1999

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Master of Arts in Psychology

University of Richmond, 1999

Contemporary metaphor theory has moved away from consideration of metaphor as a similarity statement or comparison, and toward the idea that metaphor is a temporary or permanent extension of our taxonomy of concepts in long-term memory. However, this new emphasis has resulted in a divergent pattern of results in the literature. This research was designed to integrate that pattern by testing for the role of categorization in the comprehension of metaphor, and seeing whether multiple models were needed to explain that role. Experiment 1 failed to support access of metaphorical categories in the understanding of familiar metaphors. Experiment 2 found no evidence of categorical extension or access in the understanding of metaphors, but found some support for the contention that multiple models of metaphor processing may be needed to account for all the ways in which a metaphor may be comprehended.

I certify that I have read this thesis and find that, in scope and quality, it satisfies the requirements for the degree of Master of Arts.

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A Thesis

Submitted to the Graduate Faculty

Of the University of Richmond

in Candidacy

for the degree of

MASTER OF ARTS

in Psychology

1999

Richmond, Virginia

Acknowledgements

Many people contributed to the completion of this project. I would like to thank Dr. Jane Berry and Dr. Craig Kinsley for their patience, wisdom, and thoughtful guidance throughout this project. I would also like to thank Dr. Ping Li for his support and his sustained gentle prodding toward the production of my best work. This committee has acted as my conscience throughout this project, and I will carry the lessons they have taught me for the rest of my career.

I also wish to thank the Graduate Research Committee, who provided the financial sponsorship that made this project possible, and also made it possible for me to discuss portions of this work with individuals whose ideas were crucial to the development of my own thoughts about the meaningfulness of metaphor.

Special thanks also go to Dr. Nancy Margand, without whom I might never have become a psychologist, Dr. James Warren, without whom I might never have attempted a thesis, and Walker Percy, without whom I would certainly not have attempted a thesis on metaphor.

Finally, I would like to thank my family, and Anjeanette Agro, whose love and support have been more vital to me than I can ever fully express.

The Active Architecture of Mind:
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Why is it important to study metaphor? Aristotle believed that "the greatest thing by far is to be a master of metaphor," but only recently has psychology begun to explore this opinion (Leary, 1990, p. 1). The philosophical forefathers of psychology, the British empiricists, believed that the use of metaphor was "...wandering amongst innumerable absurdities" (Leary, 1990, p. 9). According to Hume and Locke, the use of metaphor obviated logical reasoning and inhibited the proper, objective lessons of experience (Leary, 1990). Freud pointed to metaphor as the shield behind which clients would hide when they were incapable of dealing with the actual experience, associating metaphor with pathological dissemination (Anderson, 1964). Even today, important linguists like Chomsky treat metaphors as anomalous statements, only slightly more meaningful than saying "Harry store go I" (Levin, 1979). Whether as a fantastical obscurer of truth or a mere decoration available to the most proficient in language, for most of its history in the study of language, metaphor has been primarily a side issue.

However, this position has some difficulties. Consider the Aristotelian definition of metaphor: "giving something a name which belongs to something else" (Leary, 1990, p. 4). Despite what British empiricists and Freudian psychologists might argue, we do not do this only with the intent of deceit. We create a metaphor to help our hearer understand us better. When we refer to the "architecture of mind," it is not with the intent that the hearer thinks that we believe our minds are literally buildings. We do intend for the hearer to understand that minds and buildings can be similar things. While metaphors may be anomalous in structure, they are not anomalous in usage. We use and understand metaphors every single day, in common conversation. Metaphor usage is not the privilege of a select set of linguistic masters. Clinical research indicates that when a therapist uses metaphors, clients recall more of the sessions, and rate those sessions as more helpful

(Martin, Cummings, & Halberg, 1992). Other research reports increased metaphor usage during periods of insight or progress in therapy (Angus & Rennie, 1988; Evans, 1988; Angus & Rennie, 1995; Cirillo & Crider, 1995). Studies like these indicate that at some fundamental level, metaphors are part of how we think.

From findings like these, we can make the argument that metaphor is worthy of study because the use of metaphor is pervasive and has measurable cognitive effects. However, once the need for the study of metaphor is manifested, a second issue comes to the forefront: how do we do it? Why is it so easy for us to understand the metaphor "the architecture of mind?" Some metaphor theories have studied the process of categorization as a means of explaining how we understand metaphors, as well as metaphor's potential larger role in cognition. Lakoff (1987) wrote, "Nothing is more basic than categorization to thought, action, and speech." We do not encode objects in our memories as independent, free-floating representations; instead, we view those objects in terms of their similarities to other objects we already have represented there. We categorize, we classify, and we draw inferences about concepts in accordance with their category membership (Lakoff, 1987; Yamauchi & Markman, 1997). Categorical extension theories of metaphor believe that a similar process underlies the understanding of metaphor. When exposed to a metaphor, we extend a category to include a new concept, or potentially even evaluate a pre-existing metaphorical link between those concepts. The prime difference between modern theories of metaphor and previous theories of metaphor could be said to be agency: categorical extension models suggest that people are active in constructing their world.

In this paper, I will first explore how changes in categorization theory have affected the course of thought about metaphor. Next, I will evaluate some assumptions about the role of structural elements and familiarity in metaphor processing. I will also compare the predictions of three major metaphor theories within these assumptions. The first theory has been the dominant metaphor model, comparison theory, which argues that metaphors are

understood via a comparison of features between the two concepts compared in the metaphor. The second two theories are more recent models, based on category extension. Glucksberg's property attribution theory asserts that people understand metaphors by temporarily extending a category to incorporate a new member. Lakoff and Johnson's conceptual metaphor theory, on the other hand, argues that the categorical extensions are permanent, and that many of our concepts in long term memory are at least partially represented through metaphors. Metaphor understanding therefore derives from access of these pre-existing conceptual links. In the final part of the paper, I will argue that a comprehensive theory of metaphor processing may require integration of multiple models of processing, in what I call the efficiency hypothesis. The efficiency hypothesis argues that metaphor processing may be task-dependent, so that the least effortful approach is taken in understanding a particular metaphor in a given situation. To test these principles, I will conduct two studies designed to directly test the roles of these models in the understanding of a metaphor.

Categorical Understanding and the Processing of Metaphor

Classic theory of conceptual categorization believed concepts were structured in long term memory according to specific definitional qualities (Smith, 1995). No matter what the situation, a dog is an animal because it exactly fits the criteria that define the category of "animal," just as a platypus does, or a dolphin does. All members of a category have all the definitional characteristics, to the same degree, so that no member of the category is any more representative of that category. Although the classic theory believed that the taxonomy of concepts was learned, it was still based on real world characteristics that were invariant across cultures.

