Analogical Truth Conditions for Metaphors

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ABSTRACT: It has often been said that metaphors are based on analogies, but the nature of this relation has never been made precise. This article rigorously and formally specifies two semantic relations that do obtain between some metaphors and analogies. We argue that analogies often provide *conditions of meaningfulness and truth* for metaphors. An analogy is treated as an isomorphism from a source to topic domain. Metaphors are thought of as surface structures. Formal analogical conditions of meaningfulness and truth are fully and rigorously worked out for several grammatical classes of metaphors. By providing analogical meaningfulness and truth conditions for metaphors, this article shows that truth-conditional semantics can be extended to metaphors.

1. Introduction

It has often been said that metaphors and analogies are related. Aristotle (1984, p. 57b1-30) claims that metaphors are derived from analogies. Kintsch (1972, p. 280) asserts that metaphors are produced and understood using "analogy rules." Miller (1979, p. 231) argues that proportional metaphors of the form "X is the Y of Z" are based on analogical comparisons. Carbonell & Minton (1985, p. 407) assert that analogical reasoning is the "underlying cognitive process" of which metapors are linguistic manifestations. Indurkhya (1987, p. 446) assumes that "there is a structural analogy underlying every metaphor." Kittay (1987, p. 169) posits a metaphorical function that satisfies the traditional definition of an analogical mapping function. Gentner, Falkenhainer, and Skorstad (1988) claim that relational metaphors can be analyzed as analogies. Finally, the *Oxford English Dictionary* defines a metaphor as "The figure of speech in which a name or descriptive term is transferred to some object different from, but analogous to, that to which it is properly applicable."

While all of the authors cited above agree that metaphors are related to analogies, the relations that hold between them are rarely made precise. It is our intention to precisely specify some of the relations that do obtain between metaphors and analogies. We will argue that analogies at least provide *conditions of meaningfulness and truth* for metaphors. We do not claim that the only relation of analogies to metaphors is to provide conditions of meaningfulness and truth; there may be other relations between metaphors and analogies. Nor do we claim that conditions of meaningfulness and truth for metaphors always or necessarily involve analogies; there may be conditions of meaningfulness or truth for metaphors that do not involve analogies.[1] Indeed, we explicitly exclude from our treatment certain metaphors involving predications of sensory terms (Searle, 1983, p. 149). For example, our account does not cover such metaphors as

[1]Assuming that similarity is distinct from analogy, as I believe it is, another hypothesis is that metaphors have conditions of meaningfulness and truth that involve similarities. However, I regard this hypothesis as a supplement to my view rather than as an alternative to it.

"sour disposition", "sweet person", "warm reception", "cold man". Such metaphors seem to be grounded in perceptual phenomena of which we do not as yet have an adequate account.

Since our primary objective is to make precise the claim that metaphors have conditions of meaningfulness and truth involving analogies, we will make use of many of the tools of formal semantics, such as logical and set-theoretic notations. Our work is thus related to other formal theories of metaphor, such as those developed by Kintsch (1972), Miller (1979), Carbonell & Minton (1985), MacCormac (1985), Indurkhya (1986, 1987, 1989), and Kittay (1987). The work developed here is a part of a broader effort to formalize certain aspects of *the interactionist theory of metaphor* advocated by Black (1962, 1979).

We will argue for our claim in four steps. First we will provide a theory of analogy; second, we will define what we mean by a metaphor; third, we will argue that metaphors are both meaningful and that they have truth-values; fourth, we will argue that analogies provide the conditions of meaningfulness and truth for metaphors, and will specify such conditions for several classes of metaphors.

2. A Theory of Analogies

An *analogy* is traditionally said to be a triple (S, T, f_M) where S and T are systems of terms or concepts and f_M is a structure-preserving function from S to T. For example, the system S might be a system of terms or concepts denoting the elements of a hydraulic apparatus, such as pipes, pumps, tanks, and valves. The system T might be a system of terms or concepts denoting the elements of an electrical apparatus, such as wires, batteries, capacitors, and switches. The structure-preserving function f_M might map pipes to wires, pumps to batteries, tanks to capacitors, and valves to switches.

The systems involved in an analogy are often called *domains.* The system S is typically called the *source* domain (sometimes the *base*), while the system T is typically called the *topic* domain (sometimes the *target*). Domains can be thought of in terms of the scripts proposed by Schank and Abelson (1977), the experiential gestalts proposed by Lakoff and Johnson (1980), the *schemas* of Goodman (1976), or the semantic fields proposed by Kittay (1987).

