METAPHOR AND SYMBOLIC ACTIVITY, *11*(2), 125–143

Effect of Priming on the Comprehension of Predicative Metaphors

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We examine the relative influence of intra- and extrasentential context on comprehension time for metaphorical statements of the form *"Some X are Y."* Two intrasentential factors were manipulated. First, the ground of the metaphor corresponded to a semantic dimension of the subject noun that was either highly expected or not based on normative data. Second, the ground was either a high or low salient feature of the predicate noun. Extrasentential context was manipulated by preceding each metaphor with a literal sentence that was either related or unrelated to its meaning. Metaphors were read more quickly when the ground was a highly salient feature of the predicate noun or a highly expected dimension of the subject noun. In addition, reading time was reduced when the prime was consistent with the highly expected ending. However, reading times increased when the priming sentence activated the less expected ending. Taken together, the data support a schema-based model of metaphor comprehension.

In general, predicative statements of the form *An X is a Y* are intended to convey information about concepts. A large class of predicative metaphors convey this information via an implicit comparison drawn between the predicate noun and the subject noun. The purpose of the present study was to explore how metaphor comprehension is influenced by the semantic relations between the subject and predicate nouns. We did this by manipulating certain properties of both terms within a priming paradigm. We demonstrate that the subject and predicate nouns

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of predicative metaphors can each be influenced by external context, which then affects the overall comprehensibility of the metaphor.

Several models have been proposed to explain how implicit comparisons are drawn during metaphor comprehension. For example, Ortony (1979) proposed a salience-imbalance model, in which predicative statements of the form *An X is a Y* are understood by attributing features or properties of the predicate noun to the subject noun. Ortony further proposed that the metaphoricity of a predication increases as a function of salience imbalance; a good metaphor in this sense is one in which the *ground* (i.e., the meaning of the metaphor) is a low salient feature of the subject term, but a high salient feature of the predicate. This claim follows from the notion that a speaker does not normally tell a listener what the listener already knows (Grice, 1975). Thus, an important presupposition of the model is that the more salient a predicate attribute is, the more likely it is to be used to interpret a metaphor. For example, we are more likely to interpret *"John is an elephant"* to mean that John is large rather than that John has a good memory. Although Ortony did not propose an explicit model of metaphor comprehension per se, it would be a reasonable inference from his thesis that predicative metaphors with a high degree of salience imbalance should be relatively easy to interpret and thus to comprehend.

Glucksberg and Keysar (1990) took a different approach to metaphor comprehension, emphasizing the importance of the relation between the subject and predicate nouns. According to their model, metaphors are class-inclusion assertions rather than implicit comparisons. On this view, the subject noun of a metaphor is understood to be a member of the category represented by the predicate noun. Consequently, for the metaphor *"Some jobs are jails,"* attributes of the predicate noun (e.g., unpleasantness and confinement) are attributed to the subject noun because *job* is asserted to be a member of the category denoted by *jail.* Moreover, Glucksberg and Keysar argued that metaphor comprehension involves more than identifying featural similarities between the subject and predicate term. Instead, it involves identifying the predicate noun as a prototypical exemplar of a certain superordinate functional category (e.g., *unpleasant situation*) and then assigning the subject noun to that same category.

A third approach that is relevant to the comprehension of metaphors is a schema-based approach similar to those proposed to explain conceptual combination (Murphy, 1988, 1990; Smith, Osherson, Rips, & Keane, 1988). For example, Murphy's (1990) schema-modification model is an attempt to explain how people comprehend combined concepts such as *red apple* or *mountain cabin.* According to this schema-based approach, head nouns are represented as schemata that have a structured set of dimensions (or slots) along with possible values (or fillers) for those dimensions. During conceptual combination, the modifier alters the head noun schema such that the slots are filled with values provided by the modifier. For example, the modifier *red* selects and fills the color dimension in the schema for *apple.* The general idea is that the more readily a modifier can be associated with a particular dimension, the easier it will be to comprehend the noun phrase.

We believe that the interaction between the subject and predicate nouns in the comprehension of predicative metaphors is as important as the interaction between the modifier and head noun in the comprehension of combined concepts. In addition, we believe that both metaphor comprehension and conceptual combination involve modifying either the subject term or head noun to create a (potentially) novel concept. For example, in the metaphor *"Some voices are trumpets,"* the subject noun *(voices)* is being modified by *trumpets,* such that the speaker is not talking about just any type of voice, but about trumpet-like voices. Thus, the metaphor *"Some voices are trumpets"* and the combined concept *"trumpet voices"* may refer to the same derived concept because they both capture the same underlying relation.

A schema-based approach to metaphor comprehension is similar to the salience-imbalance model in that the predicate noun provides features directly rather than denoting a category. However, unlike the salience-imbalance model, a schema-based approach also explicitly allows the semantic dimensions of the subject noun, and their relative availability, to play a vital role in comprehension.

The schema-based model is also similar to the class-inclusion model in that both emphasize the interaction between the subject and predicate nouns. However, according to the schema model, the subject noun provides a framework into which attributes of the predicate are integrated. In contrast, the class-inclusion model claims that the predicate denotes a category of which the subject noun is a member.

Though the differences between the salience-imbalance model, the class-inclusion model, and the schema-based model seem subtle, we attempted to tease them apart using a priming paradigm developed by Gildea and Glucksberg (1983). Gildea and Glucksberg found that a metaphor like *"Some smiles are razors"* was easier to understand when it was preceded by a prime that was related to its ground, such as *Some tools are cutting,* than when preceded by an unrelated prime. In addition, priming the general dimension of the ground was as effective as priming the specific feature being predicated. For example, *Summers are warm* was as effective as *Winters are cold* for the target metaphor *"All marriages are iceboxes."* Gildea and Glucksberg concluded that both general and specific primes facilitate comprehension by activating the general semantic field of the metaphor's ground.