Rosch and Tversky initiated the current re-evaluation of how people parse their world. They argued that categorization and similarity were not based on some externally driven taxonomy. Instead, Rosch and Mervis (1975) discovered that categorization of

objects was motivated much more by human perceptions of relationships and resemblance, leading them to conclude that human beings played an active role in defining the nature and scope of a category. Soon after this research, Tversky (1977) published his seminal work operationalizing similarity between two concepts as a pattern of relationships between features, so that similarity increases with the number of shared features, and decreases as a function of features that one concept has, but the other lacks.

Tversky also found that similarity was a function of human judgment. For example, differences in saliency of conceptual features affected ratings of similarity, so subjects rated North Korea as more similar to China than China was to North Korea. Similarity carried an inherent bias—some features counted for more than other features. Tversky's work was further supported when Rosch, et al. (1977) published their own discoveries of basic levels of categorization and the prototype effect. Rather than the categories defining the concepts, categories are defined by the relationships between the concepts that made up the category. A category forms around a number of concepts sharing enough features to be considered similar. The basic-level of categorization was the level collecting the highest degree of resemblance within the category, while sufficiently distinguishing that category from other categories at the same level in the hierarchy.

Also contrary to the expectations of the classic theory of concepts, not all members of the category are created equal. Recall that a category is only defined by the relationships between its members. Rosch, et al. (1977) found that a concept bearing the most resemblance to most other members in the category was rated as more representative of the category. For example, a robin is consistently rated as more representative of the category of "bird" than a chicken or a penguin. This effect was called the prototype effect. "Robin" is a prototypical example of the class, "bird," because it bears the most resemblance to the other birds that make up the category.

Taken collectively, these findings indicate that human cognition has great impact on the assessment of relationships between objects. People perceive similarities that are not always inherent in the concepts. Sometimes, as in the case of the China-North Korea relationship, people will even express a preference for one order of similarity over another. Similarity in turn has a direct impact on the way that people group objects in categories. Subsequently, the categorizations that people make will influence their further perception of the world through the inferences they draw according to category membership.

Tversky and Rosch's research makes literal comparisons of similarity seem very like metaphorical comparison: they are creative perceptions of relationships between objects, rather than an exact replica of an external reality. Aspects of the stimuli, such as the saliency of features of the concepts and the way in which the comparisons are presented will affect our ratings of similarity. Moreover, there is great fluidity within categorical membership, so it is possible for a single category like "furniture" to encompass diverse concepts like sofas, tables, and television sets. In light of the subjective and fluid nature of categories, it is quite understandable that metaphor theorists would closely evaluate category creation and extension for the inner workings of metaphor processing.

The three metaphor models that will be considered here all concern themselves with judgments of similarity and categorical relationship. The distinctions between the three models may seem to be only shades of difference, but they have profound consequences for the potential importance of metaphor to human cognition. Ortony's comparison model argues that metaphoricity is just a special case of literal similarity in Tversky's theory (Ortony, 1979). In any given metaphor, features of the two concepts are exhaustively mapped, then compared with one another. The features shared by the topic, the object of comparison in the metaphor, and the vehicle, the object to which the topic is being compared, form the ground of the metaphor, and meaning derives from interpretation of that ground. When considering the statement, "the mind is a building," "mind" is the topic

of the metaphor, and "building" is the vehicle. The ground of this metaphor would be characteristics shared by both topic and vehicle, such as "structure" and "strong foundation." Thus, when someone compares a mind to a building, they seek to emphasize the mind's structured nature. This definition is in keeping with Tversky's theory of similarity: shared features contribute to the similarity, while distinctive features are disregarded for the purposes of understanding the comparison.

What makes Ortony's model of metaphoricity a special case is his operationalization of the definition of metaphoricity. A metaphor is a literal comparison in which the asymmetry between the intended features of the comparison is extreme (Ortony, 1979). In the case of "the mind is a building," structure and strong foundation are more important features in our understanding of "buildings" than they are in our understanding of "mind." This difference is stronger than that suggested by the China-North Korea example; although one direction is more appealing to us, we still understand the two countries to be similar in some literal sense. However, reversing "the mind is a building" to "the building is a mind" drastically changes the meaning of the metaphor, because the most salient features to the comparison change dramatically. Suddenly, the metaphor may be referring to "individual units acting busily in concert with one another," if the metaphor is describing a busy office building. Whatever the metaphor means, it is not the same now as it was when it was "the mind is a building." Understanding metaphors in comparison theory is just the logical extreme of understanding any type of similarity statement.

The two category extension models of metaphor processing approach this problem somewhat differently. Property attribution theorists believe that "metaphors are understood as they are stated: categorical assertions in which the concept X is assigned to the category denoted Y" (Glucksberg, McGlone, and Manfredi, 1997, p. 52). When exposed to a metaphor, we expand the category designated by the vehicle to incorporate the topic as a prototypical member, and make the relevant attributions of properties to the topic. Rather

than making an equal contribution to a ground, as comparison theory argues, property attribution theory believes that the linguistic metaphor creates the relationship between the two concepts, and that the contributions of topic and vehicle are much more distinct. The vehicle offers a range of features for attribution and inference, while the topic limits the possibilities of relevant attributions.

As with the property attribution model, the Lakoff and Johnson (1980) conceptual metaphor model assumes that metaphor comprehension results from a category extension. However, the type of extension Lakoff and Johnson propose is entirely different. Lakoff (1985) believes our representations of concepts like "mind" are completely defined by their relationships to other concepts. Some of these relationships are based on literal similarities —similarities with a real-world analog. Other relationships are based on abstract, nonliteral similarities, which Lakoff and Johnson refer to as conceptual metaphors. These conceptual metaphors are exactly the same as the literal category headings, except that their relationship lacks a real-world analog. Examples of these types of relationships would include our metaphorical experience of time as moving. This experience entails superordinate categorizations of time in terms of movement, such as the slow crawl of the clock just before summer vacation, or the way "time flies when you're having fun."

As with literal similarities, conceptual metaphors act at Rosch's basic level of categorization to characterize a particular concept. Whereas Glucksberg argues that exposure to a linguistic metaphor triggers an active and temporary extension of a literal category to hold the new metaphorical prototype, Lakoff and Johnson believe that linguistic metaphors are understood through automatic and unconscious access of these pre-existing metaphorical relationships in long-term memory. For example, in "the mind is a building," the topic of the metaphor, "mind," is partially represented in our memory as a member of the category designated by the metaphor's vehicle, "building." Seeing the linguistic

metaphor activates this conceptual metaphor, which in turn allows us to make inferences about the nature of the relationship between "mind" and "building."

