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Metaphor and the Space Structuring Model

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We propose an account of metaphor comprehension based on conceptual blending theory. We review data from on-line processing measures that support predictions of conceptual blending theory and report results of an off-line feature listing study that assessed how different sorts of contexts alter the information activated by a given word. Participants generated features for words used in the null context, sentences that promoted a literal reading of the target word, sentences that promoted a metaphorical reading, and sentences that required literal mapping. In literal mapping, the literal sense of the word was used in a way that prompts the reader to blend it with structure from a different domain. Results revealed some overlap in the features generated in each of the 4 contexts, but that some proportion of the features listed for words in literal, literal-mapping, and metaphoric-sentence contexts were unique and context specific.

Characterizing the precise relation between literal and nonliteral meaning dominates modern research on metaphor and figurative language. In traditional linguistic theory, literal and nonliteral meanings are seen as two different beasts, only one of which is well behaved. In this view, “normal” language—that is to say, literal language—involves recruiting word meanings from the mental lexicon and combining them with grammar rules. Understanding normal language also demands compliance to communicative maxims: Utterances must be truthful, relevant, and maximally informative. In fact, on traditional accounts, conforming to these max-

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ims is what enables speakers to discern literal language, which is thought to involve compositional parsing mechanisms, from nonliteral language, in which world knowledge and general reasoning processes must be invoked to understand the speaker's intended meaning.

In this article, we begin with a review of two influential approaches to metaphor processing, including the standard model of nonliteral language comprehension and a competing model based on conceptual metaphor theory (CMT). In section 2, we offer our own account of metaphor comprehension based on the space structuring model (SSM; Coulson, 2000), a theory of comprehension motivated by mental space theory (Fauconnier, 1994), and conceptual integration, or blending, theory (Fauconnier & Turner, 1998). In our model, metaphor comprehension involves coordinating various conceptual domains in a *blend*, a hybrid model that consists of structure from multiple input spaces and that often develops emergent structure of its own. In sections 3 and 4, we review evidence consistent with our model and discuss results of a feature listing study designed to assess some of its claims. In this study, people were asked to generate the features for a set of nouns used in a null context and in three types of sentence contexts that promoted a range of figurative readings. Quantitative analysis of these data shows that features produced in each sentential context differ from those for the same noun in the null context, and qualitative analysis reveals blending operations, such as elaboration. In section 5, we revisit the relation between literal and nonliteral language in light of our results and argue that both metaphorical and nonmetaphorical meanings require the simultaneous activation of multiple cognitive models and the mappings among them.

METAPHOR PROCESSING

Classic literal and nonliteral distinctions are incorporated into the standard pragmatic model of metaphor processing (Grice, 1975; Searle, 1979), the validity of which has been a major focus of research on this topic (see Gibbs, 1994, for review). In the standard model, metaphor comprehension begins when the listener realizes that the speaker has intentionally violated the Gricean Maxim of Quality, "Be truthful." On realizing the literal incongruity of a metaphoric utterance, the listener must then derive a nonliteral interpretation. Consequently, the standard model suggests that understanding metaphoric language takes longer than nonmetaphoric language and involves qualitatively different processes (see Gibbs, 1994; Gibbs & Matlock, in press).

The Standard Model and CMT

Cognitive linguists have challenged many of the traditional assumptions about literal and nonliteral language. In particular, CMT proponents have shown that metaphor is not merely a literary device, but an integral part of everyday language and thought (Lakoff & Johnson, 1980; Sweetser, 1990; Turner, 1991). Based on linguistic patterns that turn up in language after language, CMT suggests a principled relation between literal and nonliteral language, with evidence that metaphoric meanings are systematically related to literal ones. For instance, countless clusters of expressions use the same kinds of words to talk about very different experiential domains. This is seen in the way people describe love in terms of travel, as with *cruise* and *crash* in *"Their relationship was cruising along but suddenly crashed"* (see Gibbs, 1994; Gibbs & Nascimento, 1993), or in the way they use words referring to vision to express understanding, as with *see* in *"I see what you're saying"* (see Sweetser, 1990). This tendency is also apparent in the way verbal arguments are described in terms of physical battles, as in *"He attacked every weak point in the argument"* (Lakoff & Johnson, 1980).

To explain this systematicity, Lakoff and Johnson (1980) proposed that metaphors reflect the output of a cognitive process by which we understand one domain, known as the *target*, by exploiting cognitive models from an analogically related domain, known as the *source*. The systematicity in the use of source and target domain terminology derives from the fact that some of the logic of the source domain has been imported into the target in a way that maintains the mappings from one to the other. Thus construed, metaphoric language is the manifestation of conceptual structure organized by a *cross-domain mapping*—a systematic set of correspondences between the source and target that result when cognitive models from a particular source domain are used to conceptualize a given target domain.

These observations point to the inadequacy of the standard model as a comprehensive account of metaphor comprehension. The model fails to explain both the ubiquity of systematic correspondences and the logic of metaphorical expressions. It also fails to explain current metaphorical use and the development of well-documented cross-linguistic patterns. Whereas CMT proponents appeal to shared cognitive models to explain metaphor comprehension, current vocabulary use, and semantic change (e.g., Lakoff, 1993), the standard model leaves these details unexplained.

Experimental Evidence

Besides linguistic evidence against the literal–figurative dichotomy, the standard pragmatic model is also undermined by a good deal of experimental evidence. First, empirical work refutes the assumption that literal processing is obligatory and necessarily prior to metaphoric processing (e.g., Glucksberg, Gildea, & Bookin, 1982; Keysar, 1989). Psycholinguists have also challenged the prediction that metaphoric meanings take longer to compute than literal ones by contrasting reading times for both types of statements. Whereas reading times for metaphors are generally longer in minimal contexts, when the same stimuli are embedded in longer passages that provide supporting context, literal and metaphorical utterances are read and understood at the same rate (Inhoff, Lima, & Carrol, 1984; Ortony, Schallert, Reynolds, & Antos, 1978).