In the present study, we had people read metaphors similar to those in the following Statements (1–4), first described by Faries (1986). They are of four types: high subject dimension expectancy–high predicate feature salience (HH), high expectancy–low salience (HL), low expectancy–high salience (LH), and low expectancy–low salience (LL):

(1) HH: Some *voices* are *trumpets.*

(2) HL: Some *voices* are *hairdryers.*

(3) LH: Some *voices* are *lizards.*

(4) LL: Some *voices* are *bruises.*

Statements (1) and (2) are meant to be interpreted as the literal *Some voices are loud,* and Statements (3) and (4) as *Some voices are ugly.* In one study, we determined that people expected the concept of voices to be predicated on the dimension of *amplitude (loud–soft)* more than on the dimension of *beauty (beautiful–ugly).* Similarly, in a second study, we determined that *loud* and *ugly* were listed more often as attributes of *trumpets* and *lizards,* respectively, than they were listed as attributes of *hairdryers* and *bruises.* Consequently, in Statement (1), *voices* is predicated along a highly expected dimension *(amplitude)* by a concept *(trumpets)* for which the appropriate feature *(loud)* is highly salient. In contrast, in Statement (2), *voices* is predicated along the same highly expected dimension, but *loud* is a low salient feature of *hairdryers.* Similarly, in Statement (3), the dimensional expectancy is low *(beauty),* but the predicate salience is high because *ugly* is a highly salient property of *lizards*; and Statement (4) is low on both subject dimension expectancy and predicate feature salience.

Faries (1986) had research participants read the four types of metaphors and indicate when they had comprehended them. He found that people were fastest to signal that they had comprehended metaphors in which the predicate noun had a highly salient feature on a semantic dimension that was a highly expected one for the subject term, as in Statement (1). Next came metaphors that were high in either dimensional expectancy or predicate salience, but not both, such as Statements (2) and (3). People were slowest to comprehend metaphors that were low in both dimensional expectancy and predicate salience, such as Statement (4).

Some of these results are consistent with all three models. For example, it is clear that LL metaphors should be the most difficult to comprehend by any account. More interestingly, consider the difference in reading time in favor of *"Some voices are trumpets"* (HH) compared to *"Some voices are hairdryers"* (HL). This difference can be accounted for by the class-inclusion model if the category *loud things* is better exemplified by *trumpet* than by *hairdryer.* Similarly, both the salience-imbalance model and the schema-based approach can account for this finding by assuming—correctly—that *loud* is a more salient feature of *trumpets* than it is of *hairdryers.*

However, neither the salience-imbalance nor the class-inclusion models can account for the fact that metaphors like *"Some voices are trumpets"* (HH) are comprehended more quickly than metaphors like *"Some voices are lizards"* (LH), whereas the schema-based approach can account for this finding. From Glucksberg and Keysar's (1990) point of view, both predicates are highly typical members of their respective categories. That is, at least in a normative sense, *trumpet* is a good exemplar of *loud things* and *lizard* is a good exemplar of *ugly things.* Because the difficulty of identifying the two predicate nouns as prototypical exemplars of their respective categories should be roughly equivalent, from this approach it is unclear why there is a difference in comprehension time. Similarly, the finding is potentially problematic for Ortony's (1979) hypothesis because on that view, LH metaphors should be comprehended as readily as, or more readily than, HH metaphors.

From the schema-based approach, HH metaphors should be very easy to comprehend because a slot in the subject noun's schema already exists for the predicated dimension, which is a highly expected one for that particular subject noun. Moreover, the relevant (high salient) predicate feature is a feature on this very dimension. HL and LH metaphors should be less easy to comprehend than HH metaphors, but for different reasons. HL metaphors should be less easy because, although the relevant slot already exists in the subject noun's schema, the relevant predicate feature is low salient in the predicate noun; it is possible that the comprehension process attempts to match more salient predicate features into the subject noun's schema before less salient features are attempted. LH metaphors should also be less easy to comprehend than HH metaphors because the dimension of predication might not exist as a slot in the subject noun's schema; nevertheless, because the predicate feature is of high salience, a slot for this dimension can be readily created (Murphy, 1988, 1990). In terms of overall comprehensibility, the combination of a high salient subject noun dimension with a low salient predicate feature might be balanced by the combination of a high salient predicate feature with a low expectancy subject noun dimension.

As mentioned previously, a priming paradigm should allow us to distinguish among the three models. Thus, in the present study we used the four types of metaphors described previously and the same task as used by Ortony, Schallert, Reynolds, and Antos (1978) and Faries (1986): Participants simply read the sentences, one at a time, and responded when they thought they had comprehended them. The metaphors were each preceded by a literal sentence in which the predicate was a feature that was either unrelated to the subject noun or was a feature on a dimension that was either high or low in expectancy for the subject noun. At the same time, the related-prime predicate was a feature that was either high or low in salience for the predicate noun of the metaphor. Table 1 shows examples of the four related-prime and four unrelated-prime conditions. We used sentences as primes because we did not want participants to be able to distinguish between the primes and the targets in terms of the task they were to perform.

Because the primes activate the relevant predicate feature, they make features that are normally low in salience relatively highly salient. Thus, the HH and HL metaphors, which are supposed to carry the same meaning, should become functionally equivalent in terms of comprehensibility, as should LH and LL metaphors. However, the effect of this functional equivalence, in terms of observed priming effects, differs as a function of which model is being considered.

