A. Sebeok (1920–2001) initiated a project of trying to standardize the *modus operandi* of the field starting in the 1960s (e.g. Sebeok 1963, 1972). The project was itself inspired by the biosemiotic movement, which Sebeok promoted with a great deal of enthusiasm. Called the *global semiotic* project, it is still an ongoing concern (Sebeok 2001). The monumental four-volume handbook of semiotic theories and practices, which Sebeok instigated and helped to bring to fruition (Posner, Robering, and Sebeok, 1997–2004), is one of the first concrete indications that global semiotics has started to shape trends in theory and practice. The handbook is, fundamentally, an attempt to shift the focus of semioticians away from the human world of signs to the relation that inheres among the human (anthroposemiotic), animal (zoosemiotic), and plant (phytosemiotic) domains of semiosis. The premise held by Sebeok is that many (if not most) of the disparate terms and concepts used within semiotics can be easily integrated into a simple framework called *Modeling Systems Theory* (MST).

   The point-of-departure of MST is a renaming of the basic components of the sign, which is generally defined as the relation **[A stands for B]**, or **[A = B]** for short, in an unambiguous fashion. The **[A]** part is called a *form*, and the **[B]** part the *referent*. The linkage of the two dimensions produces a *model*, the **[A = B]** relation itself. Models exist across species; signs (in the traditional semiotic sense) do not. The crux of MST is that the **[A = B]** structure varies not only according to the modeling process utilized (simulation, indication, etc.), but also according to function. The purpose of this brief chapter is to present the main features of MST in schematic form, since I believe that they cohere into an approach that can truly provide a terminological framework for uniting future work in biosemiotics and semiotics generally.

FORM AND REFERENT

Before discussing MST, it is necessary to justify the use of the terms *form, referent,* and *model*, since these lie at the core of the MST approach. These terms are preferred to terms such as *signifier, signified,* and *signification* (among many others) because they are not only devoid of any partisan view of semiosis, but they overlap considerably with terminological practices in philosophy, psychology, mathematics, and linguistics, thus allowing semiotics to engage in a true meaningful interdisciplinary dialogue with these cognate fields. In Gestalt psychology, for instance, the notion of *form* is central to the understanding of cognition. Gestalt psychologists believe that form is the most important part of experience, giving coherence to each individual element of experience. A referent is simply what a form represents in virtually all fields. Finally, as in mathematics, a *model* is defined as any structure (formula, diagram, etc.) used to explain or describe relationships.

   A salient characteristic of organic life is the fact that it has the capacity to produce forms to communicate needs, urges, etc. and (in most cases) to make reference to events and objects in the immediate environment. This capacity goes under the rubric of *semiosis*, and its distinguishing trait is that it allows organisms to model

to the world they inhabit in species-specific ways. Human forms are differentiated from all other kinds of forms in that they are imbued with what is generally called "meaning." Indeed, the word *meaning* comes up constantly in semiotics, which is typically defined as the "science of meaning." But, then, what is *meaning*? As Ogden and Richards showed in their pivotal 1923 work, titled appropriately *The Meaning of Meaning*, there are at least 23 meanings of the word *meaning* in English.

To avoid such vagueness and ambivalence, the terms *reference, sense*, and *definition* are often used by cultural semioticians. Reference is the process identifying and naming something real or imaginary; sense is what that something elicits psychologically, historically, and socially; and definition is a statement about what that something refers to. Words may have the same (or similar) referents, but they also have different senses. For example, the "long-eared, short-tailed, burrowing mammal of the family Leporidae" can be called *rabbit* or *hare* in English. Both words refer essentially to the same kind of mammal. But there is a difference of sense—*hare* is the more appropriate term for describing the mammal if it is larger, has longer ears and legs, and does not burrow. Another difference is that a *rabbit* can be perceived as a "pet," while a *hare* is unlikely to be recognized as such.