Such results go against the standard model but are well explained by one fairly controversial model of metaphor processing, the direct access model (Gibbs, 1994). Motivated in part by CMT, this model holds that metaphor comprehension requires the same processes as the comprehension of literal language. The direct access model holds that difficulty in processing metaphoric language is a function of contextual support for the recruitment of the cross-domain mapping or mappings needed to understand any given metaphor. In this view, although literal meanings may tend to predominate in the interpretation of decontextualized utterances, metaphoric meanings require realistic social contexts. Controversially, the direct access model maintains that context can even bias a metaphoric meaning over a literal one.

Although the direct access model finds support in the finding that the nonliteral meaning of familiar idioms is almost immediately available, it is undermined by various reports that literal aspects of word meaning are primed even in metaphorical contexts. For example, using a word fragment completion task, Giora and Fein (1999) found that both literal and metaphoric meanings were activated in the comprehension of familiar metaphors. Similarly, using the cross-modal priming technique, Blasko and Connine (1993) found priming for the literal as well as the metaphoric meanings in familiar metaphors. For unfamiliar metaphors, they found priming only for the literal meanings of their stimuli. Moreover, in the processing of unpredictable idioms, Cacciari and Tabossi (1998) reported priming for literal meanings immediately at the offset, and for both literal and nonliteral meanings 300 msec later.

CONCEPTUAL INTEGRATION AND METAPHOR COMPREHENSION

Our own model of metaphor comprehension, the SSM, also acknowledges the prevalence of metaphor in everyday language and thought, as well as commonalities between the conceptual basis of poetic language and the conventional metaphors described by cognitive linguists (e.g., Lakoff & Turner, 1989; Turner, 1996). Like many models of metaphor comprehension, SSM also advocates commonalities in the construction of literal and nonliteral meanings. However, besides CMT, SSM is directly motivated by conceptual blending theory (Coulson, 2000; Fauconnier & Turner, 1998). *Blending* is a set of operations for combining cognitive models in a network of mental spaces (Fauconnier, 1994; Fauconnier & Turner, 1998). In SSM, comprehension involves the temporary construction of simple cognitive models along with the establishment of mappings or systematic correspondences among objects and relations represented in various models. Mappings are based on pragmatic functions such as identity, similarity, or analogy. Consequently, metaphoric meanings—which use analogy to link objects in different spaces—do not fundamentally differ from meanings that employ other sorts of mappings.

Mental Spaces

In SSM, linguistic cues prompt speakers to set up elements in *mental spaces*, a level of referential structure whose contents need not refer to objects in the world (Fauconnier, 1994). A mental space can be thought of as a temporary container for relevant information about a particular scenario as perceived, imagined, remembered, or otherwise understood. Initially devised to address indirect reference and referential opacity, mental space theory has proven to be useful for semantic and pragmatic complexities (see Fauconnier, 1997; Fauconnier & Sweetser, 1996). For instance, mental spaces can represent examples in which *Titanic* refers to both the ship and the movie about the ship, as in "'Titanic is a movie about the voyage of the Titanic." By partitioning the information in this sentence into two linked spaces, mental space theory captures the fact that although the ship and the movie differ, the correspondence between them is not completely arbitrary.

Mental space theory was initially designed to keep incompatible information about a single object in discrete representations; for instance, a girl with green eyes in reality could have blue eyes in a picture. But the more recent theory of conceptual integration posits a particular kind of mental space, a blended space, in which this sort of incompatible information is brought together to generate inferences that can be projected to other spaces (Fauconnier & Turner, 1998). For example, blended spaces can represent expressions using structure from multiple spaces, as with the headline "Titanic: Unsinkable After All." In contrast to the previous example, in which the film and the ship are clearly distinguished, the headline exemplifies simultaneous reference to the ship, claimed by some to be unsinkable but which proved otherwise, and the movie about the ship, which proved to be quite successful with both the critics and the general populace.

Conceptual Integration Networks

A computational- (though not algorithmic-) level account of blending appeals to a *conceptual integration network*, an array of mental spaces in which blending processes occur (Fauconnier & Turner, 1998). Blends have two or more input spaces structured by information from discrete cognitive domains, a generic space that contains abstract structure common to all spaces in the network, and a blended space that contains selected aspects of structure from both input spaces, as well as emergent structure of its own. For example, in the unsinkable Titanic blend, one input space contains information about the historic ship (which sunk and therefore was *not* unsinkable), whereas the other input contains information about the movie (which did well). Although one does not usually talk about whether movies are good flotation devices, the conceptual structure in these input spaces can nonetheless be aligned via analogical mappings between the ship and the movie, between the ship's voyage and the movie's run, and between the ship's fate (sinking) and the movie's fate (winning Academy Awards). Blending theory differs from CMT in that it explicitly allows for disanalogies in the representation of metaphoric expressions.

Elements in each of the four spaces in the integration network for the Titanic blend are shown in Table 1. The generic space in this network contains a schematic representation of the common event structure—that is, an unspecified agentive object that undertakes a course with an unspecified purpose and whose outcome can be successful or unsuccessful. Conceptual structure in the two input spaces, then, are analogically linked, whereas the mappings between the inputs and the generic space involve category inclusion. The blended space, too, shares the abstract event structure in the generic space and is composed of a combination of some structure from each of the input spaces. In this example, the blended space inherits some structure from the scenario associated with the historic input and some structure from the movie input, in particular, the fate of the movie. The mappings between the ship and the voyage in the blended space and the ship and the voyage in the historic space are identity mappings. However, the successful voyage of the Titanic in the blended space maps onto the success of the movie via analogy mappings (see Turner & Fauconnier, 2000, for more Titanic blends). Integrating a representation of the Titanic's voyage with the fate of the movie yields a counterfactual rendering of the Titanic's voyage in which the ship does not sink.