The salience-imbalance model makes a strong prediction that comprehension times for HL and LL metaphors will improve after related primes, compared to

TABLE 1
Examples of Stimulus Materials for the Four Related-Prime and Four Unrelated-Prime Conditions

	Subject Noun Expectancy–Predicate Salience			
Sentence Type	*High–High*	*High–Low*	*Low–High*	*Low–Low*
Unrelated prime	buses are late	buses are late	lipstick is oily	lipstick is oily
Related prime	buses are loud	buses are loud	lipstick is ugly	lipstick is ugly
Target metaphor	voices are trumpets	voices are hairdryers	voices are lizards	voices are bruises
Unrelated prime	chairs are leather	chairs are leather	policemen are honest	policemen are honest
Related prime	chairs are hard	chairs are hard	policemen are strong	policemen are strong
Target metaphor	arteries are metal	arteries are nails	arteries are moonshine	arteries are hammers
Unrelated prime	backs are rigid	backs are rigid	books are used	books are used
Related prime	backs are strong	backs are strong	books are expensive	books are expensive
Target metaphor	coffee is moonshine	coffee is a hammer	coffee is platinum	coffee is a tuxedo
Unrelated prime	hills are rolling	hills are rolling	eggs are scrambled	eggs are scrambled
Related prime	hills are small	hills are small	eggs are white	eggs are white
Target metaphor	houses are atoms	houses are ions	houses are cocaine	houses are cocoons

after unrelated primes, because the predicated feature will be made salient by the prime. It is also possible, but not necessary in this model, for improvement to occur on HH and LH comprehension times if the prime activates the relevant predicate feature above its "resting" level of activation. Note, however, that even with these priming results, this model has difficulty when HH metaphors (primed or unprimed) are comprehended more quickly than LH metaphors.

According to the class-inclusion model, priming the relevant feature of the predicate should make it easier to identify its relevant functional category and therefore make the metaphor easier (faster) to comprehend. For example, the prime *Some buses are loud* should activate the functional category of *loud things* and therefore facilitate processing both "*Some voices are trumpets*" and "*Some voices are hairdryers.*" Similarly, the prime *Some lipstick is ugly* should facilitate both "*Some voices are lizards*" and "*Some voices are bruises.*" Facilitation should occur regardless of the level of subject dimension expectancy because activating the relevant feature in the predicate term should evoke the relevant functional category. Within each set of four metaphors, because the meanings of the HH and HL metaphors differ from the meanings of the LH and LL metaphors, the overall amount of facilitation might differ between the HH and HL versus the LH and LL sentences, but all four types should show some facilitation.

In a schema-based model, whether the prime facilitates comprehension depends upon how easily the predicate feature can be integrated into the subject noun schema. This, in turn, will depend on three things: (a) how salient the relevant predicate feature is; (b) whether the dimension of predication already exists as a slot in the subject noun's schema; and (c) when the dimension does not exist, how easily a slot for it can be created. For the high expectancy metaphors HH *("Some voices are trumpets")* and HL *("Some voices are hairdryers"),* the relevant dimension *(amplitude)* is already part of the subject noun's schema. Therefore, it should be fairly easy to accommodate any predicate that contains a feature on that dimension, provided that the feature is already above a certain threshold of salience or can be made to be above that threshold by a prime. On this view, HH metaphors, which have predicates with a highly salient feature on the relevant subject noun dimension, will be easy to interpret with or without a prime because both the predicate feature and the relevant dimensional slot in the subject noun's schema are readily available. Indeed, it is possible that a related prime will not make HH metaphors any easier to comprehend than they already are without any prime. On the other hand, HL metaphors, which have predicates with a low salient feature on the relevant subject noun dimension, can be made easy to interpret if that feature is activated by the prime. This is because, once activated, the predicate feature can then be readily integrated into the extant dimensional slot in the subject noun's schema. Thus, we should see facilitation in the related-prime condition, relative to the unrelated-prime condition, for HL metaphors.

In contrast to the cases in which the dimension of predication already exists in the subject noun's schema, according to the schema-based model, if the ground of the metaphor corresponds to a less expected subject noun dimension (e.g., with LH and LL metaphors), the effect of the prime depends primarily upon predicate feature salience. If the relevant feature is a highly salient feature of the predicate noun (e.g., in LH metaphors), then that feature can facilitate the creation of a new slot in the subject noun schema (via elaboration; see Murphy, 1988), effectively transforming LH metaphors into HH metaphors. Once again, because the predicate feature is already highly salient in LH metaphors, a related prime might not be necessary to further facilitate the creation of a slot in the subject noun's schema. Finally, if the relevant feature is a low salient feature of the predicate noun (e.g., in LL metaphors), a related prime might actually interfere with comprehension, because the prime activates a feature that, although relevant to the ground of the metaphor, is inconsistent with (or at least does not belong to) the semantic dimension activated by the subject noun. For example, the feature *ugly* activated by the priming sentence *Some lipstick is ugly* is inconsistent with the highly expected *amplitude* dimension activated by the subject noun *voices*. Moreover, the primed feature is inconsistent with other salient features of the predicate. Rather than aiding comprehension of the LL metaphors, then, related primes might hinder comprehension because the prime, the subject noun, and the predicate noun each activate different semantic dimensions.

In summary, both the salience-imbalance and the class-inclusion models predict that related primes will facilitate comprehension compared to unrelated primes; the salience-imbalance model makes this prediction most strongly for the HL and LL metaphors, and the class-inclusion model makes it for all four conditions. Only the schema-based model predicts different effects of the primes on comprehension times as a function of both subject dimension expectancy and predicate salience. In particular, facilitation by related primes is strongly predicted for HL metaphors, and it would be consistent with (but not mandated by) the model to observe facilitation for HH and LH metaphors, whereas LL metaphors might actually be read more slowly after a related prime.