Despite their strong disagreement about how metaphors are processed and the subsequent effects of that processing, the main difficulty in testing these metaphor theories has been in pitting these models against one another and distinguishing which one best accounts for the experimental effects. Property attribution theorists and conceptual metaphor theorists both believe that categorical extension is the mechanism of metaphor comprehension. Both conceptual metaphor theorists and comparison model theorists think that metaphoricity is based on access of featural resemblance encoded in long term memory. Conceptual metaphor theorists just predict the topic and vehicle are linked conceptually before the metaphor draws the connection out. Because of this shared space between the theories, it is not completely surprising that each model can find unequivocal support in the literature, depending upon the task design in the experiment and the way in which the metaphor is presented. To differentiate the three models more clearly, it is worthwhile to delineate some basic assumptions that I am making about metaphor processing, and compare the predictions each of these models makes in the context of these assumptions.

Assumptions of Metaphor Processing Models

The first assumption is that the topic and the vehicle contribute differently to the meaning of a metaphor, rendering the metaphor irreversible. This topic has been broached briefly already, in the discussion of the comparison and property attribution models. A classic example of the absolute irreversibility of a metaphor can be found in Glucksberg and Keysar (1990). Reversing "that butcher is a surgeon" to say "that surgeon is a butcher" results in an entirely different meaning for the metaphor, including a diametrically opposed connotative meaning (laudatory in the first case, pejorative in the second). The

order of topic and vehicle cannot be changed without rendering the metaphor meaningless, or completely changing its meaning.

Comparison theory attempts to explain this aspect of metaphor through the principle of salience imbalance. As reviewed earlier, all features of a concept are not created equally. According to comparison theory, a metaphor uses a vehicle with a distinct set of features to emphasize those features in the topic, for which they are less prominent. Evaluating the irreversibility of "that butcher is a surgeon" can demonstrate this principle. The features of "precision" and "care" are not defining qualities of a butcher; many butchers get along very well without showing precision or care in their cuts. Thus, "precision" and "care" will not be so high on the list of features associated with butchers. However, these features are extremely important and something we look for in surgeons, so they will be much more salient. These features also happen to be one of the few places where the concepts "butcher" and "surgeon" share ground, so this comparison of surgeon to butcher makes "precision" and "care" more salient, just long enough for the metaphor to be understood. Reversing the metaphor will change the patterns of saliency, so that "sloppy" and "meat-cutter" become more salient in our representation of "surgeon."

There are important objections to this position, highlighted by Tourangeau and Sternberg (1981): "features that are part of the ground of the metaphor are often not shared by the [topic] and vehicle, and...features that are shared are often not part of the ground." Returning to the original example, "the mind is a building," close evaluation of the features that were shared by the two words reveals both these objections. The features that "mind" and "building" were said to share were "structured" and "having a foundation." However, "mind" can only have those features through the metaphor. "Mind" and "building" in a literal sense only share the most general features, such as "existing in the world," which are unimportant to our understanding of this metaphor--that feature is too general to be of use,

since most things "exist in the world." The metaphor must come first, and then the "mind" can have a structure and foundation.

Another example highlighting the difficulty with salience imbalance is the metaphor, "Susan is a computer." Assume we have no previous knowledge of Susan. According to comparison theory, we should not be able to understand this metaphor; "Susan" is an empty concept, with no features to be compared to those of "computers," and by extension, there is no ground from which meaning can be derived. However, we can understand this sentence to mean, "Susan is very intelligent and logical." In order to explain these effects, another model must be used, which emphasizes the distinct and different contributions that the topic and vehicle make to the understanding of the sentence.

Consider the three examples we have explored here: "the mind is a building," "that butcher is a surgeon," and "Susan is a computer." In each of these cases, we have listed a set of features that are more important to the vehicle than they are to the topic, i.e., "structure" for the first example, "care" and "precision" for the second example, and "logic" and "intelligence" in the third example. Not one of the attributes that constitute the meaning of the metaphor originates from the contribution of the topic. In fact, in none of these cases does the topic even require conceptualization in terms of these attributes. A mind does not have a literal structure. We perceive it as having a structure through the metaphor. We never need encounter a butcher with care and precision to understand how a butcher might be a surgeon. This evaluation leads to a single point: in a metaphor, the vehicle redefines the topic.

This redefinition is posited by the interaction theory of metaphoricity, first espoused by Black (1962). The interaction view believes that only some of the words in a metaphor are intended metaphorically. In the sentence "the mind is a building," the literal sense of "mind" is active and redefined in terms of the attributes of a building. Taken in the opposite direction, "building" provides a set of possible attributes that could be relevant to

the discussion of "mind," while "mind" acts as a limiting agent, directing us toward those attributes that are most relevant to the current discussion. "Building" offers a whole set of possible attributions, such as "structure," "built on a foundation," "having windows," "having girders," and "made out of glass and concrete." "Mind" lets us know that the features of "girders" and "made out of glass and concrete" are not important to the present discussion. The attributions that are made to the topic, such as "structure," are not inherent qualities of "mind," but instead are fashioned from "building."

The interaction view has aroused debate about exactly how the topic and vehicle might be interacting. Tourangeau and Sternberg (1981) found that the understandability of a metaphor was determined by the ambiguity of the topic (meaning the topic offered more possible reinterpretations). Glucksberg, et al. (1997) actually found the opposite: the most important qualities determining meaning of a metaphor were the level of constraint of the topic and the ambiguity of the metaphor vehicle. These interpretative differences may be explained in part by the fact that Tourangeau and Sternberg's results were actually somewhat counter to their expectations, while Glucksberg, et al. set out to explicitly test the effects of level of constraint and ambiguity. Still, these results indicate that within a metaphor, the concepts appear to work differently to channel our understanding of the metaphor.

As indicated above, level of constraint refers to how strongly the concept canalizes our attributions. For example, "that surgeon" or "my job" strongly limits the range of possibilities, because it refers to a specific case. On the one hand, "mind" has many different aspects and definitions, permitting a wide range of attributions. On the other hand, ambiguity refers to how definite the concept is. "Building" is a fairly low ambiguous vehicle. It connotes a narrow set of possible attributions implying structure and solidity. "Iceberg" is an example of a more ambiguous vehicle. It is unclear what aspects of the

iceberg will be relevant (chilling, large, or mostly hidden beneath the surface) until we see the whole metaphor and the topic and vehicle interact.