The German philosopher Gottlob Frege's (1879) emphasis on the role of sense in theories of meaning became shortly thereafter a major area of discussion within both philosophy and semiotics (and continues to be so). Frege argued that sense was as central to meaning as was reference. His famous example was that of the "fourth smallest planet and the second planet from the Sun" as being named both *Venus* and the *Morning Star*. The two terms referred to the same thing, he observed, but they had different senses—*Venus* refers to the planet in a straightforward referential way (nevertheless with implicit allusions to the goddess of sexual love and physical beauty of Roman mythology), while *Morning Star* brings out the fact that the planet is visible in the east just before sunrise. Knowledge of forms (words, figures, etc.), clearly, includes awareness of the senses that they bear in social and historical context—a fact emphasized further by philosopher Willard O. Quine (1953). In his now-classic example, Quine portrayed a linguist who overhears the form *Gavagai* from the mouth of a native informant when a rabbit is sighted scurrying through the bushes. But the linguist, Quine goes on to remark, cannot determine if the word means "rabbit," "undetached rabbit parts," or "rabbit stage," all of which are senses of that word. The sense of the form, therefore, will remain indeterminate unless it can be inferred from the context in which *Gavagai* occurs.

Definition, as mentioned, is a statement about what something means by using words and other signs (for example, pictures). As useful as it is, the act of defining leads inevitably to circularity. Take the dictionary definition of *cat* as "a small carnivorous mammal domesticated since early times as a catcher of rats and mice and as a pet and existing in several distinctive breeds and varieties." One of the problems that emerges from this definition is the use of *mammal* to define *cat*. In effect, one term has been replaced by another. So, what is the meaning of *mammal*? A *mammal*, it states, is "any of various warm-blooded vertebrate animals of the class Mammalia." But this definition is hardly a viable solution. What is an *animal*? The dictionary defines *animal* as an

organism, which it defines, in turn, as an individual form of *life*, which it then defines as the property that distinguishes living *organisms*. Alas, at that point the dictionary has gone into a referential loop, since it has employed an already-used concept, *organism*, to define *life*. This looping pattern surfaces in all definitions. It suggests that signs can never be understood in the absolute, only in relation to other signs.

In contemporary semiotics, the terms *denotation* and *connotation* are preferred to reference and sense. Consider, again, the word *cat*. The word elicits an image of a "creature with four legs, whiskers, retractile claws," etc. This is its *denotative* meaning, which is really a mental picture of *cat* in terms of specific features that are perceived to define cats in general—"retractile claws," "long tail," etc. The denotative meaning allows users of signs to determine if something real or imaginary under consideration is an exemplar of a "cat." Similarly, the word *square* elicits a mental image characterized by the distinctive features "four equal straight lines" and "meeting at right angles." It is irrelevant if the lines are thick, dotted, 2 meters long, 80 feet long, or whatever. If the figure has "four equal straight lines meeting at right angles," it is denotatively a square. The word *denotation,* incidentally, is derived from the compound Latin verb *de-noto* "to mark out, point out, specify, indicate." The noun *nota* ("mark, sign, note") itself derives from the verb *nosco* ("to come to know," "to become acquainted with" and "to recognize").

All other senses associated with the words *cat* and *square* are connotative meanings—that is, they are meanings that are derivational or extensional and thus culture-specific. Some connotative senses of *square* can be seen in expressions such as the following:

She's so *square*.	=	"old fashioned"
He has a *square* disposition.	=	"forthright," "honorable"
Put it *squarely* on the table.	=	"evenly," "precisely"

Notice that an old-fashioned person, an honorable individual, and the action of laying something down evenly nevertheless imply the denotative meaning of "square." The concept of *square* is an ancient one and, thus, probably known by everyone (hence "old-fashioned"); it is also a figure with every part equal (hence "forthright"); and it certainly is an even-sided figure (hence "evenly"). Connotation encompasses all kinds of senses, including emotional ones. Consider the word *yes*. In addition to being a sign of affirmation, it can have various emotional senses, depending on the tone of voice with which it is uttered. If one says it with a raised tone, as in a question, "Yes?" then it would convey doubt or incredulity. If articulated emphatically, "Yes!" then it would connote triumph, achievement, or victory.

Connotation is the operative sense-making and sense-extracting mode in the production and decipherment of creative texts such as poems, novels, musical compositions, art works—in effect, most of the non-technical texts that people create. But this does not imply that meaning in technical (information-based) domains unfolds only denotatively. On the contrary, many (if not all) scientific theories and models are constructed connotatively, even though they end up being interpreted denotatively over time. Above all else, it should be emphasized that

connotation is not an option, as some traditional philosophical and linguistic theories of meaning continue to sustain to this day; it is something we are inclined to extract from a form. Even something as apparently denotative as a common digit invariably induces connotative meanings. The numbers 7 and 13 in many cultures reverberate with meanings such as "fortune," "destiny," "bad luck," and so on. These are hardly fanciful or dismissible. They tend to have real-world consequences, despite their apparent superstitious senses. This can be seen, for instance, in the fact that many high rise buildings in North America do not label the "thirteenth floor" as such, but rather as the "fourteenth," in order to avoid the possibility of inviting the bad fortune associated connotatively with the number13 to the building and its residents.