Conceptual Blending and Metaphor Comprehension

Following Fauconnier and Turner's (1998) conceptual integration theory, we argue that metaphor is more than a set of mappings between a source domain and a target domain. In our view, metaphor involves a complex of mappings with multiple spaces in conceptual integration networks. SSM differs from a number of other models of metaphor comprehension in that it does not posit the existence of a discrete metaphorical meaning. Rather, metaphorical meaning arises out of the information represented in the integration network. For instance, understanding the metaphor in *"All the nurses at the hospital say that*

TABLE 1
Spaces in Conceptual Integration Network for the Unsinkable *Titanic*

Generic Space	*Input*	*Input*	*Blended*
object	ship	movie	ship
course	voyage	run	voyage
outcome	sunk	wins-Oscars	sink

surgeon is a butcher" requires coordinating conceptual structure associated with surgery, butchery, and a blend of the two (Grady, Oakley, & Coulson, 1999).

As in CMT, comprehension of the *butcher* metaphor requires one to apprehend the mappings between surgeon and butcher, patient and dead animal (e.g., cow), as well as scalpel and cleaver. However, it also involves construction of a blended space in which structure from each of these inputs can be integrated. In this example, the blended space inherits goals of the surgeon and the means and manner of the butcher. The inference that the surgeon is incompetent arises when these structures are integrated to create a hypothetical agent with both characteristics. Behavior that is perfectly appropriate for a butcher whose goal is to cut up a dead cow is indeed appalling for the surgeon operating on a live human being.

Integration in the blended space involves three related processes: composition, completion, and elaboration, each of which provides for the possibility of emergent structure. *Composition* involves attributing a relation from one space to an element or elements from the other input spaces. Composition can be as simple as integrating an element (such as *dinner*) with a frame (such as *four-course*) or can involve more creative blending, as in the integration of frames for *Irish* and *four-course* with dinner (three pints of Guinness and a bag of crisps). In either case, emergent structure arises from the contextual accommodation of a concept from one domain to apply to elements in a different domain. *Completion* is pattern completion that occurs when structure in the blend matches information in long-term memory. For instance, if a friend told you that he had gone to Baskin Robbins for ice cream, you might infer that he had eaten a cone there as well. *Elaboration,* related to completion, involves mental simulation of the event represented in the blend. For example, we suggest that the following excerpt from a performance report is funny because the reader mentally imagines the scene, *"Since my last report, this employee has reached rock bottom and has started to dig."*

We suggest that speakers exploit explicit grammatical cues to construct a blended space with conceptual structure from both input domains. Metaphor comprehension thus involves the activation of conceptual structure needed to construct the model in the blended space, the activation of conceptual structure in the input and generic spaces, and the establishment of mappings between spaces in the network. Emergent structure is activated to produce a relatively coherent juxtaposition of disparate aspects of conceptual structure from the input domains. Moreover, particular inferences that issue from the use of a given metaphoric expression reflect the fact that metaphoric projections recruit processes of conceptual blending to produce emergent structure that can be mapped back onto the inputs.

PROCESSING METAPHORIC LANGUAGE

The SSM makes a number of predictions for on-line meaning construction. For instance, because it is based on a general theory of conceptual integration, SSM suggests the same conceptual operations are involved in the comprehension of literal and nonliteral language. For example, understanding *butcher* in “During the war, that surgeon had to work as a butcher” requires the comprehender to set up simple cognitive models in mental spaces and establish mappings based on shared relational structure. As in metaphoric uses of *butcher* discussed in the previous section, inferences are generated in the blended space, where information about a surgeon’s training and skill is integrated with general information about butchers or other aspects of the context. One might, for instance, infer that the surgeon in question was overqualified for his job, or that he was forced to work as a butcher in a labor camp.

Like many modern models of metaphor processing (see Giora, 1997, for review), the SSM suggests that qualitatively similar processing operations underlie the comprehension of literal and nonliteral meanings. Consequently, the model is supported by evidence that metaphoric meanings are understood in approximately the same amount of time as literal control statements. Moreover, findings from a small set of on-line studies demonstrate that variables pertaining to difficulty of processing metaphoric items also pertain to the difficulty of processing literal items. For instance, familiarity, one such variable, is a determinant of processing difficulty for literal and nonliteral language alike (Gernsbacher, 1984). In a cross-modal priming study, Blasko and Connine (1993) showed that the familiarity of a metaphor affected reaction times for words related to its metaphorical meaning. In an eye-tracking study, Blasko and Briihl (1997) found that gaze durations for metaphorical expressions decreased as both a function of familiarity and a function of contextual support. Similarly, Frisson and Pickering (1999) found equivalent gaze durations for sentences containing interpretable metonymies and sentences containing literal interpretations of the same words (see also Frisson & Pickering, 2001/this issue).

McElree and Nordlie (1999), however, argued that the presence or absence of differences in reading times can result from a number of different factors, not all of which reflect true differences in processing time. One way to tease apart stimulus-related processing from decision-related processing is to measure the speed–accuracy trade-off curves as participants perform a judgment task at varying amounts of processing time. With adequate sampling, it is possible to observe the full time-course of processing by establishing the point in time when performance exceeds that of chance, the point at which performance reaches an asymptotic level, and the slope of the curve between the former and the latter. Using speed–accuracy trade-off to investigate the time-course of meaning activation in literal and metaphorical statements, McElree and Nordlie found no evidence of literal meanings being available earlier than figurative meanings.