Both category extension theories derive from Black's interaction view. Both believe that a metaphor is not just a comparison between two concepts, but is in fact the redefinition of one concept in terms of another. The main differences between these two theories can be found on the subsequent two assumptions, to which we will now turn our attention.

The second assumption goes to the heart of the inner workings of metaphor processing. Any comprehensive model of metaphor processing must demonstrate that it is used to understand a metaphor in any possible situation. The principle of accessibility was first developed by Glucksberg, Brown, and McGlone (1993) to challenge conceptual metaphor theory. With mild modification, though, the principle can apply to all three of the models. The principle of accessibility states simply that a critical test for a metaphor model is that its mechanics must be employed every time we are exposed to a metaphor. If the comparison model is correct, every time we are exposed to a metaphor, we must exhaustively search the features of the topic and vehicle, until we find their common ground and derive the meaning of the metaphor. If the property attribution model is correct, then every time we are exposed to a metaphor, we must make a novel class extension. If the conceptual metaphor model is correct, then every time we are exposed to a linguistic metaphor, we must access the relevant conceptual metaphorical link in long term memory to understand it.

Again, the comparison model faces some difficulty with this assumption. In order to understand a metaphor, we must access all the features relevant to both topic and vehicle in long-term memory, and because of the principle of salience imbalance, the most relevant features in the topic will not be readily apparent. Processing necessarily would require a length of time before a person is able to ascertain whether the sentence is a metaphor or

merely a nonsense statement. The metaphor cannot be recognized until the ground is determined. However, there is evidence to indicate that people intuitively recognize metaphors. Glucksberg, Gildea, and Bookin (1982) found a Stroop effect in metaphor processing. They asked subjects to identify statements as literally true or literally false. They found that sentences with potential metaphorical denotations took longer to identify as literally false, suggesting that metaphors are recognized more quickly than can be accounted for in the comparison model.

However, both of the category extension models also violate accessibility in certain conditions. Most research supporting the existence of conceptual metaphors came from tasks testing metaphors with a great deal of familiarity to us, or when creating a context for supporting material (Nayak & Gibbs, 1990; Albritton, McKoon & Gerrig, 1995). On the other hand, when presented alone, comprehension of a metaphor appears not to be driven by conceptual metaphors. Glucksberg and Keysar (1990) found no reference to an underlying conceptual construct in subjects' free write comprehension of metaphors that Lakoff and Johnson claimed were derived from underlying conceptual links. Camac and Glucksberg (1984) tested subjects on word pairs, some of which conformed to a familiar metaphorical relationship, and some of which were scrambled versions of that relationship. They found that the familiar pairs were no more recognizable than the scrambled pairs, suggesting that the creation of metaphorical links was spontaneous, versus a pre-existing construct in long term memory.

Still, it is unclear how property attribution theory can explain why metaphors aid communication (e.g. make a therapy session more helpful, or help organization of a text). The property attribution model predicts a spontaneous and, above all, temporary, category extension that fades once the metaphor is understood. It is not clear that conceptual metaphors are accessed during exposure to a novel metaphor alone, but it is also not clear that the mechanics of property attribution are used to understand metaphors as part of a

text, or metaphors that are very familiar to us. Subjects may not refer to a conceptual metaphor to explain a linguistic metaphor, but that does not necessarily mean that they did not use the conceptual metaphorical linkage to understand the linguistic metaphor upon exposure.

What may be necessary is to develop a softer view of the principle of accessibility. Glucksberg, et al. (1993) also consider this softer view; they call it the principle of availability. Availability argues that we will access a processing strategy according to the demands of the task. We might not always automatically access a conceptual metaphor to understand a linguistic metaphor, because it is unreasonable to expect that we will have a representation of every metaphor we come across. Many metaphors are too insignificant or too far outside our past experience for us to have represented previously in long term memory. If we have not previously experienced love as having similarities to a filing cabinet, then we certainly cannot refer back to long term memory to understand "love is a filing cabinet" (example from Kittay, 1997). On the other hand, is it reasonable to expect that eventually we will not develop representations of metaphorical relationships in long-term memory if they are particularly trenchant to our experience, or if we are exposed to them repeatedly? Glucksberg and Keysar (1990) state that conceptual metaphor theory is not incompatible with their perspective--they only question when a conceptual metaphor might need to be accessed.

The Third Assumption and The Efficiency Hypothesis

The third assumption is that the way we process a metaphor depends upon the structure, form, and presentation of the metaphor. In some ways, this assumption is the least controversial. It is an extension of the truism that understanding of metaphors is strongly context driven. Context refers to all the mediating variables in a given situation, from the type of metaphor that is presented (Is the metaphor an implicit or explicit comparison? Is the metaphor alone or part of a text?) to the listener's prior experience with

the concepts in the metaphor. For example, a listener who is told that "Susan is a machine," will probably interpret the metaphor differently if he or she does not know Susan than another listener who knows Susan and knows Susan has a cold personality as well as an inspired work ethic.

Prior knowledge of the concepts is not the only contextual influence driving the processing and meaning of a metaphor. The first assumption has already suggested a way in which the structure of a metaphor can guide meaning through the differential contribution of topic and vehicle. Within the metaphor, different facets of the topic and vehicle interact to contribute to the final meaning of the metaphor. Moving out from contributions of the concepts within the metaphor, the form of the sentence might have an effect as well. Property attribution models claim that metaphors are explicit class inclusion statements; the property attribution models consistently find their strongest support in the metaphors of the form "X is Y," in which the topic is X and the vehicle is Y. Most of the examples used thusfar in the paper have conformed to this form, such as "that surgeon is a butcher," "the mind is a building," and "Susan is a computer."

However, metaphors are not limited to this type. Metaphors also depend upon second-order, implicit comparisons, referring to an underlying conceptual structure. For example, "the architecture of mind," conceptual metaphor theorists would argue, requires that we first have a link between "mind" and "building" for the purposes of understanding the metaphor. Property attribution theorists might argue instead that "architecture" simply designates a low ambiguity vehicle, directing the hearer of the metaphor to exactly the features of the vehicle that the speaker wishes to be attributed to the topic. Comparison theory, unable to pick up the distinctions between topic and vehicle contributions, will also not be sensitive enough to pick up how differences in structure and form of the metaphor will affect how the metaphor is processed.