Abstract concepts, such as *motherhood, masculinity, friendship,* and *justice*, are particularly high in connotative content. In 1957, the psychologists Osgood, Suci, and Tannenbaum showed this empirically by using a technique that they called the *semantic differential*. The technique allows investigators to flesh out the connotative (culture-specific) meanings that abstract concepts elicit. It consists in posing a series of questions to subjects about a particular concept—*Is X good or bad? Should Y be weak or strong?* etc. The subjects are then asked to rate the concept on seven-point scales. The ratings are subsequently collected and analyzed statistically in order to sift out any general pattern they might bear.

Suppose that subjects are asked to rate the concept "ideal American President": for example, *Should the President be young or old? Should the President be practical or idealistic? Should the President be modern or traditional?* and so on:

Young								*old*
	$\bar{1}$	$\bar{2}$	$\bar{3}$	$\bar{4}$	$\bar{5}$	$\bar{6}$	$\bar{7}$	
practical								*idealistic*
	$\bar{1}$	$\bar{2}$	$\bar{3}$	$\bar{4}$	$\bar{5}$	$\bar{6}$	$\bar{7}$	
modern								*traditional*
	$\bar{1}$	$\bar{2}$	$\bar{3}$	$\bar{4}$	$\bar{5}$	$\bar{6}$	$\bar{7}$	
Attractive								*bland*
	$\bar{1}$	$\bar{2}$	$\bar{3}$	$\bar{4}$	$\bar{5}$	$\bar{6}$	$\bar{7}$	
friendly								*stern*
	$\bar{1}$	$\bar{2}$	$\bar{3}$	$\bar{4}$	$\bar{5}$	$\bar{6}$	$\bar{7}$	

A subject who feels that the President should be more "youngish" than "oldish" would place a mark towards the *young* end of the top scale; one who feels that a *President* should be "bland," would place a mark towards the *bland* end of the *attractive-bland* scale; and so on. If we were to ask a large number of subjects to rate the President in this way, we would get a "connotative profile" of the American presidency in terms of the statistically significant variations in sense that it evokes. Interestingly, research utilizing the semantic differential has shown that the range of variations is not a matter of pure subjectivity, but reveals, rather, a socially-based pattern. In other words, the connotations of many (if not all) abstract concepts are constrained by culture: for example, the word *noise* turns out to be a highly

emotional concept for the Japanese, who rate it consistently at the ends of the scales presented to them; whereas it is a fairly neutral concept for Americans, who tend to rate it on average in the mid-ranges of the same scales. Connotation is not, therefore, open-ended; it is constrained by a series of factors, including conventional agreements as to what signs mean in certain situations. Without such constraints, our forms would be virtually unusable. All semiosis (whether it is denotative or connotative) is a relational and associative process—that is, signs acquire their meanings not in isolation, but in relation to other signs and to the contexts in which they occur.

The distinction between denotation and connotation is analogous to Frege's distinction between reference and sense. And indeed these terms are used interchangeably in the relevant semiotic literature, as are Rudolf Carnap's (1947) terms intension (= denotation) and extension (= connotation). While there are subtle differences among these terms, it is beyond the present purpose to compare them. Suffice it to say that in current semiotic practice they are virtually synonymous:

reference	=	denotation	=	intension
sense	=	connotation	=	extension

The use of the denotation vs. connotation dichotomy is often credited to philosopher John Stuart Mill (1806–1873) but, in actual fact, it can be traced back to the medieval Scholastics, and in particular to William of Ockham (c. 1284-c. 1347). In both Ockham and Mill, however, connotation is used is a specialized way—it designates the specific referents to which a term can be applied. The distinction between denotation and connotation as we understand it today, on the other hand, was used for the first time by the American linguist Leonard Bloomfield in his seminal 1933 book called *Language*, a distinction elaborated by the Danish linguist Louis Hjelmslev (1970) a little later. Although Hjelmslev's treatment is a highly abstruse and largely confusing one, it nevertheless had the effect of putting this basic distinction on the semiotic agenda once and for all. Especially relevant is Hjelmslev's characterization of connotation as a "secondary semiotic system" for expressing subjective meanings. The French semioticians Roland Barthes (1977) and Algirdas J. Greimas (1987) subsequently made it obvious that connotation was an inbuilt feature of sign.