Information about domains can be represented in many ways; typically it is represented as lists of facts. These facts are usually written in propositional form (cf. the "description groups" in Falkenhainer, Forbus, and Gentner (1989)), although they do not usually involve variables or quantifiers and so are not propositions in the sense of first-order predicate calculus. We represent information about domains using four types of propositions: (1) functional propositions; (2) mereological propositions; (3) paradigmatic propositions; and (4) genitive propositions. It is assumed that these propositions are literal, unambiguous, and non-paradoxical. It is further assumed that each of these propositions can be assigned exactly one truth-value, either true or false. *Functional propositions* are generic propositions (Lyons, 1977) denoting types or classes of events or states of affairs involving the objects in a domain. A functional proposition consists of a verb predicate with several noun arguments. Noun arguments are labelled with thematic roles. For example, the functional proposition "A mother gives birth to a baby" is

written "gives-birth(AGENT:mother, PATIENT:baby)". We abbreviate the agent role as "A", the patient role as "P", the instrument role as "I". Other roles can be labelled accordingly. Each noun argument may have an adjectival modifier. For example, "A true idea passes a cognitive test" is written "passes(A:true(idea), P:cognitive-test)". *Mereological propositions* denote part-whole or containment relations among the objects in a domain. A mereological proposition consists of the predicate "contains" followed by an argument denoting the whole, then an argument denoting the contained part. For example, "contains(car, engine)". *Paradigmatic propositions* are used to capture the paradigmatic sense relations (Lyons, 1977) between adjectival terms in a domain. For example, "opposites(true, false)". These paradigmatic sense relations may be interpreted either as relations holding among qualities of objects or as relations holding among terms denoting qualities of objects. In either case it is possible to assign a truth-value to a paradigmatic proposition. *Genitive propositions* are used to denote predications involving the application of the genitive preposition "of" to nouns. For example, "of(mother, baby)" denotes the genitive predication in "The mother is the mother *of* the baby." Genitive propositions denote relations among noun terms in the language describing the domain and so are propositions in a metalanguage. They are true as long as they describe the genitive predications that are legal in the language.

A *structure-preserving function* f_M is a set of ordered pairs (s, t) where s is in the source and t is in the topic. Such ordered pairs are sometimes called *matches*, *correspondences*, or simply *analogies*. We allow matches between nouns, adjectives, and functional propositions. To say that f_M is structure-preserving means that it associates s with t if and only if the relations in which t participates are the same as the relations in which s participates. For example, let the source be "produces(A:mother, P:baby)" and the target be "produces(A:student, P:idea)". Since "mother" plays the AGENT role in a relation "produce", and since "student" also plays the AGENT role in a relation "produce", matching "mother" to "student" preserves the some of the relational structure of the source; likewise, matching "baby" to "idea" also preserves some of the relational structure of the source. Together the two matches (mother, student) and (baby, idea) preserve all the the relational structure of the source, so the function {(mother, student), (baby, idea)} is structure-preserving. Formally, the function f_M preserves all the relational structure of the source if for all x and y in the source and all R holding between x and y, R(x,y) implies R(f_M(x), f_M(y)) holds in the target. According to Gentner (1982, 1983), Gentner and Gentner (1983), and Falkenhainer, Forbus, and Gentner (1989), a structure-preserving function f_M must be a one-to-one function. That is, f_M must be an isomorphism. As Holyoak & Thagard (1989) point out, the constraint that f_M be one-to-one is too strong; they require only that f_M be a function, thus allowing it to be many-to-one.

Often no one-to-one or even many-to-one function exists that preserves all of the relational structure of the source; in such cases we will be content to characterize a structure-preserving function as a function that preserves as much of the relational structure of the source as possible. Moreover, in all but the simplest cases, there will be many possible matches or correspondences for many or most of the terms in the source. Although finding the structure-preserving function between a given source and target domain is a difficult task, it is nevertheless computable. Falkhainer, Forbus, and Gentner (1989) have developed a structure-mapping program which is able to compute

isomorphisms between domains; Holyoak and Thagard (1989) have developed a program called ACME which uses constraint satisfaction techniques to find structure-preserving functions.

So far our discussion of analogy has said little about truth; analogies, as they are traditionally defined, can hold between source and target domains composed of false or absurd propositions. We therefore distinguish between an analogy and a true analogy. An analogy is true if its source and target domains are true. Source and target domains are sets of propositions. A set of propositions is true if the conjunction of its members is true.