If the first assumption suggests the way the internal structure of the metaphor can influence processing, the second assumption acknowledges that external forces may also drive the meaning of a metaphor. No theory of metaphor processing has been able to demonstrate that their processing model is accessible in each and every situation in which metaphors are encountered. In fact, the evidence supporting each model appears to depend very much upon how the metaphor is presented. If the metaphor is presented by itself, the property attribution model appears to give the best account of how processing has occurred, at the expense of the conceptual metaphor model, which has to be presumed not to be available if the class inclusion is novel. If the metaphor is presented as part of a text, the conceptual metaphor model appears to explain how the information is processed.

The third assumption acknowledges that the way in which we process a metaphor is affected by the demands of the task. This assumption also suggests why we should find the broad range of results reflected in the literature: the form of a metaphor and the way in which a metaphor is presented affect the demands the task makes of us and the goals we set to accomplish the task. Metaphor theorists presume that one and only one model should account for the way in which metaphors are processed. Within the parameters I have set down here via the three assumptions, I wish to argue that one model may be insufficient to explain the mosaic of results, and a combination of models may be only adequate explanation of how we understand metaphors.

This assertion, the efficiency hypothesis, is built on the task demands of metaphors in various contexts. Conceptual metaphors are the most efficacious explanation of the way we understand a text, because metaphors offer a imagistically rich way to organize material and help us remember it. Conceptual metaphors might also be involved in the comprehension of highly familiar metaphors. It seems reasonable to suppose that after repeated exposures to a metaphor that the metaphor should develop a place in long term memory. On the other hand, it would be wasteful to represent every single possible

metaphorical relationship. A property attribution model offers a much more efficient process for the day-to-day understanding of novel metaphors.

The efficiency hypothesis suggests that people will process metaphors in such a way that allows them to comprehend the metaphor and fulfill the demands of the task, while minimizing effort. When we encounter metaphors in a text, making a novel property attribution with exposure to each new metaphor is counter-productive. Instead, a representation in long-term memory may be built, which we use to ponder this information, and to conceptualize its abstract ideas. The same principle follows for metaphors that are quite familiar to us. After repeated exposures to "love is a journey" or one of its close relatives, we should be familiar enough with it that we do not need to process it through yet another novel class extension.

This second process is somewhat supported in the literature. Nayak and Gibbs (1990) found that subjects show a preference for idiomatic images that have a conceptual relationship to the other information (although this finding has been contested—see Glucksberg, Brown, and McGlone (1993)). In these cases, a conceptual metaphor approach to processing the metaphor allows subjects to access the benefits of the approach. Access to pre-existing conceptual links acts as a short cut to understanding familiar metaphors, because they are already represented. Abstract concepts, without an external referent, can be compared to a concrete object, and therefore better understood. Imagine trying to define "love" without using a metaphor. Making conceptual metaphor links in long-term memory also makes that information available for later processing, improving memory for the information that metaphor was used to organize.

The property attribution model allows us to differentiate between the wheat and the chaff. We encounter a multitude of metaphors on a daily basis, through conversation, music, film, and literature, in a myriad of different contexts. Many of these metaphors are too specialized or do not bear enough relevance to our own lives to require a permanent

representation in our long term memory. We simply will not encounter them often enough to justify the effort of creating a new conceptual link. Furthermore, if we developed conceptual representations for every single metaphor we encountered on a daily basis, our minds would quickly become cluttered with the detritus of rather insignificant metaphors that improved our understanding of the world little, if at all. It seems much more likely that we would make a novel class inclusion to understand a metaphor like "love is a filing cabinet." Then, once the metaphor is understood, the categories revert to their former order, dissolving the tenuous relationship between love and filing cabinets.

Support for an efficiency hypothesis can also be found in the strong conceptual relationship between the two categorical extension models. Both models are descendents of the interaction theory, and make a similar case for the action of topic and vehicle. Although the details of the processing structures are different, both models make the case for a categorical extension being the main fulcrum for metaphor understanding. Even the progenitors of these models admit that the existence of one model does not preclude the existence of the other model (Glucksberg & Keysar, 1990).

I believe that the first step to assess the viability of the efficiency hypothesis is systematic exploration of the processing models across the different potential situations in which metaphors can be understood. Besides evaluating the ways in which metaphors are processed in different situations, I believe it is also important to construct an experiment that will directly compare the assumptions of the two metaphorical models at the same time, within the same construct. In the following two studies, I attempted to accomplish these goals. The first experiment employed explicit metaphors of the form "X is Y." These stimuli metaphors were chosen from a list of metaphors that are common in our society. The second experiment used implicit metaphors such as "The test shook my mind to its foundations." These metaphors appear to rely on an underlying conceptual relationship, such as conceiving of "mind" in terms of "building."

On the other hand, these metaphors may be understood quite easily through to the property attribution model as well, through a more abstract categorical extension designating "things that have foundations." The attempt to resolve this question in the second experiment also tried to accomplish the second goal: testing the basic premises of each particular model, and directly pitting the two models against one another to see which offers the better explanation in a particular situation.

The studies addressed the following questions. First, how context-dependent is metaphor processing? That is, how do elements such as the structure of the metaphor and the subjects' familiarity with the metaphor affect how the metaphor is processed? This question will be addressed in both experiments. In the first experiment, the focus will be on external forces that guide metaphor processing. In the second experiment, the focus is on the internal structure of the comparison in the metaphor, varying the metaphor structures between explicit ("X is Y.") and implicit structures (in which the crucial metaphorical comparison is not stated) to see what effect these structural variables have on metaphor processing. Second, which type of metaphor model best explains the way in which metaphors are processed? This second question will be tested in the second experiment, which will in part assess the respective contributions of the topic and vehicle to metaphor understanding, to see how similar those contributions are.

Third, must multiple models of metaphor processing be used in order to give a full account of the way in which metaphors are processed? This last question refers directly to the efficiency hypothesis. If the results completely support one model at the expense of every other model, the efficiency hypothesis will not be supported. However, if these experiments demonstrate a mosaic of results that no one model can account for, an outcome that the literature appears to support, more attention may need to be focused to the possibilities outlined by the efficiency hypothesis.

Experiment 1

This experiment was based on the claim that conceptual metaphors organize information at the basic level of categorization (Lakoff, 1987). Rosch, et al. (1977) found that basic level category types instantiated faster recognition of a category member than the actual name of the category member. For example, if the target word was "recliner," subjects were faster in recognizing "recliner" if the prime was "chair" (the basic level category name)--even faster than if the other prime was "recliner" (the superordinate concept representation). This result indicates whether one concept is the basic-level categorization designation of another. By extension, if conceptual metaphors work at the basic level, as Lakoff (1985) argues, instantiating subjects with the conceptual metaphor category designation should instantiate faster response latencies as well. Via this argument, priming with the vehicle (which designates the category name) should be faster than priming with the topic (the superordinate concept representation), because conceptual metaphor theory argues that the topic is permanently represented in terms of the category designated by the vehicle.