In MST the terms denotation and connotation continue to be used. However, the referents that they imply, called *denotata* and *connotata* respectively, are not unless they are required. Connotation is a uniquely anthroposemiotic phenomenon. If the case arises then a referent can be further specified as denotative or connotative. A referent is, thus, anything that is given form; it can be a mating request signaled by a coo, a territoriality sign (such as urination), and so on and so forth. Most referents manifest themselves as signals in animals; only in the human world do they crystallize as true signs (symbols, words, etc.) with connotative values. The relation itself, **[A = B]**, is a model, a form that is connected to a referent in some discernible way. In MST, therefore, it can stand for a signal, a sign, a text, etc.—anything that stands for something other than itself in some specific way and according to the biology of the species that emits and is capable of receiving it.

For example, most male birds sing from a series of perches that outlines their territory (the area claimed and defended). A typical song has two main purposes. (1) It warns other males of the same species to stay out of the territory; (2) it attracts a mate. To human ears, the songs of all the birds of a particular species may sound alike. However, each bird's voice sounds different to the other members of the species. Even in a crowded colony, parent birds can single out the voices of their chicks, and chicks recognize those of their parents. In MST terms, this is so because their forms are recognizable by each species as are their referents.

In 1974 Marcel Florkin suggested that the concepts of *signifier* and *signified* were equivalent to *genotype* and *phenotype* respectively, proposing that biosemiotics assumes the basic Saussurean conception of semiosis. Barbieri (1985, 2003) has, however, insinuated later that this proposal is not completely satisfactory since a cell has a triarchic structure consisting of genotype, phenotype and ribotype dimensions (the ribotype is the ribonucleoprotein system). So, rather than use terms that refer to human semiosis (signifier and signified, for instance), and which have a particular tradition within semiotics proper, the basic terminological proposal by MST is that simple terms such as *form* and *referent* are preferable because they allow for a larger inclusivity of phenomena. In effect, form is the genotype, referent the phenotype, and model the ribotype minus the specific biological connotations that such terms imply.

Model-making is especially prolific and creative in anthroposemiosis. Before building a house, a constructor will make a miniature model of it and/or sketch out its structural features with the technique of blueprinting. Explorers will draft a map of the territory they anticipate investigating. A scientist will draw a diagram of atoms and subatomic particles in order to get a "mental look" at their physical behavior. Miniature models, blueprints, maps, diagrams, and the like are so common that one hardly ever takes notice of their importance to human life; and even more rarely does one ever consider their *raison d'être* in the human species. Human model-making constitutes a truly astonishing evolutionary attainment, without which it would be virtually impossible for people to carry out their daily life routines. All this suggests the presence of a *modeling instinct* that is to human mental and social life what the physical instincts are to human biological life. In effect, the main tenet of MST is that the forms made by humans to understand the world result from this instinct. The modeling process can be simulative, whereby the form is designed to simulate its referent in some way (through resemblance, imitation, etc.). It can also be relational. The pointing finger is a relational form that is designed to show the spatial relation of some referent to the pointer or to some other referent. And, of course, it can be based on cultural conceptualizations. The form made with the index and middle finger in the shape of a "V" to stand for "peace" is the outcome of specific cultural events (which need not concern us here).

But modeling instincts occur in other species as well. As various contemporary biosemioticians have cogently argued (e.g. Hoffmeyer 1996, Sebeok 2001), such "instincts" are really strategies that allow members of the same species to convey information. For instance, the mating behavior of a fish called the three-spined

stickleback includes many examples of instinctive modeling behavior. The male stickleback chooses a mating area and drives other fish from it. He then collects plants and shapes them into a small mound. He wriggles through the completed mound, creating a tunnel, which is slightly shorter than the fish. The mound is a mating nest. Meanwhile, his normally dull-colored body undergoes a change in color—his belly becomes bright red and his back bluish-white. The male then starts to court females. Whenever a female enters his mating area, he swims towards her and performs a zigzagging "dance." He continues dancing until a female follows him to his nest, where she lays her eggs. The female then swims away, and the male fertilizes the eggs, staying near the nest to protect the eggs and, later, the neonates. Mound, tunnel, and dance are all examples of models in the biosemiotic sense being discussed here. Each male stickleback is born with the capacity to make such models built into his nervous system.