A sample analogy derived from an analysis of a text from Plato (1984) is shown in Tables 1 and 2. The analogy is shown in Tables 1 and 2. Table 1 contains the source and topic domains, while Table 2 contains the function f_M. The source domain represents information about giving-birth, while the topic represents information about intellectual productivity. The source and topic domains are here considered to be true, so that the analogy is a true analogy.

Source Domain	Topic Domain
S1:contains(mother, womb)	T1:contains(student, mind)
S2:contains(womb, baby)	T2:contains(mind, idea)
S3:produce(A:mother, P:baby)	T3:produce(A:student, P:idea)
S4:of(mother, baby)	
S5:of(baby, mother)	T4:of(idea, student)
S6:give-birth(A:mother, P:baby)	T5:express(A:student, P:idea)
S7:help(A:midwife, P:mother)	T6:help(A:teacher, P:student)
S8:of(midwife, mother)	T7:of(teacher, student)
	T8:of(student, teacher)
S9:pass(A:liveborn(baby), P:physicaltest)	T9:pass(A:true(idea), P:cognitivetest)
S10:opposites(liveborn, stillborn)	T10:opposites(true, false)

Table 1. Domains from Plato's *Theaetetus*.

f_M: Source	→	Topic
mother	→	student
womb	→	mind
baby	→	idea
midwife	→	teacher
liveborn	→	true
stillborn	→	false
S3	→	T3
S7	→	T6
S9	→	T9

Table 2. Analogical map f_M for the domains in Table 1.

3. Metaphors

The Identification of Metaphors

The term "metaphor" has been used to denote analogies, scientific models, metonymies, and similar phenomena (Indurkhya, 1987). It has also been used to denote a string of words (a surface structure) or a speech act. Loewenberg (1975), for instance, characterizes a metaphor as a type of speech-act, which she calls a metaphorical proposal. For Loewenberg, a metaphor is not just a string of words, but is also the production of that string.

An *utterance* is either a written or spoken sequence of words in some natural language. We define a *metaphor* as a syntactically well-formed utterance in which some of the words are used literally and some are used metaphorically. Note that this definition is not circular, but indicates that the metaphorical character of an utterance (a whole) depends on the metaphorical character of its words (its parts). In order to determine when a word is used literally or metaphorically, we need to discuss the notion of categorizations. Our definition of metaphor in terms of categorizations is based on Kittay's theory of the identification of metaphors (Kittay, 1987, ch. 2).

Every predicate in a language is associated with *categorizations*. The categorizations for an n-place predicate are given by a set of n-tuples of categories. Such n-tuples associate a category with each argument of the predicate. Categorizations are stored in a language-user's semantic memory.[2] The categorizations of a predicate record the categories to which the arguments of the predicate conventionally or ordinarily belong. Our categorizations thus include Katz and Fodor's (1964) selectional restrictions. For example, the categorizations of the verb "produce" record the categories to which the noun arguments of produce conventionally or ordinarily belong. Thus the categorizations of "produce" might be given by the set of ordered pairs {(mother, baby), (student, idea), (volcano, lava)}. The categorizations for "is" are specified by sets of ordered-pairs expressing the taxonomic relations of instance and class inclusion.[3] Besides including selectional restrictions, categorizations may also include extra-linguistic knowledge conventionally associated with a predicate by some community of language-users. For example, if Smith is a surgeon, then there is a community of language-users for which this predication is conventional; for that community, (Smith, surgeon) is in the categorizations of "is".

In order to determine whether a predication satisfies the categorizations of its predicate, we first form the n-tuple of the categories of the arguments of the predicate, then determine whether that n-tuple is a member of the predicate's categorizations. For example, in the case of "The mother produced a baby", the pair of the categories of the

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[2]The categorizations of a predicate certainly do not exhaust our semantic knowledge concerning the predicate; in particular, the categorizations of a predicate do not include the predicate's definition. Categorizations capture only our *syntagmatic* knowledge of the word, that is, our knowledge of the *types* of words with which a word can properly combine in a syntactically well-formed string.

[3]The categorizations of "is" certainly do not exhaust our semantic knowledge concerning the verb "to be"; in particular, the categorizations only capture our knowledge of the relations "is a kind of" and "is an instance of". They do not include information about the use of "is" to predicate adjectives of nouns, nor of the use of "is" to express identities (e.g. "Socrates is the wisest man").

arguments of "produce" is (mother, baby); since (mother, baby) is a member of the categorizations of "produce", the sentence satisfies the categorizations of "produce".