Method

Participants. Subjects were University of Richmond undergraduate students. Twenty-one people participated in this experiment. Of these, nineteen were Introductory Psychology students who received class credit for their participation. Two additional subjects, while still University of Richmond undergraduates, were not from the Introductory Psychology course, and were paid $6 for their participation.

Apparatus. Every experimental session was run in the same testing room, on the same Power Macintosh. The experiment was written in the PsyScope software package (Cohen, MacWhinney, Flatt & Provost, 1993). Each subject was exposed to one of 15 metaphors of the type "X is Y," drawn from one of two sources. One source was the

Conceptual Metaphor database at the University of California-Berkeley, which is part of an ongoing project to document linguistic metaphors that refer to conceptual metaphors that appear to be prevalent in society. The second source was a normed list of metaphors composed by Katz, et al. (1988). The Katz list is part of research project designed to create a source of metaphors for research into figurative language. The metaphors were selected for their familiarity to most English-speakers, while still retaining some figurative value. The metaphors used in this experiment are listed in Appendix 1. All stimulus exposure took the form of black text on an otherwise blank white screen.

Procedure. Subjects were exposed to a sentence expressing an explicit metaphor.. Each metaphor was presented six times, so each prime preceded both a word and a nonword. Nonwords were nonsense strings of letters, matched to words in overall length and vowel usage. For example, "the mind is a machine" appeared six times. The vehicle prime "machine" primed both the word "mind" and a nonword "alrqut." Each subject saw the same metaphors, and the presentation of testing materials was randomized to prevent order effects.

Following exposure to the sentence for two seconds, subjects saw a fixation line of crosses, and then they were primed with a word from one of three conditions (topic, vehicle, or unrelated), and finally a target string of letters. They were asked to identify the target string as a word or nonword by keypress. Subjects pressed the 1 key if the target as a word, and 3 if the target was a nonword. The computer recorded response latencies, defined as the time between appearance of the target and identification by key press of the target as a word or nonword. In addition, the computer gave subjects audible feedback to let them know whether their response was correct or incorrect. Prior to beginning the actual testing trials, each subject was given five practice trials to familiarize them with the experiment's procedure.

For analysis, each subject's mean response time in the control condition was treated as a baseline value. The mean response latency in the topic and vehicle conditions was subtracted from the control latency, yielding a difference from baseline score for each subject's mean response latencies in each condition. Response latencies for the nonword condition were eliminated from the analysis presented here, as they were only incorporated to create a task demand to insure subject engagement with responses. Response latencies exceeding three standard deviations from the mean were also not included. Two subjects were dropped from analysis because their means were more than three standard deviations from the rest of the group. Following data transformation, a within subjects t-test was run.

Results and Discussion

As depicted in Figure 1, the mean response latency for the topic prime was 650.16 ms (SD = 161.22), while the mean response latency for the vehicle condition was 688.16 ms (SD = 158.39). Contrary to the predictions of the hypothesis for this experiment, the topic prime instantiated slightly (but not substantially) faster response latencies in the recognition task than did the vehicle prime condition. I then performed a t-test on those difference scores. An alpha level of .05 was used for the statistical test. The difference between the topic and vehicle condition was not statistically significant (t (18) = 1.56, n.s.).

Experiment 1 sought to assess what role familiarity played in the processing of a metaphor. Specifically, subjects would be exposed to commonplace metaphors to see if these linguistic metaphors appeared to be represented in long term memory as conceptual metaphorical relationships at the basic level of categorization. In experiment 1, this hypothesis would have been supported if the basic level category designator, the vehicle, instantiated a faster recognition of the target than the superordinate category designator, the topic. However, this proved not to be the case. The response latencies were not

significantly different from one another, suggesting that conceptual metaphors were not used to understand the linguistic metaphors.

While these results do not support the conceptual metaphor model, they may be interpreted in part as support for the property attribution model. Although any nonsignificant results must be interpreted with caution, the longer reaction times for the words following the vehicle prime may imply some degree of interference. It should be expected that a related word would prime quicker responses than a completely unrelated word. It is possible that in this task, the co-existing literal and metaphorical meanings of the vehicle countered each other. In the sentence, subjects might have performed an ad hoc class extension. When the vehicle re-appeared as a prime, subjects may have instantiated its literal meaning. The literal meaning would thus slow, rather than speed processing. This result would certainly be in line with current research, in that when presented in a unitary state, metaphors are more likely to be interpreted via a novel class extension versus referring to a conceptual mapping. However, as indicated above, it is always risky to interpret a null result without definite empirical substantiation ruling out other possibilities. With regards to the relationship between external contextual factors and metaphor processing, it can only be said that Experiment 1 fails to find evidence that familiarity elicits access of conceptual metaphors.

Experiment 2

Experiment 2 focused on the interaction of concepts in metaphor processing, by measuring the effects of topic constraint and vehicle ambiguity on comprehension of the metaphor. The experiment replicates and extends a study first done by Glucksburg, et al. (1997). In that study, subjects were primed with a metaphor missing either its topic or vehicle. Through this priming task, Glucksberg's group sought to isolate aspects of the topic or vehicle contributing to understanding of the metaphor. Glucksberg, et al. (1997)

found that the prime only speeded comprehension when the topic fitted into the high constraint category, and the vehicle was less ambiguous, supporting the interaction view of metaphor processing.

Experiment 2 hoped to not only replicate those results, but also to find a similar effect when exposing subjects to implicit metaphors. Although not actually appearing in the linguistic metaphor, the vehicle fragment does represent Lakoff and Johnson's hypothesized basic level designator for the implicit metaphor. If an unambiguous vehicle prime facilitated faster reading comprehension time for the implicit metaphor, this speeded response would suggest that subjects were understanding the metaphor via reference to an underlying conceptual relationship in long term memory. For example, according to this argument the vehicle fragment "********* are jails" should facilitate comprehension of the sentence "My prison guard of a manager will set me free at 5:00," because this implicit metaphor depends upon the conceptual metaphorical link between jobs and jails.

Method

Participants. Forty-five University of Richmond undergraduate and graduate students participated in this study, for either class credit or $6 compensation. Testing sessions were individual, and lasted 15 to 20 minutes.

