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Empirical Constraints on Computational Theories of Metaphor: Comments on Indurkhya

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Empirical analyses have provided some important constraints for computational theories of metaphor. Three such constraints relate to (1) the similar processing time for literal and metaphorical language, (2) the time-limited processing of many metaphors, and (3) the dissociation of metaphor comprehension and appreciation. Indurkhya's (1986, 1987) model is discussed with respect to these issues.

The goal of developing a computational theory of metaphor is an admirable one (Indurkhya, 1986, 1987). Such a theory, however, is adequate only to the extent that it can be embedded into a more comprehensive account of language processing. Empirical investigations have provided some important constraints on how the comprehension and evaluation of metaphorical language may fit into this grander scheme. My goal for these brief comments is to describe three constraints and illustrate their consequences both concretely for Indurkhya's theory and more abstractly for other possible computational models. The three sections of this commentary discuss issues of metaphor processing that are highlighted by Indurkhya's work.

1. COMPARING METAPHORICAL AND LITERAL LANGUAGE

The relationship between literal and nonliteral uses of language has become a research topic of major interest in psycholinguistics (see Gibbs, 1984, 1987a, for reviews). The victim of much of this research has been the Standard Pragmatic Model of comprehension, which has appeared in many guises in several disciplines (e.g., Carbonell, 1982; Searle, 1979; Sperber & Wilson,

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1986). This model suggests that the comprehension of all utterances which speakers produce starts obligatorily with the computation of literal meanings. Only when listeners find the literal meanings to be at odds with the contexts of utterance do they search for metaphorical meanings. Were this theory correct, a listener would only understand *Sally is a block of ice* correctly once he or she had ruled out the literal possibility that *Sally* was composed of frozen water.

The Standard Pragmatic Model makes a strong prediction about the time-course of comprehension: Because literal analysis must be completed before metaphoricity can even be entertained, a metaphorical use of an utterance should inevitably take longer to understand than a literal use of the same utterance. This prediction has been repeatedly falsified (e.g., Gerrig & Healy, 1983; Gildea & Glucksberg, 1983; Glucksberg, Gildea, & Bookin, 1982; Inhoff, Lima, & Carroll, 1984; Ortony, Schallert, Reynolds, & Antos, 1978). Consider, for example, the use of the utterance, *The winter wind gently tossed the lacy blanket* in these two brief stories:

> Joan didn't want to put her silk blanket in her automatic dryer. Although it was January, she risked putting it on the clothesline. The winter wind gently tossed the lacy blanket.

> Joan looked out into her yard with great excitement. Over night, a layer of snow had covered the ground. The winter wind gently tossed the lacy blanket.

In the first story the utterance is used literally; in the second, metaphorically. In an experiment, students were asked to read a large number of stories that ended with identical target sentences used either literally or metaphorically. The students were instructed to read the stories as they would normally read text that they wanted to understand. Reading times for the two uses of each utterance did not differ. When they were used as literal utterances, the students took an average of 2.60 s to read them; as metaphorical utterances, their reading times averaged 2.53 s. This difference was not statistically reliable. (Analyses of variance with both subjects and items as random variables produced $F < 1.0$). This result is typical of what has been found in past research (see Hoffman & Kemper, 1987, for a review). It is perhaps even more persuasive because, in this case, a second set of students were asked to rate how well target sentences fit their contexts. Despite the lack of a processing difference, the raters much preferred the literal uses of the utterances, which were rated at 6.81 on a 9-point scale, over the metaphorical uses, which were rated at 6.48 (subjects: $F(1,36) = 4.86$, $p = .03$; items: $F(1,20) = 7.11$, $p = .01$; $minF'(1,55) = 2.89$, $p < .10$). The students' intuitions about goodness—their preference for the literal uses—did not mirror the minimal processing differences.

Experiments like this one have provided an important constraint on models of comprehension, called the *total time* constraint (see Gibbs & Gerrig, in press):

> There is a unique total time associated with the recovery of a speaker's meaning when an utterance is performed in an appropriate context.

The consequence for authors of computational models of metaphor is that they are not licensed to hypothesize processes that would require elongated comprehension times for metaphors.

Indurkhya's model appears to violate this constraint. For example, he suggests that,

> the first time a metaphor is encountered, the subject has to spend a considerable amount of effort in generating T-MAPS that can provide an appropriate interpretation (1987, p. 466).

Although there is no explicit comparison to literal statements, Indurkhya implies that over repeated encounters with the same metaphor, processing becomes less laborious. Taken together, these claims suggest—incorrectly—that metaphors should take more time to understand than literal uses of the same utterance.

The same conclusion about Indurkhya's theory can be arrived at through a close examination of the two uses of *The winter wind gently tossed the lacy blanket* given earlier. When used literally, this utterance contains no comparison statement to turn on Indurykhya's special comprehension apparatus. Even when used metaphorically, there is no comparison explicit in the utterance. The comparison of *snow* to *a lacy blanket* must be recovered from context (in Indurkhya's terminology, one of the *domains* is unstated). Thus, by contrast to the literal use, the reader must first discover and then explore a comparison statement. Again, Indurkhya's theory appears to make the strong prediction that it ought to take longer to understand a metaphor. Again, this prediction is contradicted by empirical analysis.

The total time constraint does not automatically discredit all attempts to provide special computational apparatus for processing metaphors: Equivalent time does not logically entail equivalent processes (see Gibbs & Gerrig, in press). What it does require, however, is that the author of a computational model give some account of how the inclusion of special processes can nonetheless yield the appropriate time-course for comprehension. Indurkhya, in particular, has created an impressive computational edifice. It will gain credence to the extent that it can be made to adhere to this total time constraint.