If the application of a predicate to a set of arguments satisifies all of the predicate's categorizations, then the predicate and each of its arguments are being used conventionally. We identify literal usage with conventional usage (Kittay, 1987). The literal use of a predicate and each of its arguments is indicated by marking each of those words with the subscript "LIT", for "literal". For example, the president is a kind of politician, hence (president, politician) is in the categorizations of "is". Consequently, the categorizations of "The president is a politician" are conventional, so the predicate "is" and both of its arguments are given the subscripts "LIT". The resulting sentence is "[The president]$_{LIT}$ [is]$_{LIT}$ [a politician]$_{LIT}$".

Metaphor involves violation of conventional usage, hence violation of categorizations. If the application of a predicate to a set of arguments violates any of the predicate's categorizations, then the predication is a metaphor; either the predicate or some of the arguments that violated its categorizations are being used metaphorically. The metaphorical use of the predicate, or of any of its arguments, is indicated by marking that word with the subscript "MET", for metaphorical. Violation of selectional restrictions thus marks a statement as a metaphor. For instance, "Students give birth to ideas" violates the selectional restrictions on both the AGENT and PATIENT of "gives-birth", and so is the metaphor "[Students]$_{LIT}$ [give birth]$_{MET}$ to [ideas]$_{LIT}$". However, violation of categorizations is more general than violation of selectional restrictions. For instance, "Smith is a plumber" does not violate any selectional restrictions. But if we know that Smith is a surgeon, then "Smith is a plumber" violates our categorizations and so is the metaphor "[Smith]$_{LIT}$ [is]$_{MET}$ [a plumber]$_{MET}$".

The Grammar of Metaphor

Tirrell (1991) and Brooke-Rose (1970) have analyzed the grammar of metaphor. In particular, Tirrell distinguishes six grammatical types of metaphors. (1) *Simple identities,* of the form "A is B". For instance, "Juliet is the sun." (2) *Pure predications,* of the form "A is F"; for instance, "Juliet is brilliant." (3) *Sortal predications,* of the form "A is a K"; for instance, "Man is a wolf." (4) *Substitution metaphors,* "formed by substituting a term that does not literally apply for one that does". (5) *Noun-function metaphors,* of the form "The B of A"; for instance, "A commitment to empiricism lies at the heart of my theory." (6) *Verb-function metaphors,* of the form "A Vs B" where V is a verb which A cannot literally do, or which cannot literally be done to B; for instance "Theaetetus gives birth to an idea."

The following is a list of some grammatical forms of metaphor. The list is derived from Tirrell's. Each grammatical form in the list is preceded by a descriptive name and followed by examples. The list is not exhaustive, but covers the major types. Even if it is incomplete, a theory that can account for the semantics of these types of metaphors has covered most of the cases.

A grammatical form is a syntactically well-formed string of grammar symbols. A grammar symbol is either a word or the name of a grammatical category, such as ADJ, VERB, or BE. For example, NOUN denotes the set of nouns. Numerical subscripts on grammatical categories are used to distinguish occurences of that category. We indicate

literal use by marking a word or phrase with the subscript "LIT"; we indicate metaphorical use by marking a word or phrase with the subscript "MET". A grammatical form defines a set of phrases or sentences.[4] A member of the set defined by the form is obtained by replacing each name of a grammatical category with a member of that category. For instance, "A mother gives-birth to a baby" is a member of the set defined by <DET $NOUN_1$ VERB PREP DET $NOUN_2$>, and "Socrates is a philosopher" is a member of the set defined by <$NOUN_1$ is a $NOUN_2$>.

1. Noun-identification metaphors.

$[NOUN_1]_{LIT}$ $[BE]_{MET}$ DET $[NOUN_2]_{MET}$
Socrates is a midwife.
Ideas are birds.

2. Noun-identification with genitive phrase.

$[NOUN_1]_{LIT}$ $[BE]_{MET}$ DET $[NOUN_2]_{MET}$ $[of]_{LIT}$ $[NOUN_3]_{LIT}$
An idea is a baby of the mind.
A student is a mother of ideas.
The lion is the king of beasts.

3. Adjective-predication metaphors

DET $[NOUN]_{LIT}$ $[BE]_{MET}$ $[ADJ]_{MET}$
Some ideas are stillborn.
Kathleen's mind is brilliant

4. Verb-predication metaphors.

$[NOUN_1]_{LIT}$ $[VERB]_{MET}$ $[NOUN_2]_{LIT}$
Students give birth to ideas.
Perception delivers the images to the aviary.