EXPERIMENTS 1A AND 1B

We conducted two studies to obtain stimulus items for the experimental conditions. In the first study we measured the frequency with which particular features (adjectives) were generated for a set of sentence beginnings. In the second study we measured the frequency with which particular attributes were generated for nouns that had been generated in the first study.

Experiment 1a: Sentence Completion Norms

Stimuli, design, and procedure. There were 168 unique phrases of the form *This [that, his, her] X is a. . . .* These were divided randomly into five lists of 36 phrases each (12 of the phrases were repeated to even out the lists, but no person saw the same phrase twice). Five random orders of each list were constructed, for a total of 25 test forms. Eighty-five undergraduates from the University of Alberta participated to fulfill a course requirement, so each of the five lists was given to 17 participants.

Participants were tested in groups of about 25 each. They were seated at desks, and the forms were distributed so that no adjacent individuals had the same form. Participants were instructed to complete each sentence on the form with an ending that they thought fit the sentence appropriately. The examples given were mostly single adjectives (e.g., *This pencil is dull*). Participants were explicitly asked to try not to think of weird or witty ways to complete the phrases. It generally took from 20 to 30 min to complete this task.

Results. We counted the number of occurrences of instances of a particular dimension or category that were listed for each subject term and expressed the result as a percentage of the total number of responses for the term. For example, a participant who completed the phrase *Her desk is* with either the ending *neat* or *messy* would contribute a frequency point to the category *neatness*. Thus, the norms reflect the frequency of features listed for an entire dimension, not just one particular feature.

We counted synonyms and antonyms, as well as the actual features that would become the primes, in the total for each subject term. For example, for the eventual metaphor *"Some desks are junkyards,"* the dimension being predicated is *neatness,* and the value along the dimension is *messy.* But in counting up the frequencies for that dimension, we included the responses *messy, neat, cluttered, empty,* and *tidy.* The results of the tabulation for the 32 subject nouns used in Experiment 2 are shown in Table 2 for the high-expectancy subject noun dimensions and in Table 3 for the low-expectancy subject noun dimensions. It can be seen that, for the most part, the low expectancy dimensions were not mentioned by any participants; nevertheless, the values chosen to predicate the subject nouns for those dimensions always resulted in plausible literal statements (e.g., *Some houses are white* is a plausible statement, even though no participant listed any color as a completion for the phrase *Some houses are*).

Experiment 1b: Feature Lists

Stimuli, design, and procedure. A total of 450 nouns from Experiment 1a were used in this study. They were randomly partitioned into 15 lists of 30 words each. Each list was then randomized, giving a total of 75 forms. Fifteen groups of 15 undergraduates each from the University of Alberta participated for course credit, for a total of 225 participants. Each participant generated features for one of the lists.

The experiment was conducted in a classroom with about 30 participants at a time. They were instructed to generate as many features or characteristics as they could for the referents of each of the words on their lists. It took from 30 to 45 min to complete the task.

Results. The features generated were tabulated for each of the 450 words. Synonyms were counted as the same feature (e.g., *big* and *large*). The data for the nouns used as predicates in Experiment 2 are shown in Tables 2 and 3.

EXPERIMENT 2

The two sets of norms yielded overlapping, but not identical, data. For example, in the first set, the phrase *That brick is* was most often completed with reference to weight, indicating that weight is a highly expected predicate for the concept *brick.* Being heavy was also a highly salient feature of bricks, as indicated by its high frequency as a listed feature in the second set of norms. There were usually differences between the norms, however, which justifies not only the collection of both sets of data, but the conceptualization of the subject and predicate terms as having potentially different contributions to the comprehen-

TABLE 2
Percentage of Participants in Experiment 1a Listing Values Along Highly Expected Subject Noun Dimensions and Percentage of Participants in Experiment 1b Listing High and Low Salient Predicate Features for Predicate Nouns

Subject Noun	*Predicated Feature on Dimension*	*% Listing Any Value on Dimension for Subject Noun*	*High Salient Predicate*	*% Listing Predicate Feature*	*Low Salient Predicate*	*% Listing Predicate Feature*
arteries	hard	29.4	metal	46.7	nail	13.3
ballet	graceful	29.4	swan	66.7	stallion	20.0
coffee	strong	29.4	moonshine	40.0	hammer	13.3
desk	messy	64.7	junkyard	60.0	roadmap	0.0
drug	dangerous	41.2	dagger	53.3	tuberculosis	33.3
ears	large	52.9	elephant	86.7	Earth	26.7
fish	large	29.4	dinosaur	66.7	bathtowel	33.3
floor	shiny	29.4	aluminum	53.3	crystal	20.0
gossip	harmful	35.3	poison	86.7	pollution	26.7
house	small	35.3	atom	86.7	ion	6.7
jacket	warm	29.4	sauna	100.0	lamp	26.7
jewel	expensive	52.9	caviar	60.0	medicine	6.7
lake	cold	23.5	antarctic	93.3	asteroid	6.7
letter	long	29.4	telescope	46.7	submarine	13.3
music	loud	47.1	jackhammer	46.7	sun	6.7
park	beautiful	47.1	lizard	46.7	bruise	13.3
paycheck	small	88.2	ant	73.3	thorn	20.0
restaurant	expensive	29.4	platinum	46.7	tuxedo	13.3
seatbelt	tight	41.2	cage	66.7	closet	13.3
shirt	dirty	29.4	slum	73.3	badger	6.7
shoe	large	29.4	mountain	46.7	vault	13.3
sofa	soft	82.4	fur	66.7	haystack	13.3
speech	boring	23.5	turtle	80.0	hippo	6.7
stomach	large	35.3	tank	60.0	hospital	13.3
surgeon	precise	35.3	swiss watch	66.7	architect	6.7
teeth	white	58.8	cocaine	86.7	cocoon	6.7
train	fast	58.8	cheetah	93.3	hurricane	6.7
vacation	fun	52.9	party	60.0	sports	26.7
voice	loud	58.8	trumpet	46.7	hairdryer	20.0
wallet	empty	41.2	ghost town	73.3	desert	13.3
weekend	boring	58.8	sermon	46.7	professor	13.3
wind	strong	29.4	ammonia	73.3	moose	13.3
M		42.5		65.6		14.8
SE *M*		2.9		3.0		1.5