At this point, it is clearly obvious that it is necessary to distinguish between forms and models as they occur in Nature and as they are developed in cultural settings. The products of instinctive modeling tendencies can be called, simply, *natural forms* and those shaped by culture *artifactual forms*, i.e. forms made intentionally to stand for something. In animal species the range of artifactual modeling will, clearly, be much more limited than it is in the human species.

There are four general types of forms: *singularized, composite, cohesive*, and *connective* (Sebeok and Danesi 2000). In traditional biological theory *singularized forms* are called *signals* across species (in anthropo-, zoo-, and phytosemiotics). The term *sign* is used instead to set human semiosis apart from animal semiosis. In MST, on the other hand, a sign is classified in the same category as a signal, since it is defined as a singularized form that is specific to the human domain that models a singular (unitary) referent or referential domain. Singularized forms can be verbal or nonverbal. The English word *cat*, or the Spanish word *gato*, for example, are verbal singularized forms standing for the referent "carnivorous mammal with a tail, whiskers, and retractile claws;" a drawing of a house cat is its nonverbal (visual) equivalent. Now, a description of the same referent as "a popular household pet that is useful for killing mice and rats" constitutes, clearly, a different kind of form. This is known traditionally as a descriptive *text*. In MST, a text can be defined, more exactly, as a *composite form*; i.e. as a form that has been made to represent various aspects of a referent or referential domain—"household pet," "killing mice," etc.—in a composite (combinatory) manner. Although texts do not exist in other species, composite forms do. The well-known example of the "bee dance" is a case-in-point. Classifying a *cat* in the same category as a *tiger, lion, jaguar, leopard, cheetah,* etc. exemplifies a third type of modeling strategy— namely, the tendency to perceive certain forms as *cohering* into a general model of something. This is known traditionally as a *code*. In MST, a code can be defined as a system of forms that allows for the representation or communication of referents perceived to share common traits—e.g. *cat, tiger, lion, jaguar*, etc. = the feline code. Codes can also be natural or artifactual. The best-known example of a natural code (literally Nature's Code in this case) is the genetic code. The genetic code lies

in the order of the bases in the DNA molecule. This order of bases is passed on from one generation of cells to the next, and from one generation of an organism to the next. It makes a dog give birth to a dog, not a cat. It is this order that determines the color of eyes, the shape of ears, and thousands of other traits. Finally, the use of the word *cat* in an expression such as "He's a cool *cat*" is the result of a fourth type of modeling strategy, known traditionally as *figural*. In MST, the term *connective form* is preferred instead, because a figural sign (a metaphor, a metonym, etc.) is more precisely a model connecting one type of referent (or referential domain) to another. In the above case, a human referent is connected to a feline referent. Connective forms are unique to human semiosis.

These four types of modeling strategies are not mutually exclusive. Indeed, they are highly interdependent—singularized forms go into the make-up of composite forms which, in turn, are dependent upon the forms that cohesive systems make available. MST thus provides a simple framework for comparing human semiosis with animal and plant semiosis.

MODELING SYSTEMS THEORY

Although MST has roots in the work of various twentieth-century semioticians, it has never really blossomed forth as a comprehensive theoretical and methodological framework for general use in semiotics until Sebeok's pivotal work, which itself is really a particular interpretation of ideas found in the writings of the biologist Jacob von Uexküll (1909) and of various members of the so-called Tartu School of Semiotics, of which Yuri Lotman (1991) is probably the best known. Four general principles underlie the MST perspective:

1. Species-specific understanding of the world is indistinguishable from the forms used to model it (the *modeling principle*).
2. Modeling unfolds in various ways, from simulation to indication and symbolism (the *variability principle*).
3. Models and their referential domains are interconnected to each other (the *interconnectedness principle*).
4. All forms display the same pattern of structural properties (the *structuralist principle*).

Needless to say, it is not possible to go here into the many interesting philosophical problems related to what is knowledge. The *modeling principle* implies simply that in order for something to be known and remembered, it must be assigned some form. The *variability principle* implies that modeling varies according to the referent and to the function of the modeling system. The *interconnectedness principle* asserts that a specific form is interconnected to other forms (words to gestures, diagrams to metaphors, etc.). The *structuralist principle* claims that certain elemental structural properties characterize all forms (selection, combination, etc.). These are well known and need not be discussed here.