5. Verb-predication with PATIENT genitive.

$[NOUN_1]_{LIT}$ $[VERB]_{MET}$ $[NOUN_2]_{MET}$ $[of]_{LIT}$ $[NOUN_3]_{LIT}$
A student gives birth to a child of his mind.
A commitment to empiricism lies at the heart of my theory.

4. Meaning and Truth for Metaphors

Truth-Conditional Semantics for Metaphors

We aim to provide meanings for metaphors. It has been argued (Davidson, 1967) that the meaning of an utterance is given by its truth-conditions. In other words, it has been

[4]The sets of sentences defined by grammatical forms are not mutually exclusive. A grammatically ambiguous sentence is a member of more than one such set.

argued that S means that p is equivalent to S is true if and only if p. Following Davidson, we aim to provide truth-conditions for metaphors.

Two positions have been taken concerning the meanings of metaphorical utterances: (1) a metaphorical utterance has one and only one kind of meaning, its *literal meaning* (supplied by its literal truth-conditions) and (2) a metaphorical utterance has two kinds of meaning, its literal meaning (supplied by its literal truth-conditions) and its *metaphorical meaning* (supplied by its metaphorical truth-conditions). We consider each of these positions in turn.

In favor of the first position, Davidson (1975) argues that a metaphor has only the meaning supplied by its literal truth-conditions. For example, the meaning of "Socrates is a midwife" is the meaning of "$[\text{Socrates}]_{\text{LIT}}$ $[\text{is}]_{\text{LIT}}$ $[\text{a midwife}]_{\text{LIT}}$", and "$[\text{Socrates}]_{\text{LIT}}$ $[\text{is}]_{\text{LIT}}$ $[\text{a midwife}]_{\text{LIT}}$" is true if and only if Socrates is a member of the set of midwives. The difficulty with this view is that interpreting metaphors in accordance with their literal truth-conditions invariably turns them into contradictions or tautologies, that is, patent falsehoods or trivial truths. For example, Socrates is obviously not a member of the set of midwives. Yet it is an undeniable fact of language use that people deliberately utter metaphors in order to communicate. According to Grice (1975), communication is a cooperative activity in which the participants obey a number of maxims. One of these, the maxim of Quality, states: "Try to make your contribution one that is true". It is therefore hard to see why people would deliberately utter falsehoods in order to communicate. The maxim of quantity says: "Make your contribution as informative as required", while the maxim of Relation is "Be relevant". It is therefore hard to see why people would deliberately utter tautologies.

Truth conditions for metaphors that make them patently false or trivially true are inadequate. In response it has been argued (Goodman 1978; Binkley 1974) that metaphors are non-trivially true or false. As such, they must have truth-conditions that are non-trivially true or false, and these truth-conditions cannot be their literal truth-conditions. It would therefore appear that metaphors must have two sorts of truth-conditions, their literal truth-conditions, and their metaphorical truth-conditions. Having two different kinds of truth-conditions, a metaphor would have two different kinds of meaning. A metaphor's literal meaning would be given by its literal truth-conditions, while its metaphorical meaning would be given by its metaphorical truth-conditions. For example, "Socrates is a midwife" would have two different truth conditions, its literal and its metaphorical truth conditions. Consequently, "Socrates is a midwife" would be literally false, but metaphorically true.

The difficulty with this view is that it assigns two different truth-values to a single sentence. What is worse, it requires an account of two different kinds of truth: literal truth and metaphorical truth. We prefer to assign one and only one truth-value to one sentence, and we prefer to have one and only one kind of truth. To this end, we employ an insight of Goodman (1978). Analyzing the sentence "The lake is a sapphire", Goodman claims that it is metaphorically true if and only if "The lake is metaphorically a sapphire" is literally true. Goodman's analysis fits squarely within our own conception of the literal and metaphorical use of words. For Goodman has distinguished between the two sentences "The lake is literally a sapphire" and "The lake is metaphorically a sapphire". Where Goodman uses the adverb "metaphorically", we would use the subscript "MET"; where Goodman would use the adverb "literally", we would use the

subscript "LIT". The meaning of "[The lake]$_{LIT}$ [is]$_{LIT}$ [a sapphire]$_{LIT}$" is given by one set of truth-conditions, while the meaning of "[The lake]$_{LIT}$ [is]$_{MET}$ [a sapphire]$_{MET}$" is given by a different set of truth-conditions. But we do not thereby affirm that the two sentences have two different types of meaning involving two different types of truth.