TABLE 3
Percentage of Participants in Experiment 1a Listing Values Along Low Expectancy Subject Noun Dimensions and Percentage of Participants in Experiment 1b Listing High and Low Salient Predicate Features for Predicate Nouns

Subject Noun	*Predicated Feature on Dimension*	*% Listing Any Value on Dimension for Subject Noun*	*High Salient Predicate*	*% Listing Predicate Feature*	*Low Salient Predicate*	*% Listing Predicate Feature*
arteries	strong	0.0	moonshine	40.0	hammer	13.3
ballet	loud	0.0	jackhammer	46.7	gun	6.7
coffee	expensive	0.0	platinum	46.7	tuxedo	13.3
desk	expensive	0.0	caviar	60.0	medicine	6.7
drug	strong	11.8	ammonia	73.3	moose	13.3
ears	soft	0.0	fur	66.7	haystack	13.3
fish	bothersome	0.0	housefly	66.7	dandelion	20.0
floors	small	0.0	ant	73.3	thorn	20.0
gossip	loud	0.0	trumpet	46.7	hairdryer	20.0
house	white	0.0	cocaine	86.7	cocoon	6.7
jacket	messy	5.9	slaughterhouse	46.7	war	6.7
jewel	large	5.9	dinosaurs	66.7	bathtowel	33.3
lake	dry	0.0	melba toast	73.3	nest	6.7
letter	messy	0.0	junkyard	60.0	roadmap	0.0
music	slow	0.0	turtle	80.0	hippo	6.7
park	cold	0.0	antarctic	93.3	asteroid	6.7
paycheck	precise	0.0	swiss watch	66.7	architect	6.7
restaurant	boring	0.0	sermon	46.7	professor	13.3
seatbelt	heavy	0.0	anchor	60.0	piano	0.0
shirt	confining	5.9	cage	66.7	closet	13.3
shoe	hard	0.0	metal	46.7	nail	13.3
sofa	large	0.0	mountain	46.7	vault	13.3
speech	fun	0.0	party	60.0	sports	26.7
stomach	empty	23.5	ghost town	73.3	desert	13.3
surgeon	dangerous	0.0	dagger	53.3	tuberculosis	33.3
teeth	shiny	5.9	aluminum	53.3	crystal	20.0
train	warm	0.0	sauna	100.0	lamp	26.7
vacation	long	5.9	telescope	46.7	submarine	13.3
voice	ugly	5.9	lizard	46.7	bruise	13.3
wallet	large	11.8	tank	60.0	hospital	13.3
weekend	fast	17.6	cheetah	93.3	hurricane	6.7
wind	harmful	0.0	poison	86.7	pollution	26.7
M		3.1		63.6		14.0
SE *M*		1.0		2.9		1.5

sibility of predicative statements in general. For example, the most frequent endings generated to the phrase *This tree is* had to do with the dimension of age, whereas the features most often listed for tree had to do with color and size. In Experiment 2, we examined the effects of subject dimension expectancy and predicate salience on metaphor reading times when a preceding literal predicate is either related or unrelated to the metaphor's expected dimension of predication. The participants' task was to indicate when they had comprehended the metaphor; this is the same procedure used by Ortony et al. (1978) and Faries (1986).

Method

Materials. A set of 128 sentence primes and 128 target metaphors was used. Four types of metaphors were constructed by crossing the dimensional expectedness of the subject noun (high vs. low) and the salience (high vs. low) of the predicate noun feature that was relevant to the meaning of the metaphor as illustrated in Table 1.

For the target sentences, 32 nouns each appeared once as a subject noun in each of the four stimulus conditions, so any differences among the conditions cannot be attributed to the subject nouns per se. For the predicates, one set of nouns for which a particular feature was highly salient—for example, *trumpet* (loud)—and a second set of nouns for which the same features were low salient, but true—for example, *hairdryer* (loud)—was used in both the high and low expectancy subject dimension conditions (with different subject nouns, of course). Because the relevant predicate features were the same across the high and low subject noun expectancy conditions, any differences obtained as a function of subject dimensional expectancy cannot be attributed to the particular predicate features that were used.

Tables 2 and 3 show the target stimuli used and their rated values for subject noun expectancy and predicate feature salience. For example, the first row in each table illustrates the following four target metaphors (and the relevant ground):

HH: *Arteries* are *metal* (hard).

HL: *Arteries* are *nails* (hard).

LH: *Arteries* are *moonshine* (strong).

LL: *Arteries* are *hammers* (strong).

A related and an unrelated prime were created for each target sentence. The unrelated primes used adjective predicates that were not directly related to the meaning of the targets in any way. The related primes were chosen from the predicates generated in Experiment 1b and corresponded to the relevant feature of the target's predicate noun, which, of course, was the ground of the metaphor. Further, this feature belonged to a dimension that was either likely or unlikely to be in the subject noun's schema. The related and unrelated primes were identical for each high and low predicate salience pair that shared the same subject noun (see Table 1).

Design

The sentences were divided into four lists of 32 prime–target pairs. Each subject noun occurred once per list, and each list contained eight sentences from each of the four conditions. For each list, half the sentences in each condition were preceded by a related prime and the other half by an unrelated prime. The second version of each list was created by switching the related and unrelated primes from the first version of the list. Across the four pairs of lists, each target item was preceded once by a related prime and once by an unrelated prime.