The first true scientific-philosophical study of signs was the one carried out by St. Augustine (354–430 AD). This philosopher and religious thinker was among

the first to distinguish clearly between *natural* and *conventional* (artifactual) signs, and to espouse the view that there was an inbuilt *interpretive* component to the whole process of representation (Deely 2001, 2003). It was, as well known, the British philosopher John Locke (1632–1704) who introduced the formal study of signs into philosophy in his *Essay Concerning Human Understanding* (1690), anticipating that it would allow philosophers to understand the interconnection between representation and knowledge. But the task he laid out remained virtually unnoticed until Saussure and Peirce took it upon themselves to provide a scientific terminology that made it possible to envision even more than what Locke had hoped for—namely, an autonomous field of inquiry centered on the sign. Their terminology, as argued here, is particularly useful in understanding human semiosis in and of itself. Peircean terminology has currently arisen to be the dominant form, probably because it clearly expands the semiotic paradigm (at leas implicitly) to include basic semiosic propensities such as simulation and indication. The key concept in both Saussurean and Peircean views of the sign is that no single form can bear meaning unless it enters into systematic connections with other forms. A primary goal of MST, and of biosemiotics generally, is to show how these connections crystallize.

Incidentally, the origin of biosemiotics as a distinct contemporary mode of inquiry can be traced to the work of Jacob von Uexküll (1909), since it was von Uexküll who was the first to describe communication processes in an interspecies fashion (at least to the best of my knowledge). His basic proposal was that the Innenwelt (inner world) of an organism is well adapted to interpret the Umwelt (the outer world it inhabits) in a specific way and thus to generate species-specific models of it. His use of *model* and *form* as generic terms is at the basis of MST.

Let us now look more closely at the four types of forms. The function of a singularized form, as mentioned, is to make reference to single objects, unitary events, individual feelings, etc. in some way (Thom 1975, Sebeok 1994). Throughout the history of semiotics, there have been several attempts to identify and classify them. Among these, Peirce's typology with 66 varieties is surely the most comprehensive, far-reaching, and sophisticated of all such attempts. In the verbal domain, one can also mention Roman Jakobson's (1970) classificatory system, which has shed considerable light on the minutiae of singularized verbal modeling. A singularized form that results from an attempt at simulation is known in Peircean theory as an *icon*. In this case the form **[A]** is a simulative model of **[B]**, its referent: i.e., it results from a modeling strategy that attempts to capture some sensory property of the referent through resemblance, imitation, etc. In human semiosis, Roman numerals such as I, II, and III are iconic forms because they are designed to resemble their referents in a visual way (one stroke = one unit, two strokes = two units, three strokes = three units); onomatopoeic words (*boom, zap, whack*, etc.) are also products of iconic modeling because they constitute attempts to portray referents in an acoustic way; commercially-produced perfumes that are suggestive of certain natural scents are likewise iconic because they attempt to model scents in an artificial way; and so on.

There are endless manifestations of iconicity in zoosemiosis, involving all types of sensory channels—chemical, auditory, visual, etc. Unlike human iconicity, however, they are (in all likelihood) tied to biological functions. An elegant (if sometimes disputed) example of iconic animal behavior is graphically described by Kloft (1959). Kloft suggested that the hind end of an aphid's abdomen, and the kicking of its hind legs, constituted, for an ant worker, iconic models, standing for the head of another ant together with its antennae movement. The ant can purportedly identify the likeness (the near end of the aphid) with its meaning (the front end of an ant), and act on this information, i.e. treat the aphid in the manner of an effigy. Camouflage too is a natural iconic modeling system. Many animals are difficult for enemies to see because they resemble their surroundings. For instance, a dark moth lying against the brown or black bark of a tree is hard to see. However, that same moth would be clearly visible if it sat on a green leaf. A number of animals can change their colors and thus remain camouflaged even when moving among backgrounds that have different colors. The chameleon, a type of lizard, is green when surrounded by leaves but turns brown when moving slowly on bark or on the ground. The ptarmigan, an Arctic bird, is brown in summer but becomes white in winter, when snow covers the ground.