Design. The experiment employed a 2 x 2 x 2 x 2 within subjects design. Two of the four conditions replicated the Glucksberg, et al. (1997) experiment: term type and prime informativeness. Term type refers to the information conveyed in the priming sentence fragment. The topic level of term type referred to sentence fragments containing the topic of the metaphor only, while the vehicle level designated sentence fragments containing only the metaphor vehicle.

Prime informativeness was more complex. In keeping with the interaction view of metaphor comprehension, the topic and vehicle primes varied in terms of constraint and ambiguity, respectively. Although ambiguity and constraint are treated as separate

constructs in property attribution theory, in Glucksberg's design, they are measured as one construct, prime informativeness. To review these two concepts from their earlier presentation, ambiguity designates the range of possible meanings that a certain metaphor might have, and refers primarily to the vehicle of the metaphor. Constraint is defined as the way in which a metaphor's topic confines the meaning of the metaphor, acting as a limiting agent in the interaction between the topic and the vehicle. Thus, prime informativeness describes this interaction: a high constraint topic with a low ambiguous vehicle will be a high informative prime, while a low constraint topic with a high ambiguous vehicle will be a low informative prime. Prior to beginning the study, Glucksberg's group asked a group of Princeton students (independent of the testing group) to rate the topics and vehicles used in the study for both their level of constraint and ambiguity. Level of constraint and ambiguity are the only types of metaphors that were compared in this study; however, Glucksberg, et al. (1997) did support their assumption by also testing for the effects of vehicle constraint and topic ambiguity, which they found to have no significant effect on comprehension times.

However, Experiment 2 has two new variables. The first, a prime-no prime variable, indicates whether metaphors were primed with a sentence fragment or not prior to their appearance on the screen. In the earlier experiment, Glucksberg's group collapsed the prime-no prime independent variable by analyzing the difference between the two for their analysis. The final variable introduced in this experiment was either explicit or implicit, and referred to whether the metaphor was tailored to the formula of "X is Y," or if instead the underlying conceptual metaphorical link gave rise to the meaning of the sentence.

Apparatus. Experiment 2 was administered on PsyScope software running on the same Power Macintosh and in the same room as Experiment 1. Half of the stimuli sentences were taken or adapted from Glucksberg, et al., 1997. The other 24 metaphors were developed by the author as implicit metaphors, which depended upon the underlying

comparison depicted in the Glucksberg metaphors, so that each explicit metaphor had an implicit analog. In all, subjects saw 48 sentences, presented twice (once with a prime, once without), for a total of 96 trials. The order of presentation was randomized to prevent order effects. Following this computer part of the testing session, each subject was administered a paper-and-pencil test, during which they were asked to complete fill-in-the-blank statements based on the metaphors they had just read.

Procedure. While the experimenter was in the room, subjects read an instruction screen with the following information, modified from a similar set of instructions used by Glucksberg, et al. (1997):

> In this study, you will be asked to read a series of metaphors. A metaphor is a figurative statement that compares two objects, like "The mind is a machine" or "Larry slithered past his ex-girlfriend at the diner."
>
> In the experiment, you will first see a line of asterisks for a brief period of time.
>
> Focus on those asterisks.
>
> In some cases, before some of the metaphors you are about to read, you will see an incomplete sentence for a few seconds. Please think about the ways that the concept in the incomplete sentence might be used to portray another object. For example, if you saw the incomplete sentence "The mind is *********," you should think of the things that might have a relationship with a mind.
>
> Before other metaphors, you will see no information. In this case, just focus on the line of asterisks until it is replaced by a sentence.
>
> When you see a complete sentence, like "The mind is a machine," you should just read it, and when you feel you have understood it, you should strike the space bar on the keyboard. Once you strike the space bar, you will move on to the next sentence.
>
> Following the experiment, you will receive a brief questionnaire containing some of the metaphors you will be seeing momentarily. You will be asked to complete a series of sentences based on some of the metaphors you are about to see. It is very important that you carefully read all of the information presented during the experiment in order to do well on the memory test.
>
> If you have any questions, please talk to the experimenter now.

Once subjects finished reading the directions, the experimenter emphasized that subjects only need respond to complete sentences, not sentence fragments, and that subjects should not try to memorize the sentences, but instead upon reading and comprehending them, press the space bar to move to the next sentence. If the subject had no further questions, the experimenter then left the room, until subjects completed this first part of the experiment and called the experimenter back into the room.

As indicated in the instructions, each subject first saw a fixation line of crosses that lasted 500 ms. In the prime condition, the fixation line of crosses was replaced by a sentence fragment that lasted for two seconds. In the no prime condition, the fixation line persisted for that additional two seconds. In both conditions, the next step was the presentation of the target metaphor, which stayed in place until the subject struck the space bar to indicate they had read and understood the metaphor.

Following the computerized phase, subjects completed a paper-and-pencil questionnaire with ten sentence completion items directly taken from primes they were exposed to during the first part. The experimenter supervised this questionnaire. Two subjects who did not correctly complete at least 6 of the 10 sentence fragments were eliminated from analysis, so 43 subjects were actually included in the final analysis.

Mean values of the variables were calculated. Comprehension latencies under 500 ms were excluded from analysis, as being too short a time to read any of the sentences. Comprehension latencies exceeding three standard deviations from the mean were also excluded from analysis as outliers. Combined, excluded values constituted only 0.02% of the collected data.

Results and Discussion

Cell means and standard deviations for the variables are reported in Table 1. (Please note that when the no prime condition includes means for prime informativeness and term type, the mean has been determined by identifying the no prime condition in terms

of its prime equivalent, since each sentence was seen twice--once with and once without the prime.)

Insert Table 1 here

Results indicated several main effects and lower level interactions, as shown in Table 2, but these results must be considered in light of the significant three-way interaction between metaphor structure, prime informativeness, and term type, $F = 6.76$, $p < 0.01$.

Insert Table 2 here

To test for the sources of variance in this three-way interaction, a series of repeated measures t-tests was run to compare the cell means individual means. In keeping with the Bonferroni procedure, the alpha level of 0.05 was divided by 32 (the number of t-tests), to give a more stringent test of the hypotheses. This division yielded an alpha level of 0.002. Of the series of t-tests, for the vast majority of cases, the data yielded significant results only when explicitly structured metaphors were compared with implicitly structured metaphors. The t-tests for the interaction results are reported in Table 3.