The sentences were presented in blocks of four prime–target pairs, where each block contained one pair from each of the four conditions. However, no constraint was placed on the ratio of related to unrelated primes within a given block. Each participant received one of the eight lists of stimulus sentences, and each list was presented to five participants. Thus, we had a mixed design, with lists as a between-subjects factor, and prime type (related or unrelated), subject noun expectancy (high or low), and predicate feature salience (high or low) as within-subjects factors. The presentation order of the items within each list was randomized separately for each participant within the blocks of four trials.

Procedure and Apparatus

Participants were tested individually. They were seated in front of a table with a computer screen and a touch plate that was used to record responses. The touch plate was a wooden board with a large and small metal plate on it. The participants placed the palm of their preferred hand on the large metal plate and rested their index finger on a small wooden block located next to the small metal plate. Participants responded by tapping the small metal plate once with their index fingers.

Before the experimental trials began, the experimenter read instructions and answered any questions about the procedure. The participant then saw six practice sentences consisting of one metaphor from each condition and two primes. Both primes were related to the following target metaphor. Each participant saw the same set of practice sentences in the same order. The participants were given a short break after the practice trials and were encouraged to ask the experimenter to explain parts of the procedure that they did not understand.

The sentences (both the primes and the targets) were displayed one at a time on the computer screen with a 500-ms delay between sentences. Each trial was signaled by the simultaneous presentation of a fixation cross at the left of the screen and a 250-ms beep. After this warning signal, the entire sentence was displayed on the screen with the first letter replacing the fixation cross. The sentence remained on the screen until the participants had indicated by tapping the touch plate that they had read and understood it. Timing began as soon as the sentence was displayed. The sentences were presented in graphics mode, and their width ranged from 54 to 99 mm.

Eight "catch" trials were included during the course of the experiment, during which participants were asked to paraphrase the sentence that they had just read. These trials were included to ensure that the participants were reading each sentence for meaning. There was one catch trial per block, and the position of the catch trial within a block was randomly selected with the constraint that only target sentences were paraphrased. That is, a catch trial never followed a prime sentence because doing so would have broken up a prime and target.

Catch trials were signaled by two short (50 ms) beeps and an asterisk that replaced the target sentence after the participant's response for that trial. Participants typed in their answers on a computer keyboard and were allowed to edit their responses using the backspace key. When they were finished typing in their paraphrases, the participants pressed the return key and then were prompted by the computer to tap the touch plate once to resume the experimental trials.

Participants

Forty-three undergraduates from the University of Alberta participated in partial fulfillment of a course requirement. The data from 3 participants were excluded from analysis because their first language was not English.

Results

Trials with reading times greater or less than 3 SDs from the grand mean obtained across subjects and conditions were omitted from analysis; across all 40 subjects, 31 trials (2.4%) were eliminated based on this criterion. Mean reading times were then obtained across trials within each condition and prime type, yielding eight scores per subject.

Two analyses of variance (ANOVAs) were conducted, one with subjects random and one with items random. The latter analysis was possible because the same 32 subject nouns appeared in all four Subject Expectancy × Predicate Salience conditions; the means from this analysis are reported below. For both ANOVAs, prime type, subject expectancy, and predicate salience were repeated measures. In addition, list was a between-subjects factor in the subject analysis.

Both subject dimension expectancy, *min* $F'(1, 53) = 4.63, p < .05$, and predicate feature salience, *min* $F'(1, 57) = 9.54, p < .025$, affected metaphor comprehension. When the subject noun dimension was highly expected (3,834 ms), metaphors took less time to read than when the relevant dimension was less expected (4,437 ms). Likewise, metaphors with highly salient predicate noun features (3,699 ms) took less time to read than did metaphors with low salient predicate features (4,572 ms). However, the effects of these factors were influenced by prime type to varying degrees.

Planned comparisons were used to examine differences between the four related- and unrelated-prime conditions, using the Bonferroni method (error rate = .05). When the feature relevant to the ground of the metaphor had high predicate salience (HH and LH), there were basically no priming effects, irrespective of subject noun expectancy. Reading times for HH metaphors like *"Some voices are trumpets"* were 3,258 ms and 3,072 ms on related and unrelated trials, respectively, $t(31) = 1.18, p > .05$. Similarly, reading times for LH metaphors like *"Some voices are lizards"* were 4,198 ms and 4,267 ms on related and unrelated trials, $t(31) = 0.44, p > .05$.

In contrast, there were substantial priming effects for metaphors with low salient predicate nouns (HL and LL), but they were in opposite directions. Reading times for HL metaphors (*"Some voices are hairdryers"*) were faster after related primes (4,277 ms) than after unrelated primes (4,728 ms), $t(31) = 2.854, p < .0125$. However, reading times for LL metaphors (*"Some voices are bruises"*) were slower after related primes (4,936 ms) than after unrelated primes (4,349 ms), $t(31) = 3.73, p < .0125$. The data for all conditions are shown in Figure 1.