A singularized form that results from an attempt to indicate some relation is known as an *index*. Indexical forms do not resemble their referents, like iconic ones do. They indicate or show where they are in relational, spatial, or temporal terms. In this case the modeling process consists in putting the form user in relation to a referent, or several referents in relation to each other. Words such as *here*, *there*, *up*, *down*, etc. have this quality. They indicate the location of the form-user in relation to the referent (as near, up, etc.). Arrows used as semaphores and the index finger used to point out things are other examples of indexical forms.

Natural indexicality is also manifest in various animal species. In fact, a vast map of indexical marks is printed overnight by animals of all sorts (Ennion and Tinbergen 1967). Tracks, scents, and other forms that identify the location or existence of a certain animal in a species-specific way are all indexical forms. For example, a wolf marks out its territory by urinating on bushes, rocks, and other objects. The scent of urine warns intruders of the wolf's presence and the risk of an encounter. The more aggressive forms of defense generally are used when the intruder is especially persistent.

A singularized form that results from some culture-specific convention is known, of course, as a symbol: e.g. a cross figure standing for "Christianity;" a V-sign made with the index and middle fingers standing for "peace;" the color white standing for "cleanliness," "purity," "innocence," and so on. Several societies may use the same symbols, but they will tend to stand for different referents. In many societies, for example, the color red symbolizes war and violence. But in China red represents marriage. Among American Aboriginal peoples, it stands for the East. Red symbolizes life in the Shinto religion of Japan, but law schools in France. In effect, a symbol has only the meaning that people have given it. In their mythologies, people have used symbols to help explain the world. The Greeks symbolized the

sun as the god Helios driving a flaming chariot across the sky. The Egyptians represented the sun as a boat. Animals, human beings, and plants have all stood for ideas and events. Some groups adopted the serpent as a symbol of health because they believed that by shedding its skin, the serpent becomes young and well again. The Greeks portrayed Asclepius, the god of healing, holding a staff with a serpent coiled around it. The staff is often confused with the caduceus of the god Mercury, which has two snakes coiled around it. Today, both are used as symbols of the medical profession.

Symbols are rare in the zoosemiotic domain, but not completely absent from it. Examples such as the stickleback one mentioned above seem to verge on the symbolic. Indeed, rudimentary manifestations of natural symbolism can be found in Nature if one looks for them (Pitts and McCulloch 1947, Haldane 1955, Sebeok 1973, Jacob 1974). A rhesus monkey, for instance, shows fear by carrying its tail stiffly out behind; baboons convey fear by carrying a vertical tail. However, the converse is not necessarily true: "a mother of a young infant [baboon] may hold her tail vertical not in fear but to help her infant balance on her back; and the tail may also be held vertical while its owner is being groomed in the tail region" (Rowell 1972: 87). This is, arguably, symbolic behavior given that tail orientation stands in an indirect fashion for an emotion. Consider, further, the behavior of the insects of the carnivorous family Empididae. In a species of dipterans of this family, the male offers the female an empty balloon prior to copulation (Huxley 1966). The evolutionary origin of this seemingly bizarre gesture has been unraveled by biologists. But the fact remains that the gift of an empty balloon is a wholly symbolic act, designed simply to reduce the probability that the male himself will fall prey to his female partner.

Composite modeling, as mentioned, is the activity of representing complex (non-unitary) referents by combining various forms in some specifiable way. Drawings, narratives, theories, conversations, etc. are all examples of composite forms in the human domain. These are constructed with distinct singularized forms that fit together structurally, but which are, as a whole, different from any one taken individually. In analogy to atomic theory, a singularized form can be compared to an atom and a composite form to a molecule made up of individual atoms, but constituting a distinct physical form in its own right. Salt is made up of sodium and chlorine, but is not a simple combination of the two.

Composite modeling occurs in all facets of human life, allowing people to envision distinct bits of information and real-world referents as integrated wholes. Such modeling is also found in animals. A striking example can be seen in the behavior of a small family of cerophagous picarian birds (*Indicator indicator*). This species has developed a remarkable symbiotic relationship with certain mammals—ratels, baboons, and humans—by employing a strategy that guides other birds to the vicinity of wild bees' nests. A would-be guiding bird will come to, say, a person, and chatter until followed, but keep out of sight of the pursuer most of the time (Friedmann 1965).