Moreover, event-related brain potential (ERP) data support the claim in the direct access model that difficulty in the comprehension of metaphoric utterances is largely a function of contextual support (Pynte, Besson, Robichon, & Poli, 1996). This latter finding is especially important because the ERP methodology can address some limitations of chronometric studies. As Gibbs (1993) noted, parity in reading times for literal and metaphorical expressions need not entail parity in the underlying comprehension processes. It is possible, for example, that literal and metaphorical meaning might take the same amount of time to comprehend, but that the latter required more effort or processing resources (Coulson & Van Petten, 2000). Alternatively, comprehension processes for literal versus metaphoric utterances might take the same amount of time to complete and yet involve quite different computations (Gibbs & Gerrig, 1989).

ERPs

Because they involve a direct and continuous measure of brain activity, ERPs can potentially distinguish between qualitatively different sorts of processing, even if their corresponding behavioral manifestations require the same amount of time (see Coulson, King, & Kutas, 1998, for a review). ERPs are small voltage fluctuations in the EEG that are time-locked to sensory, motor, or cognitive events collected by recording EEG while participants perform a cognitive task such as reading (Rugg & Coles, 1995). By averaging the EEG time-locked to multiple tokens of a given type (e.g., the onset of a word used metaphorically), it is possible to isolate aspects of the electrical signal that are temporally associated with the processing of that type of *event* (such as understanding a metaphoric meaning). The result of averaging is a waveform with a series of positive and negative peaks, known as *components* labeled by reference to their polarity (“P” for positive-going and “N” for negative-going) and when they occur relative to the onset of the stimulus event, or relative to other ERP components.

One ERP component of particular interest to researchers interested in meaning is the N400, so called because it is a negative-going wave that peaks approximately 400 msec after the presentation of a meaningful stimulus. The N400 was first noted in experiments contrasting sentences that ended sensibly and predictably with others that ended with an incongruous word. Congruous words elicited a late positive wave, whereas incongruous endings elicited a negative wave beginning about 200 msec after the stimulus was presented and peaking at 400 msec post-stimulus (Kutas & Hillyard, 1980). Subsequent research indicates that N400 is elicited by all words written, spoken, or signed, and that N400 amplitude indexes the difficulty of integrating a word into the established context (see Kutas, Federmeier, Coulson, King, & Muente, 2000, for a review). The greater the processing difficulty associated with a word, the larger the N400 component it elicits (see Figure 1, and note that negativity is plotted up).

Taking advantage of this well-known interpretive feature of the N400, Pynte and colleagues (Pynte et al., 1996) contrasted ERPs to familiar and unfamiliar metaphors in relevant versus irrelevant contexts. They found that regardless of the familiarity of

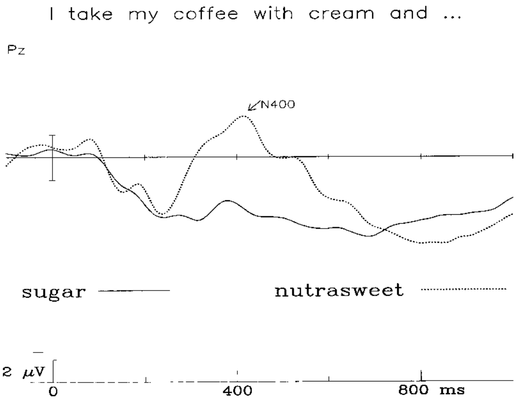

FIGURE 1 Classic N400 effect. The solid line shows the ERP from one electrode site for processing words that were highly expected in the context. The dashed line shows the ERP elicited by words that were unexpected in the context.

the metaphors, N400 amplitude was a function of the relevance of the context. Moreover, by using ERPs, Pynte and colleagues employed a measure that is in principle capable of revealing the qualitative processing differences predicted by the standard model. In fact, they observed no evidence of a qualitative difference in brain activity associated with the comprehension of literal and metaphoric language.

Reports that literal and nonliteral language comprehension both display a similar time-course and recruit a similar set of neural generators are consistent with predictions of the SSM. Moreover, the SSM also makes predictions for comprehension difficulty, predicting a gradient of processing difficulty related to the extent to which the integration requires the comprehender to elaborate the scenario set up in the blended space. This prediction was tested by Coulson and Van Petten (2000) when they compared ERPs elicited by words in three different contexts on a continuum from literal to figurative, as suggested by blending theory. For the literal end of the continuum, Coulson and Van Petten used sentences that promoted a literal reading of the last term, as in “He knows that whiskey is a strong *intoxicant.*” At the metaphoric end of the continuum, they used sentences that promoted a metaphoric reading of the last term, as in *“He knows that power is a strong intoxicant.”* Coulson and Van Petten also posited a *literal-mapping* condition, hypothesized to fall somewhere between the literal and the metaphoric uses, such as “He has used cough syrup as an *intoxicant.*”

Literal-mapping stimuli employed fully literal uses of words in ways that were hypothesized to include some of the same conceptual operations as in metaphor comprehension. These sentences described cases where one object was substituted for another, one object was mistaken for another, or one object was used to represent another—all contexts that require the comprehender to set up mappings between the two objects in question and the domains in which they typically occur. In line with many models of metaphor comprehension (e.g., Gibbs, 1994; Giora, 1997; Glucksberg, 1998), the SSM predicts qualitatively similar brain responses to literally and metaphorically used words, suggesting the same processes are used in literal and nonliteral language comprehension. Furthermore, in positing a continuum from literal to metaphorical based on the difficulty of the conceptual integration needed to comprehend the statement, blending theory predicts a graded difference in N400 amplitude for the three sorts of stimuli.