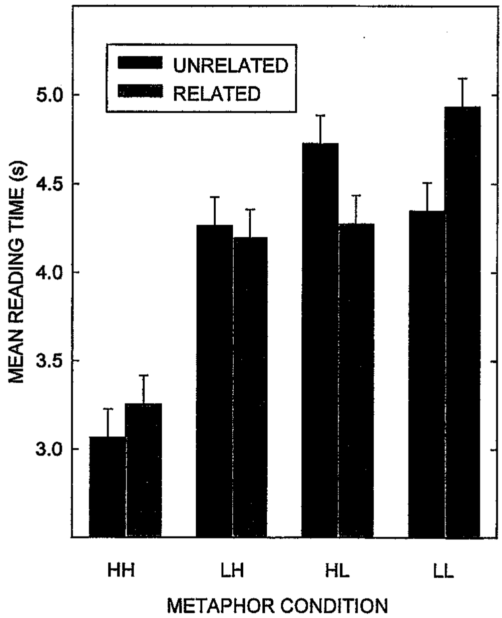

FIGURE 1 Mean reading times as a function of subject noun expectancy, predicate salience, and prime type. The error bars represent the error term used for the four planned comparisons between each related and unrelated prime condition; as they were derived from the mean square error for the triple interaction, they are relevant to any other comparison between means. (HH = high expectancy–high salience; LH = low expectancy–high salience; HL = high expectancy–low salience; LL = low expectancy–low salience.)

A triple interaction between subject dimension expectancy, predicate feature salience, and prime type in the ANOVAs corroborated the findings of the planned comparisons. This interaction was reliable for items, $F(1, 31) = 8.32$, $p < .01$, and approached reliability in the subject analysis, $F(1, 32) = 2.77$, $p < .15$, *min* $F'(1, 51) = 2.08$, $p < .20$.

GENERAL DISCUSSION

Both subject noun expectancy and predicate feature salience affected metaphor comprehension. However, the effects of these factors were qualified by the external context provided by the primes. High predicate salience metaphors (HH and LH) were relatively unaffected by prime type, whereas the two types of low salient metaphors (HL and LL) were susceptible to priming. However, for low salient predicates, the effect of the priming context differed as a function of subject noun expectancy. Relative to an unrelated prime condition, a related prime sped up comprehension when the subject dimension was highly expected (HL) but slowed comprehension when the subject dimension was less expected (LL).

As mentioned previously, the salience-imbalance, class-inclusion, and schema-modification models diverge in their predictions regarding the effects of priming. For example, the salience-imbalance model predicted a speed-up in comprehension times for both HL and LL metaphors, whereas we obtained facilitation for the former but interference for the latter. Moreover, the salience-imbalance model has difficulty with the finding that HH metaphors were comprehended faster than LH metaphors, whether or not they were preceded by a related prime.

Both the class-inclusion and schema-based models predicted that related primes will speed comprehension of HL metaphors (such as *"voices are hair-dryers"*). However, recall that the rationale behind this prediction differs between the models. According to the class-inclusion model, the prime should speed up the selection of the correct functional category, whereas according to a schema-based model, the prime should boost the salience of the appropriate predicate feature, thereby allowing the appropriate dimensional slot in the subject noun's schema to be selected and filled more quickly.

The main finding that distinguishes between the schema-based and the class-inclusion models is the difficulty in comprehension observed for LL metaphors following a related prime. According to the class-inclusion model, predicate prototypicality is low in both HL and LL metaphors, and the related prime should aid in the selection or identification of a functional category (e.g., *ugly things*). Thus, on this view, it is not clear why interference occurs in the LL condition. Although Glucksberg and Keysar (1990) said that the ground of a metaphor is provided by the interaction between the subject and predicate, they later claimed that once the category is selected by the predicate, the subject is viewed in light of the selected category. Also, they argued that the predicate's "prototypicality is crucial for construing the category" (p. 14). On this view, it does not follow that expectancies induced by the subject noun should influence category selection in such a way that a related prime aids comprehension in one case and interferes with it in the other. In addition, if only context-relevant features are compared (as Glucksberg and Keysar suggested) it is also not clear why a related prime interferes with the interpretation of LL metaphors. On their view, a related prime should be helpful in that it accentuates appropriate, context-relevant features of the subject and predicate terms.

In contrast, according to the schema model, the relevant dimension for an LL metaphor (e.g., the *attractiveness* dimension for *"Some voices are bruises")* is not present in the schema for the subject noun and, therefore, must be created via elaboration (see Murphy, 1988, 1990). The related prime corresponded to the feature of the predicate that was relevant to the ground of the metaphor (i.e., the predication), but the feature being primed was inconsistent with a dimension that was more highly expected for the subject noun than the one that was being predicated. For example, in the metaphor *"Some voices are bruises,"* the *amplitude* dimension is activated by the subject noun, whereas the feature *ugly* is activated by the related prime *(Some lipstick is ugly).* That is, unlike HL metaphors such as *"Some voices are hairdryers,"* for LL metaphors the to-be-predicated dimension is not activated by the subject noun. This inconsistency between the highly expected subject noun dimension and the primed predicate feature rendered the related prime unhelpful in creating and filling an appropriate dimensional slot in the schema for the LL metaphors, resulting in slower comprehension times.

Thus, according to the schema-based model, two factors could have contributed to the difficulty of interpreting LL metaphors after a related prime. First, the subject noun dimensions (e.g., *amplitude*) that were likely to have been highly activated in the subject noun's schema were not the relevant predicate dimension (e.g., *attractiveness*). Second, other attributes (e.g., *painful, black and blue*) more salient than the relevant low salient attribute (e.g., *ugly*) were likely to have been more highly activated in the predicate. Both of these factors could hinder the selection or creation of the relevant dimension in the subject noun.

To summarize, Ortony's (1979) similarity-based model can account neither for the finding that HH metaphors are easiest to comprehend nor for the slowed comprehension of LL metaphors preceded by related primes. In contrast, both the class-inclusion and schema-based models correctly predict that HH metaphors should be the easiest to comprehend; however, of these two models, only the schema-based model can account for why a related prime interferes with the interpretation of LL metaphors. Thus, of the three models considered, the schema-based model provides the best account of the data.