Cognitive Processing of Metaphors

Our model has certain consequences for multi-stage models of metaphor interpretation, such as Searle's three-stage model. According to Searle (1979), when a language-user hears "S is P", she first parses it as "[S]$_{LIT}$ [is]$_{LIT}$ [P]$_{LIT}$", assigns literal truth conditions to it, then evaluates those literal truth conditions against the appropriate context. Second, on the basis of such evaluation, the hearer determines whether or not the literal truth conditions (i.e. the literal meaning) is semantically acceptable or defective. According to Searle, signs of semantic defectiveness include "obvious falsehood, semantic nonsense, violations of the rules of speech acts, or violations of conversational principles" (Searle, 1979, p. 114). If the literal reading is semantically defective, the hearer procedes to the third stage, which involves computing a metaphorical reading for the sentence that avoids its literal semantic defects. For example, a metaphorical reading that makes the sentence true.

Multi-stage accounts have come under heavy psychological attack. In particular, Gibbs (1984) attacks Searle's three-stage model as psychologically inadequate. Our model contrasts with multi-stage views such as Searle's on logical grounds. We hold that when a competent language-user hears an utterance, she parses that utterance, then checks its categorizations and marks its component words with "LIT" and "MET". Having determined the usage of each of its words, the language-user assigns truth conditions to the utterance, then endeavors to evaluate those truth conditions with respect to context. Obviously, we do not believe that the truth conditions for "[S]$_{LIT}$ [is]$_{LIT}$ [P]$_{LIT}$" are the same as those for "[S]$_{LIT}$ [is]$_{MET}$ [P]$_{MET}$". We therefore agree with MacCormac (1985, p. 209) that statements are judged to be literal or metaphorical *before* they are assigned truth values. Since we do not believe that people always and only take terms literally, we cannot agree with Beardsley (1958, p. 142) when he claims that "a metaphor is a significant attribution that is either indirectly self-contradictory or obviously false in its context." We do not agree with Searle that it is necessary to compute the literal truth conditions of an utterance prior to any further semantic processing.

We hold that multi-stage processing does not occur for the typical language-user processing the typical metaphor. Nevertheless, we do not claim that it never occurs. Our model allows multi-stage processing to occur for some language-users and some metaphors. Very literal-minded individuals would be strongly predisposed to assign all "LIT" markers to words regardless of categorization violations, hence would characteristically have to go back and process an utterance a second time after realizing its literal falsity. The same may be true of the typical language-user regarding metaphors whose violations of categorizations are subtle. While our model suggests a strong tendency towards identical processing courses for both literal and metaphorical utterances, it does not forbid multi-stage processing.

5. Analogies as Giving Conditions of Meaningfulness and Truth for Metaphors

We now provide conditions of meaningfulness and truth for metaphors. It should be apparent that meaningfulness is necessary for truth (or falsity); a metaphor that is meaningless is neither true nor false, but has a truth-value gap. It should also be apparent that these conditions can only be evaluated against a *background* of assumptions made by the producer or interpreter of a metaphor (see Searle, 1979; 1983). First, we provide and discuss conditions of meaningfulness and truth for simple noun-identification metaphors of the form $<[\text{NOUN}_1]_{\text{LIT}}\ [\text{BE}]_{\text{MET}}\ \text{DET}\ [\text{NOUN}_2]_{\text{MET}}>$. Then we lay out conditions for meaningfulness and truth for the various different grammatical forms of metaphors discussed earlier. All of the conditions supplied involve analogies.

Conditions for Noun-Identification Metaphors

As an example of evaluating conditions of meaningfulness and truth, consider the noun-identification metaphor "$[\text{Time}]_{\text{LIT}}\ [\text{is}]_{\text{MET}}\ [\text{a river}]_{\text{MET}}$". This metaphor has the form $<[\text{NOUN}_1]_{\text{LIT}}\ [\text{BE}]_{\text{MET}}\ [\text{DET NOUN}_2]_{\text{MET}}>$. We hold that a metaphor of this form is meaningful if and only if there is an analogy such that NOUN_1 is analogous to NOUN_2. Formally, a metaphor of this form is meaningful if and only if there exists an analogy (S, T, f_M) such that NOUN_1 is in T, NOUN_2 is in S, and $\text{NOUN}_1 = f_M(\text{NOUN}_2)$. Hence "$[\text{Time}]_{\text{LIT}}\ [\text{is}]_{\text{MET}}\ [\text{a river}]_{\text{MET}}$" is meaningful if and only if we can find some analogy (S, T, f_M) such that "time" is in T, "river" is in S, and "time" = f_M("river"). It is not difficult to find the source and target domains S and T. Let T be "Time flows." Let S be "Rivers flow." The function f_M is obvious. Likewise, we hold that a noun-identification metaphor is true if and only if there exists a true analogy (S, T, f_M) such that NOUN_1 is in T, NOUN_2 is in S, and $\text{NOUN}_1 = f_M(\text{NOUN}_2)$. Hence "$[\text{Time}]_{\text{LIT}}\ [\text{is}]_{\text{MET}}\ [\text{a river}]_{\text{MET}}$" is true if and only if "Time flows" and "Rivers flow."