Overall, data reported by Coulson and Van Petten (2000) were largely consistent with the predictions of the SSM. In the early time window, 300 to 500 msec post-onset and before, ERPs in all three conditions were qualitatively similar, displaying similar waveshape and scalp topography. This suggests that during the initial stages, processing was similar for all three sorts of contexts. Moreover, as predicted, N400 amplitude differed as a function of metaphoricity, with literals eliciting the least N400, literal mappings the next-most, and metaphors eliciting the most N400, suggesting a concomitant gradient of processing difficulty. The graded N400 difference argues against the literal–figurative dichotomy inherent in the standard model and suggests processing difficulty associated with figurative language is related to the complexity of mapping and conceptual integration.

FEATURE STUDY

In their ERP study, Coulson and Van Petten (2000) showed a processing gradient, which they attribute to the complexity of blending operations needed to understand words in the literal, literal-mapping, and metaphorical contexts. However, aside from the authors' native-speaker intuitions, there was no evidence to show that placing these words in different sentential contexts would promote the retrieval of different sorts of conceptual structure, as hypothesized in the SSM. Indeed, a general characteristic of research that addresses the issue of continuity between processes underlying literal and metaphoric language comprehension is that it fails to address the details of metaphor comprehension. However, another way of addressing the relation between both sorts of meaning construction is to examine the information that people activate when they understand literal versus nonliteral language.

This is the approach taken by Tourangeau and Rips (1991) in a study that compared the sorts of features people listed for metaphoric language with those listed for the contributing source and target domain concepts. Tourangeau and Rips found that many of the features listed for the metaphoric meanings were *emergent;* that is, they were not established parts of either of the domains in the metaphor. For instance, *respected* was listed as a feature of the eagle in *"The eagle is a lion among birds"* but was not listed as characterizing either eagles or lions when considered independently (Tourangeau & Rips, 1991). Furthermore, their participants rated the emergent features as being more crucial to the meaning of the metaphor than, for example, features that people listed for both eagles and lions. Tourangeau and Rips suggested that this pattern of data argues against models such as Gentner's (1983; Gentner & Wolff, 1997; Wolff & Gentner, 2000) structure-mapping engine and Glucksberg and Keysar's (1990) property attribution model, which posit the computation of shared features as the basis of metaphor comprehension.

Like Tourangeau and Rips (1991), we suggest that metaphor comprehension requires the transformation rather than pure transfer of properties from one domain to another. Moreover, the transformation occurs via blending processes such as completion and elaboration. In positing continuity between literal and nonliteral meaning construction, the SSM predicts that emergent features should arise in the course of conceptual integration across the continuum from literal to figurative meanings. Consequently, we conducted an off-line study that compared the sorts of features participants generated to words in a null context with the features they listed for the same words in literal, literal-mapping, and metaphoric contexts of the sort employed by Coulson and Van Petten (2000).

In this study, we are primarily concerned with the role of sentential context in the construction of meaning, especially how manipulating the context in which a word appears can influence the interpretation of that word, as determined by the features participants produce. One possibility is that participants would generate the same features for a word, regardless of the context in which it appeared. Such a result would suggest the construction of word meaning is removed from contextual integration, being identical from context to context. Alternatively, people might generate features relevant to and reflective of the particular sentential context in which they occur. This pattern of responses would indicate that people integrate contextual factors in such a way as to alter their understanding of individual words. Furthermore, in a qualitative analysis of features participants generate, we should expect to see evidence of blending processes such as completion and elaboration in all three sorts of contexts.

Method

Design, stimuli, and participants. The study was a within-participants design with four conditions, including a null context and three sentential contexts. In the null context, the target word appeared in isolation. In the sentential contexts, the target word appeared at the end of a sentence context. In the literal condition, the target word appeared in its literal sense, as with *anchor* in "Last time he went sailing he almost forgot about the *anchor*." In the metaphoric context, the target word appeared in its metaphorical sense, as with *anchor* in "Amidst all the trappings of success, his wife was his *anchor*." The literal-mapping condition served as an in-between condition, whereby the target word was used in its literal sense, but appeared in a context requiring the reader to perform some of the same integration operations hypothesized to underlie metaphor comprehension. For example, the literal-mapping stimulus for *anchor* was "We were able to use a barbell for an *anchor*," in which a barbell has been projected into the sailing scenario to fulfill the function of an anchor.

The 35 words in this study were embedded in a larger feature listing study that included 12 lists seen by 120 UCSC undergraduates, all fluent English speakers. In the null context, each word was seen and rated by 20 participants. In the sentential contexts, each word was seen by 10 participants in each of the three types of sentences. Stimuli were distributed across lists such that no participant saw the same item in more than one context.

Procedure. Participants were given a booklet with two sections: part A, a list of words (null context condition), and part B, a list of sentences (randomly ordered items from three sentential context conditions). In part A, participants read each item and jotted down two to three features or characteristics of that item. In part B, they read each sentence and quickly listed two or three features for the underlined word. Participants were told that they were not being timed but were encouraged not to dwell on any one item. When unsure about the meaning of a word, they were to leave a blank.

Results. For each of the 35 stimuli, participants' responses were compiled into a file that contained a list of features generated for that word in the null context and in each of the three sentence conditions. Data were quantified in two ways, one a measure of the proportion of unique features in each condition and one a measure of the similarity of the features for words in different sentential contexts. First, for each of the three sentence types, we calculated the proportion of features that were unique to that condition—namely, not produced for any of the other conditions. When words were presented in literal contexts, 41.77% of the features were not generated in either of the other sentential contexts or for the same words in the null context. When words were presented in literal-mapping contexts, 39.66% of the features were unique to that context. Finally, when words were presented in the metaphorical context, 46% of the features were unique.