One advantage of a schema-based model over the class-inclusion model is that properties of the subject and predicate nouns are used directly rather than being evaluated in light of a common category. In using properties directly, a schema-based model avoids the problem of specifying how the functional categories proposed by Glucksberg and Keysar (1990) are selected to begin with. That is, for every predicate noun, there is a virtually unlimited number of superordinate, functional categories. For example, a *chair* is usually construed to be a member of the category *furniture,* but it can also belong to a number of ad hoc categories (see Barsalou, 1983) such as *things used to reach the top shelf, things made of wood,* or *things designed by architects.* The class-inclusion model does not clearly outline how any particular category is selected from among the many that are possible. For example, Glucksberg and Keysar pointed out that the metaphor *"Jobs are jails"* is interpretable because *jobs* is seen as a member of the category *unpleasant situations.* Yet, the literal superordinate category of *jails* is *institution* or *building.* Moreover, jails can represent other categories (such as *large brick buildings, places with heavy bars and locks,* or *dangerous situations*) that are not used in the interpretation of the metaphor. Given the abundance of possible functional categories, it seems that in some sense, one has to already know the ground of the metaphor in order to select the appropriate category.

This problem of selecting the appropriate category is especially apparent with HH metaphors such as *"Some voices are trumpets."* The superordinate of *trumpets* is *musical instruments,* yet the meaning of this metaphor is *"Some voices are loud."* Moreover, voices can be viewed as musical instruments. In addition, *trumpet* is not necessarily a prototypical member of *loud things.* Other concepts, such as *rock bands* or *jets,* are much better exemplars of this category. In addition, the functional categories (*loud things, ugly things*) that must be proposed to comprehend the metaphors used in our study can be replaced by a single, dominant feature (such as *loud* or *ugly*). Although it may be premature to rule out entirely the general notion of the use of categories during metaphor comprehension, the class-inclusion model is, as yet, underspecified in terms of the specific properties guiding the construction of functional categories.

The influence of extrasentential context has been well documented in the area of concepts and conceptual combination (Murphy, 1990; Roth & Shoben, 1983) as well as in the area of metaphor comprehension (Gildea & Glucksberg, 1983; Ortony et al., 1978). Moreover, the interaction between either the subject and predicate nouns of a metaphor or the modifier and head noun of a combined concept is important in deriving the ultimate interpretation of the phrase. Context may activate the relevant dimension in the subject noun's schema as well as the relevant modifier, in the case of combined concepts, or the relevant predicate feature in the case of metaphors. This notion is consistent with Searle's (1979) view that people must select certain features to incorporate into an interpretation of a metaphor, based in part on the context provided by the subject term (e.g., *"Sam is a pig"* vs. *"Sam's car is a pig"*). Priming either the relevant subject noun dimensions or the relevant predicate features is one way this selection might occur.

By demonstrating how a schema-based approach can accommodate metaphor comprehension, we highlight the underlying commonalities between the mechanisms used to comprehend both metaphors and combined concepts. In a schema-based approach, the subject noun of a metaphor is analogous to the head noun of a combined concept in that it provides a schema into which the modifier (or predicate noun) is integrated. Moreover, metaphors like "*Some voices are trumpets*" and combined concepts like "*trumpet voices*" may ultimately refer to the same derived concept, in that they both capture the same underlying relation between *voices* and *trumpets*. In both cases, the relations among the dimensions within head (subject) noun schema and the relation between these dimensions and possible fillers in the modifier (predicate) play a vital role in the interpretation of the meaning of the phrase. If this conjecture is valid, it lends substance to the notion that in everyday discourse, mechanisms underlying metaphor comprehension are not fundamentally different from those underlying literal language comprehension, and that a model derived from schema-based approaches to conceptual combination can be a useful theory of metaphor comprehension.

ACKNOWLEDGMENTS

The experiment reported in this article was supported by a grant to the second author from the Natural Sciences and Engineering Research Council of Canada. Experiment 2 was reported at the meetings of the Canadian Psychological Association, Calgary, Alberta, in 1991. We are grateful to Gregory Murphy for his comments on an earlier version of the manuscript and to Richard Honeck for a most thorough, thoughtful, and helpful review.

REFERENCES

Barsalou, L. (1983). Ad hoc categories. *Memory and Cognition, 11,* 211–227.

Faries, J. M. (1986). *Constraints on metaphorical word meaning.* Unpublished master's thesis, University of Alberta, Edmonton, Canada.

Gildea, P., & Glucksberg, S. (1983). On understanding metaphor: The role of context. *Journal of Verbal Learning and Verbal Behavior, 22,* 577–590.

Grice, H. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Syntax and semantics: Vol. 3. Speech acts.* New York: Academic.

Glucksberg, S., & Keysar, B. (1990). Understanding metaphorical comparisons: Beyond similarity. *Psychological Review, 97,* 3–18.

Murphy, G. (1988). Comprehending complex concepts. *Cognitive Science, 12,* 529–562.

Murphy, G. (1990). Noun phrase interpretation and conceptual combination. *Journal of Memory and Language, 29,* 259–288.

Ortony, A. (1979). Beyond literal similarity. *Psychological Review, 86,* 161–180.

Ortony, A., Schallert, D., Reynolds, R., & Antos, S. (1978). Interpreting metaphors and idioms: Some effects of context on comprehension. *Journal of Verbal Learning and Verbal Behavior, 17,* 465–477.

Roth, E., & Shoben, E. (1983). The effect of context on the structure of categories. *Cognitive Psychology, 15,* 346–378.

Searle, J. (1979). Metaphor. In A. Ortony (Ed.), *Metaphor and thought* (pp. 94–123). Cambridge, England: Cambridge University Press.

Smith, E., Osherson, D., Rips, L., & Keane, M. (1988). Combining prototypes: A modification model. *Cognitive Science, 12,* 485–527.