As a more obscure example, consider the metaphor "$[\text{Time}]_{\text{LIT}}\ [\text{is}]_{\text{MET}}\ [\text{an uncle}]_{\text{MET}}$". The metaphor is meaningless if we can find no analogy (S, T, f_M) that makes "time" analogous to "uncle." But it is meaningful if we can find such an analogy. To this end, consider the following quasi-Hegelian story about time:

> Time and space emerge from the self-sundering of spirit; these initially undifferentiated moments of the original unity of spirit suffer internal division as spirit unfolds all its inner distinctions. Distance and direction emerge from the self-sundering of space, while past, present, and future emerge from the self-sundering of time.

If we make "X emerges from the self-sundering of Y" analogous to "X is a descendent of Y," then we have an analogy between space, time, distance, direction, past, present, and future and a geneological tree. In the geneological tree, time and space are siblings; distance and direction are descendents of space, and past, present and future are descendents of time. Thus time is a sibling of space, and distance and direction are

descendents of space. All we need to do is think of time as masculine, and it makes perfect sense to speak of time as an uncle, for time is the uncle of distance and position. However farfetched, the story makes the metaphor meaningful. But the story does not make the metaphor true unless the story itself is true.[5] If we regard the story as true, then we regard the metaphor as true.

Meaningfulness and Truth Conditions for Metaphors

Below we provide truth conditions for metaphors with different grammatical forms; each truth condition can be changed to a meaningfulness condition simply by removing the constraint that the analogy be true. An example for each truth condition is given that shows how the truth condition validates a metaphor. The background for these truth conditions is the two true analogies given earlier. In order to articulate the conditions, we need some notational conventions. Logical and set-theoretic operators are used with their standard meanings. If F is a functional proposition, we use the notation $[ADJ(NOUN)]_{LIT} \in F$ to mean that ADJ(NOUN) is a component of F. For instance, "true(idea)" is such a component of "passes(A:true(idea), P:cognitive-test)". The value of the function AgentOf(P) is the noun argument of the functional proposition P that plays the AGENT role in P; the functions PatientOf(P) and InstrOf(P) are defined similarly for the PATIENT and INSTRUMENT roles respectively. Items enclosed in braces are optional.

(1) Noun-identification metaphors.

$<[NOUN_1]_{LIT}\ [BE]_{MET}\ DET\ [NOUN_2]_{MET}>$
is true if and only if
$(\exists S, T, f_M)((S, T, f_M)$ is a true analogy &
$NOUN_1 \in T$ & $NOUN_2 \in S$ & $NOUN_1 = f_M(NOUN_2))$

$<[Teachers]_{LIT}\ [are]_{MET}\ [midwives]_{MET}>$
is true if and only if
$(\exists S, T, f_M)((S, T, f_M)$ is a true analogy &
$teachers \in T$ & $midwives \in S$ & $teachers = f_M(midwives))$

(2) Genitive metaphors

$<DET\ [NOUN_1]_{LIT}\ [BE]_{MET}\ DET\ [NOUN_2]_{MET}\ of\ [NOUN_3]_{LIT}>$
is true if and only if
$(\exists S, T, f_M)((S, T, f_M)$ is a true analogy &
$NOUN_1 \in T$ & $NOUN_1 = f_M(NOUN_2)$ &
$(\exists NOUN_4)([of(NOUN_2, NOUN_4)]_{LIT} \in S$ &
$NOUN_3 = f_M(NOUN_4)))$

[5]Though such stories may be false in the actual world, there may be possible worlds in which they are true. This is the point at which possible world semantics is useful for metaphors.