As mentioned, a cohesive model is known in traditional semiotic theory as a code. The Roman numeral system is a simple example of a cohesive system fashioned in part iconically. This system consists of seven symbols for representing all numbers from 1 to 1,000,000: I for 1, V for 5, X for 10, L for 50, C for 100, D for 500, and M for 1000. An example of an indexical code is the system of street signs used typically to regulate and guide traffic. These provide such information as the distance of certain places from specific locations, the direction one is traveling in, etc. Essentially codes are organizational grids of referents and referential domains.

Natural cohesive modeling is found in the animal kingdom, albeit not in the same way that it is found in human semiosis. A remarkable example of a cohesive model can be observed in the mound constructions that are engineered by common termites. These social insects have the ability to construct extremely hard walls from bits of soil cemented with saliva and baked by the sun. Inside the walls numerous chambers and galleries are constructed by these ingenious engineers, interconnected by a complex network of passageways. Ventilation and drainage are provided, and heat required for hatching the eggs is obtained from the fermentation of organic matter, which is stored in the chambers serving as nurseries. Of more than 55 species common in the United States, the majority builds its nests underground. The subterranean termites are extremely destructive, because they tunnel their way to wooden structures, into which they burrow to obtain food. Now, upon close examination, the mound structure simulates the constituents of the termite's social evolution, even after the colony itself has become extinct—i.e. the mound visually mirrors the social organization of these architect insects. This is a dramatic example of unwitting cohesive iconicity manifesting itself in Nature as a property of a species' social behavior (Sebeok 1991).

Finally, connective forms are the result of associative reasoning—a cognitive capacity that is unique to humans. The ever-burgeoning literature on what has come to be known as *conceptual metaphor theory* (e.g. Lakoff and Johnson 1980, 1999, Lakoff 1987, Johnson 1987, Gibbs 1994, Goatley 1997, Fauconnier and Turner 2002) has made it obvious that such forms permeate human communicative and representational behavior. A connective form results when abstract referents are linked to concrete ones. The formula *thinking is seeing*, for example, is a connective form because it delivers the abstract concept of "thinking" **[A]** in terms of the physiological processes associated with seeing **[B]** This underlies utterances such as:
1. I do not *see* what possible use your *ideas* might have.
2. I can't quite *visualize* what that new *idea* is all about.
3. Just *look at* her new *theory*; it is really something!
4. I *view* that *idea* differently from you.

A specific metaphorical statement uttered in a discourse situation is now construable as a particular externalization of a connective form. So, when we hear people using such statements as those cited above, it is obvious that they are not manifestations of isolated, self-contained metaphorical creations, but rather, specific instantiations of a form connecting thinking with seeing.

A connective form may also be the product of metonymic modeling. Metonymy entails the use of an entity to refer to another that is related to it. A metonymic model results when part of a domain starts being used to represent the whole domain (Lakoff and Johnson 1980: 35–40):

5. She likes to read Dostoyevski (= the writings of Dostoyevski).
6. He's in dance (= the dancing profession).
7. My mom frowns on blue jeans (= the wearing of blue jeans).
8. Only new wheels will satisfy him (= car).

Each one of these constitutes an externalization of a metonymically-derived model: (5) is an instantiation of *the author is his or her work*, (6) of an *activity of a profession is the profession*, (7) of a *clothing item represents a lifestyle*, and (8) of a *part of an object represents the entire object*.

CONCLUDING REMARKS

The disciplinary status of semiotics as a "science" has always been a topic of debate. Indeed, many semioticians have refused (and continue to refuse) to call their field a science, preferring to define it with terms like "activity," "tool," "doctrine," "theory," "movement," "approach" (Nöth 1990: 4). However, just as many perceive semiotics to have the necessary characteristics to qualify it as a scientific enterprise. Umberto Eco (1978), for one, argues that semiotics meets five basic criteria that characterize any science:

1. it is an autonomous discipline;
2. it has a set of standardized methodological tools;
3. it has the capability of producing hypotheses;
4. it affords the possibility of making predictions;
5. its findings may lead to a modification of the actual state of the objective world.

Lacking from this list, however, is the presence within semiotics of a set of terms for classifying semiotic observations and then discussing and communicating them in unambiguous ways. MST forces all semioticians to reflect upon the foundational notions of their science and, more precisely, on how these can be communicated and discussed in true scientific fashion. Sebeok left us an exciting new agenda for doing exactly this.

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