As is evident in Figure 2, metaphors elicited reliably more unique features than the other two (literal) sentence types. Nonetheless, placement of the stimuli in all three sorts of sentences resulted in the elicitation of a substantial proportion of unique features. The high proportion of unique features in each of the sentence contexts (ranging from 40% to 46%) suggests a remarkable degree of context-sensitivity in the conceptual structure participants retrieved for these materials. Although the off-line feature listing task cannot assess whether participants actually use this information during comprehension, the generation of unique features indicates a systematic difference across conditions in the availability of the information that the

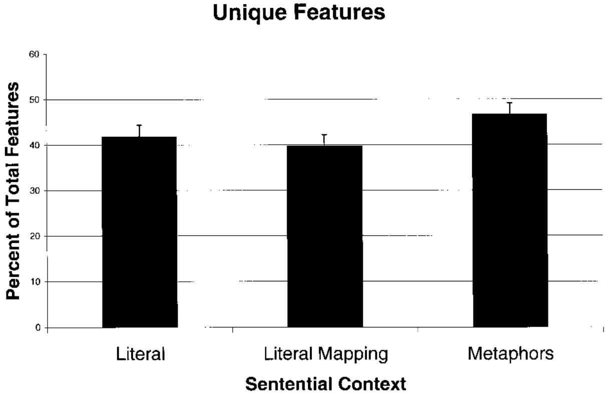

FIGURE 2 Percentages for unique features generated per context type. Error bars represent the standard error of the mean.

participants considered relevant. These differences suggest a word's appearance in any sentential context can modulate which aspects of conceptual structure participants are likely to exploit in meaning construction. This was especially the case for sentential contexts that promoted a term's metaphorical meaning.

However, it is potentially misleading to focus on the percentage of *unique* features. For example, it is possible that participants listed different words to express characteristics of the stimuli in each of the sentential contexts, but that the conceptual differences denoted by those words were minimal. For this reason, we assessed the similarity of the feature sets elicited by stimuli in each sentence type by using the *latent semantic analysis* method, a method for creating statistical profiles of linguistic items via the representation of words in a high dimensional semantic space derived from statistical analysis of large text corpora (see Landauer, Foltz, & Laham, 1998). By extracting multivariate correlation contingencies between a word and its context, latent semantic analysis produces representations whose relative proximity in semantic space can be shown to closely mimic human judgments of semantic similarity (Landauer & Dumais, 1997).

To assess the semantic similarity of the feature sets elicited in our study, we transformed each feature set into a vector in a high dimensional semantic space (300 dimensions) derived from latent semantic analysis of a large corpus (119,627 paragraphs) of machine readable texts, including novels, newspaper articles, and educational texts. This yielded four vectors for each word, one that represented the null context features and one for each of the literal, literal-mapping, and metaphorical feature sets. Semantic similarity was assessed by measuring the cosine of the angle between the vectors in each sentence condition to the vector representing the null context feature set. The cosine thus functions as a measure of proximity in semantic space, where 1 is identity and 0 represents orthogonal vectors.

The average similarity score was 0.84 between the null context and the literal feature sets, 0.81 for the null context and the literal-mapping feature sets, and 0.78 for the null context and the metaphorical feature sets. These scores indicate that the features listed for words in the metaphorical contexts were the least similar to those listed in the null context, words in the literal contexts were the most similar, and words in the literal-mapping contexts fell somewhere in between. Repeated measures analyses of variance on cosine measures revealed a main effect of sentence context, $F(2, 68) = 5.48$, $p < .01$, but post hoc comparisons suggested that although the literal and metaphorical measures differed reliably from each other, $t(1, 34) = 3.26$, $p < .01$, the literal mappings did not differ from either the literal or the metaphorical measures. This result is consistent with the assumption that the literal-mapping stimuli were intermediate with respect to literal and metaphorical stimuli.

Our analysis also included examination of unique features generated for a few words in the three sorts of sentence conditions. Although participants were specifically instructed to focus on the word at the end of the sentence, many features listed were apparently influenced by previous context. For example, with “Unfortunately, what started as a mere flirtation with the stock market has become an *orgy*,” participants generated unique responses, such as EXCESSIVE, CROWDED, INDULGENT, that might be classified as low-salient properties of orgies. However, they also listed CONFUSING, COMPLICATED, and EXPENSIVE. These negative properties are clearly influenced by context, such as the word *unfortunately*, and the integration of concepts related to orgies with concepts related to the stock market.

Moreover, evidence of integration was not limited to contexts that promoted a metaphorical reading. It was also observed in the literal-mapping and literal contexts for *orgy*. For the literal-mapping context, “He saw some hippies headed for the river and assumed it was an *orgy*,” participants listed unique features such as ’70s, DRUGGIES, SMOKING, WOODS, and SKINNY DIP, which clearly reflect concepts related to context, including *hippies* and *river*. It is reasonable to assume that such responses reflect the process of elaboration or imaginative simulation of what the hippies might do or how they might behave. Similarly, features generated in the literal context “They ended the year with a huge party that everyone remembered as the *orgy*” also show the influence of context. For instance, unique responses for *orgy* in the literal context include FOOD and DRINK, items not normally associated with the canonical meaning of *orgy* but that emerge through completion of the party scenario.

In the metaphor *“The coach said he’d miss his seniors because they were the backbone,”* responses included RELIABLE, SECURE, and RIGID, as well as BEST and FASTEST, which were clearly influenced by integration of information about the role of backbones in vertebrates and the role of the seniors on the coach’s team. Examples such as this underline the importance of the relational structure shared between the input domains, as emphasized in Gentner and colleagues’

(Gentner & Wolff, 1997, Wolff & Gentner, 2000) model of metaphor comprehension. Although the SSM also maintains an important role for analogical mapping in metaphor comprehension, the presence of shared relational structure is not as essential for our model as for Gentner and colleagues. In fact, the SSM predicts that people can comprehend metaphorical meanings that involve explicit disanalogies between the input domains.