<The [mind]$_{LIT}$ [is]$_{MET}$ the [womb]$_{MET}$ of [ideas]$_{LIT}$>
is true if and only if
($\exists$S, T, f_M)((S, T, f_M) is a true analogy &
mind $\in$ T & mind = f_M(womb) &
([of(womb, baby)]$_{LIT}$ $\in$ S &
idea = f_M(baby)))

(3) Adjective-predication metaphors

<[NOUN1]$_{LIT}$ [BE]$_{MET}$ [ADJ]$_{MET}$>
is true if and only if
($\exists$S, T, f_M)((S, T, f_M) is a true analogy & $NOUN_1 \in T$ &
($\exists NOUN_2$)($NOUN_2 \in S$ & $NOUN_1 = f_M(NOUN_2)$) &
($\exists F_S$)(F_S is a functional proposition in S &
$[ADJ_2(NOUN_2)]_{LIT} \in F_S$))

<[idea]$_{LIT}$ [is]$_{MET}$ [liveborn]$_{MET}$>
is true if and only if
($\exists$S, T, f_M)((S, T, f_M) is a true analogy & idea $\in$ T &
(baby $\in$ S & idea = f_M(baby)) &
(S9 is a functional proposition in S &
[liveborn(baby)]$_{LIT}$ $\in$ S9))

(4) Verb-predication metaphors

<[NOUN1]$_{LIT}$ [VERB]$_{MET}$ {PREP} {DET} [NOUN2]$_{LIT}$>
is true if and only if
($\exists$S, T, f_M)((S, T, f_M) is a true analogy &
($\exists P_S$)(P_S is a functional proposition in S &
$NOUN_1 = f_M(AgentOf(P_S))$ & VERB = $VerbOf(P_S)$ &
$NOUN_2 = f_M(PatientOf(P_S))$))

<[Students]$_{LIT}$ [give birth]$_{MET}$ to [ideas]$_{LIT}$>
is true if and only if
($\exists$S, T, f_M)((S, T, f_M) is a true analogy &
S6 is a functional proposition in S &
students= f_M(AgentOf(S6)) & give-birth = VerbOf(S6) &
ideas = f_M(PatientOf(S6)))

(5) Verb-predication metaphor with PATIENT genitive. This rule shows how complex metaphors can be analyzed into simpler metaphors.

<[NOUN1]$_{LIT}$ [VERB]$_{MET}$ [NOUN2]$_{MET}$ of [NOUN3]$_{LIT}$>
is true if and only if
(∃NOUN4)([NOUN1]$_{LIT}$ [VERB]$_{MET}$ [NOUN4]$_{LIT}$ is true &
[NOUN4]$_{LIT}$ BE the [NOUN2]$_{MET}$ of [NOUN3]$_{LIT}$ is true)

<[Students]$_{LIT}$ [give birth]$_{MET}$ to [children]$_{MET}$ of [their minds]$_{LIT}$>
is true if and only if
([students]$_{LIT}$ [give-birth]$_{MET}$ to [ideas]$_{LIT}$ is true &
[ideas]$_{LIT}$ are the [children]$_{MET}$ of [mind]$_{LIT}$ is true)

6. Conclusion

This article has proposed conditions of meaningfulness and truth for metaphors. That truth conditions exist for metaphors amounts to the claim that the processes of generating and interpreting metaphors are at least partially rule-governed, and that the rules for the generation and interpretation of metaphors are much like those for the generation and interpretation of literal sentences. To say that the processes of generating and interpreting metaphors are rule-governed is not to deny their creativity. The creation and interpretation of metaphors are creative acts. But it does not follow that these activities are not rule-governed. The opposition of creative activity to rule-governed activity is facile; in language use, for example, even the most creative utterance must obey the rules of grammar if it is not to be mere nonsense.

The conditions of meaningfulness and truth provided here are computable, and can be used as the basis for mechanical procedures for the interpretation and generation of metaphors. Indeed, these conditions have already been implemented in a computer program, NETMET, that generates sophisticated, syntactically rich metaphors from databases of literal language. The ability of a computer program to generate metaphors challenges many classical assumptions in the philosophy of language. It challenges the claim by Davidson (1978, p. 29) that "There are no instructions for devising metaphors", and it challenges the similar claim by Cohen (1975, p. 183) that "metaphors cannot be generated mechanically."

Indeed, the existence of truth conditions for metaphors reveals a strange conflict within truth-conditional semantics. On the one hand, truth-conditional semanticists have declared that their project is to extend truth-conditional semantics to ever larger fragments of natural language (Davidson, 1967). On the other hand, they have excluded metaphor as a matter of language use or pragmatics, and denied that it has a semantic character (Davidson, 1978). But the desire to extend truth-conditional semantics clearly conflicts with the exclusion of metaphor; for if truth-conditional semantics is not to be extended to metaphor, where is it to be extended? The account given here shows the viability of a truth-conditional approach to metaphors, and reveals that the crippling limitations truth-conditional semanticists impose upon themselves are nothing but artificial methodological handicaps.

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