2. VARIETIES OF METAPHOR UNDERSTANDING

Ideally, a computational model should describe the processes that drive metaphor comprehension in real-world contexts. Although the laboratory is one such context, the task of "reading a sentence and pushing a button when it has been understood" is unusual with respect to most other situations of language use. In particular, we might be reluctant to think that a reader had extracted all of the meaing out of a metaphor, such as Shakespeare's classic, "Juliet is the sun," in the 2 or 3 seconds it might take him or her to press a button in an experiment—explaining exactly what "Juliet is the sun" means can take minutes, hours, or articles. Nonetheless, the time pressure in the experiment accurately reflects the time pressure a listener experiences when "Juliet is the sun" appears in its original context, as part of Romeo's speech (*Romeo and Juliet,* Act 2, Scene 2, 1-5):

> But soft! What light through yonder window breaks?
> It is the east, and Juliet is the sun.
> Arise, fair sun, and kill the envious moon,
> Who is already sick and pale with grief
> That thou, her maid, art far more fair than she.

In whatever time the actor allows before beginning "Arise, fair sun," we would expect the theatergoer to come to some understanding of "Juliet is the sun."

At issue is exactly what we mean when we say that a listener has understood a metaphor (see Gibbs, 1987b, for a discussion). A computational theory should describe the representations of meaning that listeners arrive at when they experience metaphors in the theater, in conversation, or other time-limited circumstances, as well as the representations that result when a particularly elegant metaphor can be enjoyed at leisure. The first type of understanding can be called *time-limited comprehension* and is governed by the total time constraint; the second type can be called *leisurely comprehension* and may well involve types of processing that are largely specialized for metaphor. What becomes critical in developing a computational theory is for the author to make a claim about which of these two types of comprehension (and there may be more) are being modelled. Different theories may be required for the two types: We do not know whether the processes that allow metaphors to be understood swiftly in conversation are coextensive with, a subset of, or distinct from, the processes that allow them to be enjoyed at leisure.

The scope of a theory with respect to type of comprehension will determine the pertinence of some empirical constraints. If, for example, Indurkhya's model only describes leisurely comprehension, then the criticisms leveled against it for failing to adhere to the total time constraint become irrelevant. This does not, however, seem to be Indurkhya's intention. Rather, Indurkhya's theory explicitly mentions two stages in the course of metaphor comprehension, producing two classes of implications:

> The first class of implications corresponds to what the speaker intended by the metaphor and the second class corresponds to the additional implications that the hearer derives from the metaphor (1987, pp. 471–472).

Thus, Indurkhya's theory might account for the two different varieties of metaphor understanding in a natural manner. What needs to be explored is the possibility of incorporating features of the real-world processing context into the mathematical formalism. Although parsimony may dictate that we try to account for both time-limited and leisurely comprehension with a single computational model, distinct theories may ultimately be required to model the complexities of real-world metaphor use.

3. METAPHOR QUALITY

Indurkhya argues against multiple theories in another realm by making the suggestion that the same model can be used to describe both recovery of meaning and evaluation of quality. Several past theorists have made similar claims that metaphor comprehension can be described as the forging of a relationship between two domains—and that assessments of quality are a function of the similarity between, and within, the two domains (e.g., Malgady & Johnson, 1980; Tourangeau & Sternberg, 1981, 1982). Unfortunately, the possibility of a unified model of comprehension and appreciation has been challenged both by research on metaphors in extended natural contexts and by research on time-limited comprehension.

Consider again Shakespeare's "Juliet is the sun." This image has almost become drab from overuse out of context. Returned to the speech from which it is drawn, it nonetheless recovers much of its original freshness. McCabe (1983; see also Camac & Glucksberg, 1984) confirmed much the same intuition by contrasting evaluations of metaphor quality in and out of context. Some of McCabe's subjects read formulaic versions of metaphors, such as, *A star is a diamond.* Other subjects read the same comparison made in more extended settings, such as, *The star shone like a diamond in the midnight sky. Its radiance guided the ancient traveler to his destination.* A third set of subjects rated the similarity of *star* and *diamond.* For the formulaic metaphors, there was a strong correlation between ratings of similarity and ratings of metaphor quality; for the extended metaphors, no such relationship existed. Furthermore, McCabe found no relationship between ratings of comprehensibility and ratings of quality. Assessments of quality in the extended contexts were not a function of some simple metric of understanding.

Further doubt about the intimate relationship of understanding and appreciation arises under conditions of time-limited comprehension. Gerrig and Healy (1983) wrote good and bad versions of a large set of metaphorical sentences. For example, *The night sky was filled with drops of molten silver* provides a more pleasing image than does, *The night sky was filled with drops of molten resin.* Students' ratings confirmed the difference in quality. However, when another group of students was asked to read and understand these metaphors, the goodness of the metaphor had no reliable effect on reading times. The students were efficiently able to extract meaning from metaphors that were otherwise unpalatable. In general, judgments of quality are made over time and, as Indurkhya acknowledges, may be influenced by many factors special to the individual experiencing the metaphor. The exigencies of time-limited processing—in conversation or in the theater—may preclude the possibility of a strong relationship between comprehension and appreciation.

4. CONCLUSIONS

The goal of these comments has not been to do damage to Indurkhya's theory, but rather to suggest some useful empirical constraints for all computational theories of metaphor. What is most necessary is sensitivity to the time-course with which metaphors are understood—with respect both to literal language and to contexts of use. Indurkhya is correct in asserting that metaphor comprehension is "inherently computational" (1987, p. 452). The goal of fleshing out this insight can best be accomplished by allowing empirical discoveries to constrain formal analyses.

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