Responses for the literal-mapping context "The paleontologists quickly discovered that the foot bones were actually fragments of *backbone*" included BREAK, BROKEN ARMS, DELICATE, and INJURY, features that have little or nothing to do with backbones per se. Once again it is apparent that context influenced the features participants produced. We suggest that *fragments* drove the choice of responses in these examples and that the people who listed these features used elaboration to produce a scenario to explain why the bones were fragmented. Responses for the literal context "At the academy, young FBI officers are taught to target the *backbone*" include VULNERABLE, IRREPARABLE, and DAMAGING, which involves the integration of information about FBI officers with what it means to *target* a backbone and completion of the integrated scenario. Other examples of features generated are shown in Table 2.

In sum, we found that there are differences but also similarities in the types of features generated in each context. In particular, metaphorical sentences elicited more unique features than the other two conditions, but the overall high proportion of unique features generated in all sentential contexts suggests a good deal of context sensitivity. At the same time, though, we have to acknowledge that the similarity across the feature sets was quite high. Approximately 60% of the features listed in each sentential context were also listed in the null context, indicating some degree of constancy in the conceptual structure available for meaning construction. Therefore, we can assume that when a word appears in a sentential context, the presence of the word and its interaction with the context can alter or drive certain aspects of conceptual structure, which are exploited in meaning construction. We attribute the systematic differences in the types of features produced in various sentential contexts to differences in blending operations. In particular, as noted, literal and literal-mapping stimuli tended to engender completion, whereas metaphorical stimuli were more likely to engender elaboration.

AS TIME GOES BY

In positing continuity between literal and nonliteral meaning construction, the SSM is supported by the consistent finding that when contextual factors have been equated, literal and metaphoric meanings take the same amount of time to compute. The SSM is also supported by research that indicates that variables such as familiarity and contextual support influence the processing difficulty of both literal and

TABLE 2
Examples of Some Features Generated With Metaphoric, Literal-Mapping, and Literal Contexts

	offshoot
met	You might think ambition is a productive emotion, but jealousy is often its offshoot.
	Unique features: DOWN-SIDE, UNWANTED, MOTIVATION, REASON
lit-map	The way those two trees have grown together, the left one looks like an offshoot.
	Unique features: FORK, CONNECTION, LEAN
lit	The Rockies are the major mountain range around here, this one is just an offshoot.
	Unique features: SMALL, EXTRA, ADDITION, SUBSIDIARY, RANDOM
	Shared features (appear in three different contexts): BRANCH, GROW
	meteor
met	Spectacular and short-lived, the right mix of gin and vermouth is a meteor.
	Unique features: INTOXICATING, STRONG
lit-map	Not well versed in astronomy, she mistakenly thought the comet was a meteor.
	Unique features: FALLING FROM THE SKY, FLASH, DANGER, BALL
lit	She looked up into the night sky and happened to see a meteor.
	Unique features: DISTANT, UNIVERSE, EXPANSIVE
	Shared features: FAST, SHOWER, ROCK, BRIGHT, SHOOTING
	reststop
met	She said it was serious but her relationship with him was just a reststop.
	Unique features: NOTHING SERIOUS, WAITING, IN BETWEEN, REBOUND
it-map	Looking at the photo closely he realized the campground was actually a reststop.
	Unique features: PARK, PLACE ALONG THE ROAD, OPEN, RECREATION
lit	After tracking him for days, the police finally cornered the fugitive.
	Unique features: INTERSTATE, STOPOVER, PITSTOP
	Shared features: BREAK, BATHROOM, RESTROOM, RELAX, HIGHWAY
	cattle
met	Blindly following orders, those cult members were cattle.
	Unique features: BLIND, STUPIDITY, DEPENDENT, UNTHINKING, DEATH
lit-map	He mistook the herd of gazelles for cattle.
	Unique features: HORNS, WILD, GOATS, DOMESTICATED
lit	We grew some corn for ourselves but more of it for the cattle.
	Unique features: FOOD, CHEWING, VARIOUS STOMACHS
	Shared features: COW, ANIMALS, MEAT

nonliteral language. Furthermore, ERP data suggest that the same set of brain regions mediate the construction of both literal and nonliteral meanings. However, continuity between literal and nonliteral language processing is a feature of most modern models of metaphor comprehension. Consequently, evidence that supports the SSM also supports the direct access model in which metaphorical meanings can be activated independently of literal ones (Gibbs, 1994), a parallel model in which neither the literal nor metaphorical interpretation has priority (Cacciari & Glucksberg, 1994; Glucksberg, 1991), and an underspecification model in which the processor initially activates the same underspecified representation for literal and figurative meanings and only later fills in the details (Frisson & Pickering, 1999, 2001/this issue).

However, the SSM finds more support in the ERP data reported by Coulson and Van Petten (2000). Although the direct access model is supported by the similar time-course of ERPs elicited by metaphoric and literal uses of the same words, it is undermined by quantitative differences in the N400 that indicate metaphors are harder to process. This finding also argues against the underspecification model (Frisson & Pickering, 1999).[1] If the parser employs a single underspecified representation each time it encounters a word, processing difficulty should be independent of figurativity and thus predicts equivalence in N400 amplitude as well as in gaze durations. Although the gradient of processing difficulty, from literal to literal mapping to metaphorical, might be consistent with other models of metaphor comprehension, it is most directly implied by the theories of blending and mental spaces.

Of interest, the processing difficulty gradient observed by Coulson and Van Petten (2000) was paralleled to a certain extent by the similarity gradient of the different feature sets participants generated in this study. Comparing features that people generated for words used in contexts that promote the same range of figurative meanings as in Coulson and Van Petten, we found that literal meanings were most similar to the information associated with a word in the null context, literal mappings the next-most similar, and metaphorical meanings the least similar. This presents the possibility that the observed difficulty gradient relates to blending operations needed to activate the features that were unique to each context. Qualitative analysis of these unique features indeed suggests that although there is evidence for all of the blending processes in each of the conditions, literal uses tend to engender composition and completion, whereas metaphorical uses were more likely to promote elaboration.

Of current models of metaphor comprehension, the SSM is most similar to the model proposed by Cacciari and Glucksberg (1994), especially in being a parallel model. Perhaps it is not surprising, then, that the SSM is supported by findings in a study by Cacciari and Glucksberg (1995) in which participants were asked to describe mental images formed in conjunction with the comprehension of a number of Italian idioms normed for familiarity and for opacity, or the extent to which its literal and figurative readings were related to one another. Of interest, Cacciari and Glucksberg reported descriptions of imagery judged as *figurative*, which seem to us to represent the sorts of images associated with a blended space. For example,

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[1] Of course, the underspecification model could be resuscitated if it were found that brain activity underlying the N400 is correlated to measures of total reading time rather than to the first fixation measure used by Frisson and Pickering (see Frisson & Pickering, 2001/this issue, for review). At present, first fixation is the best sign of immediate processing difficulty in eye-tracking studies of visual language comprehension. N400 is the best sign of immediate difficulty of lexical integration in the ERP. However, the exact relation between the two measures is currently unknown.

for the Italian idiom *"lose one's head,"* which means to become crazy, so-called figurative depictions of this idiom included, "I am laughing to tears and I lose my head in a jump, the head jumps away," as well as "A crazy person that no longer has control over his actions, his head is empty, transparent, without its content, the brain" (Cacciari & Glucksberg, 1995, pp. 50–51).

Both of these examples are characteristic of cognitive models represented in the blended space in a conceptual integration network. Although not all blends are chimerical, it is not unusual for unrealistic, impossible events such as a headless body, or a head without a brain, to be represented in the blended space. The first example, in which we have a head that spontaneously separates itself from its body, can be represented in a conceptual integration network in which one input contains a model of the realistic implications of a head falling off (death), and the other contains a model of an unspecified cause resulting in erratic behavior. The blended space inherits the cause from the first input and the effect from the second, such that the head falling off the body is understood to cause erratic behavior. In the SSM, the meaning of metaphoric language is not represented in any single space in the integration network or in any single analogical link, but emerges from apprehension of the relations among the various elements in the network.

Cacciari and Glucksberg (1994) argued that evidence for the activation of literal meanings in metaphorical context reflects the parallel activation of both sorts of meanings. In contrast, the SSM explains such data by pointing to the principled relation between literal and nonliteral meaning in conceptual blending theory. Whereas researchers in CMT argued that the literal content of metaphorical expressions indicates congruity between both the language and the logic of the source and target domains, conceptual blending theory takes this observation one step farther in arguing that the mixture of source and target domain language in metaphoric utterances is mirrored in the logic of the blend. Indeed, blending theory is in part motivated by the observation that speakers often employ source domain language without fully utilizing source domain logic.

Evidence for the import of blending in metaphoric language can be found in examples that contain partial disanalogy (e.g., Coulson, 1996). For example, the presence of disanalogy is particularly common in idioms like *"digging your own grave"* (discussed in Coulson, 1997; Fauconnier & Turner, 1998). Coulson (1997) showed how various instances of the metaphoric idiom *"digging your own grave"* involve imagery from one input (the source input of death and grave digging), but the causal structure of the other input, in which the person is unwittingly contributing to his or her own future failure. Although the mapping might seem to draw an analogy between the grave digger and the fool, in fact digging a grave does not cause anything (other than the grave itself) that might be mapped onto the grave-digger's failure. Even in abhorrent instances such as that described in a 1995 Associated Press blurb (HEADLINE: YOUTH KILLED WITH SHOVEL, BURIED IN HOLE HE HAD DUG; Crime: A man and a teen-ager who allegedly taunted the victim before beating him to death are arrested)[2], the digging itself does not lead to death.

We suggest that the ready availability of literal meaning in idiom interpretation is no accident, as it stems from the import of conceptual structure in one or more of the input spaces in a conceptual integration network. Idiom interpretation requires the construction of a number of cognitive models, one of which corresponds to the source domain and what would be dubbed a literal interpretation of the metaphoric expression. Moreover, the activation of conceptual structure from the source domain is not random but seems to be limited to some metaphor-relevant aspects, with metaphor-irrelevant aspects being actively suppressed (Gernsbacher & Robertson, 1999). The context specificity of source domain activations may arise from inherent constraints on the alignment of structure between spaces in the network.

And so we find ourselves telling a story reminiscent of that told by linguists of old. Although we reject a firm dichotomy between literal and nonliteral language and argue that qualitatively similar processing operations underlie the comprehension of both sorts of meanings, our proposal is not too far removed from the old suggestion that readers construct a *literal* interpretation automatically as part of the parsing process. However, in the SSM, this grammatically cued meaning construction occurs more or less in parallel with the structuring of other spaces in the network. Consequently, parallel activation of meaning does not reflect a blind activation process to be followed by selection of the correct meaning. Rather, parallel activation is thought to reflect the construction of cognitive models in various spaces in the network. For this reason, it is crucial for establishing the overall meaning, which involves comprehension of the relation among the cognitive models in the source input, the target input, and the blended space. Continuity between literal and nonliteral language comprehension consists in the space-structuring, mapping, and blending operations needed to construct literal and nonliteral meanings alike.

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[2] Thanks to Todd Oakley for bringing this (albeit gruesome) example to our attention.

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