Insert Table 3 here

As Table 3 shows, most of the variance in the structure by prime informativeness by term type interaction could be accounted for by the differences between the explicit and implicit metaphors. The differences between the explicit and implicit metaphors are confounded with sentence length. Explicit metaphors had a mean length of 4.58 words (SD = 0.20), while implicit metaphors had a mean length of almost double that, at 9 words (SD = 0.46). This difference was significant at the alpha level of 0.05 ($t = -25.10$, $p < 0.001$).

However, Table 3 also indicates that in one case within a variable, the comparison between the implicit high informative and implicit low informative vehicle conditions, there was a significant difference. This difference only just achieved significance at the more stringent level ($t = 3.36$, $p = 0.002$). The effect size for this difference was 0.51. In this case, sentence length was not a confound. The implicit high informative vehicle condition had a mean length of 8.83 words (SD = 2.28), while implicit low informative metaphors had a mean length of 9.00 words (SD = 2.71). This difference was nonsignificant at the 0.05 level ($t = 0.12$, n.s.).

All three research questions were assessed in Experiment 2, but only one of the hypotheses was partially supported. The first hypothesis was that Glucksberg's results would be replicated, and an interaction between different aspects of the topic and vehicle primes would facilitate comprehension latencies. Based on Glucksberg's study, support for this hypothesis depended upon a significant main effect of prime informativeness, no main effect of term type, and no significant interaction between prime informativeness and term type (Glucksberg, et al., 1997). Instead, I found a flat relationship between high and low informativeness in the explicit condition. High informative primes (high constraint topics and low ambiguous vehicles) offered no significant advantage over their low informative counterparts. These results fail to support the findings of Glucksberg's group.

How does a high informative variable become so much less informative in a subsequent experiment using mostly the same set up and same materials? One possible

explanation has to do with the types of analyses we chose to do. Treating the prime-no prime condition as a variable, rather than compositing them into a difference score, represents one of the major separations between Glucksberg's original experiment and this study. As one of the only significant differences in methodology, it must be considered a prime suspect. However, the expectation is that support for the property attribution model should be robust to changes in statistical methodology. It seems unlikely that treating the presence or absence of a prime as a variable instead of analyzing difference scores would contribute to the failure of this experiment to replicate those results.

Another possibility is that the explicit metaphor results support Ortony's comparison model. Within the explicit metaphor structure, there were no significant differences for prime informativeness or term type. This finding is consistent with comparison models of metaphor comprehension, which suggest that both topic and vehicle contribute to the meaning of the metaphor in the same way. The informativeness of the prime would not matter, because the interpretation of the metaphor depended ultimately depended upon having both the topic and vehicle, and comparing them to determine the meaning of the metaphor. However, just as in Experiment 1, this possibility depends upon a null result, and any inferences must be drawn with caution.

Alternatively, the constructs of topic level of constraint and vehicle ambiguity could be flawed. By collapsing different aspects of the topic and vehicle into one variable, informativeness, Glucksberg, et al. (1997) must assume those effects will be stable. High informative primes will always be low ambiguous vehicles interacting with high constraint topics, and low informative primes will always be high ambiguous vehicles interacting with low constraint topics. First, the distinction between ambiguity and constraint is not clear conceptually. An ambiguous vehicle will also fail to constrain possible interpretations; a high constraint topic will very likely not be very ambiguous. However, while not clear conceptually, Glucksberg, et al. (1997) were able to operationally define them within their

study, and support those operational definitions. Second, the presumption of stability may not be a secure one. As briefly discussed in the introduction, Tourangeau and Sternberg (1981) found that topic ambiguity played the critical role in determining the comprehension of a metaphor. The results of this study may further support that those operational definitions may not be stable, calling into the question the usefulness of prime informativeness as a construct.

The second research question asked whether conceptual metaphors were accessed in the understanding of implicit metaphors. This hypothesis would be supported by a significant three-way interaction between metaphor structure, prime informativeness, and term type. If conceptual metaphors organize our concepts at the basic level of categorization, then high vehicle informativeness should facilitate faster comprehension latencies in the implicit metaphor condition, because the high informative vehicle is the clearest designator of the basic-level relationship assumed to underlie the comparison in the implicit metaphor.

While the interaction between metaphor structure, prime informativeness, and term type was significant, a close examination of the means and the relationships between the variables that are the source of this interaction do not support this hypothesis. In fact, although the difference between the high informative vehicle condition and the low informative vehicle condition was significant, it favored the low informative vehicle condition, suggesting that the presence of a more ambiguous vehicle made the metaphor easier to interpret. In fact, the comprehension latency for the high informative vehicle condition is the longest latency in this interaction—significantly longer than every single other variable, from the explicit low informative topic term type condition to even the implicit high informative topic term type.

The latter finding is particularly damaging to the hypothesis that conceptual metaphors are used to process implicit metaphors. The vehicles do not act in the way that

basic-level category designators act. Vehicle primes did not facilitate faster comprehension latencies than topic primes in any condition. For this reason, there is no evidence that conceptual metaphors were accessed to understand any metaphors in this study.

The third research question raised the idea that metaphor structure influences the way a metaphor is interpreted, so that perhaps requiring multiple models of metaphor processing required multiple models of how we process metaphor according to the one that best suits the demands of the task. This hypothesis was to be supported by a significant main effect of metaphor structure, which the data from Experiment 2 support. However, this main effect is confounded with sentence length; the significantly longer implicit metaphors should take longer to read, because they have more words. However, the result also points to the fact that in at least one case, sentence length was not a factor: the comparison between the high informative vehicle condition and the low informative vehicle condition. In this case, although sentence length was not a factor, subjects still read metaphors with more ambiguous vehicles faster than metaphors with less ambiguous vehicles. The effect size also indicates that this effect was substantial (medium-sized) and may be more than a statistical anomaly.

Support for the efficiency hypothesis depends upon the finding that different mechanisms are used to understand different types of metaphors in different situations. Experiment 2 failed to find significant results for either the property attribution model or the conceptual metaphor model. In fact, the results run exactly opposite in most cases to the expectations of these theories. Thus, while Experiment 2 does support the position that different metaphors may require different processing mechanisms, it fails to demonstrate a role for either of the category extension models in the understanding of explicit or implicit metaphors.

Since the comparison model hypotheses offer one possible counter-explanation for the results in the explicit condition, the question must be asked: is this implicit pattern

compatible with the comparison models? The Tversky (1977) model argues that a metaphor is merely another kind of similarity statement, so that there still should be no real interaction between topic and vehicle, so this possibility is excluded. The Ortony (1979) model proposes that a metaphor is just a special case of similarity characteristics, deriving its metaphoricity from a salience imbalance, in which less important aspects of the topic are emphasized by comparing it with a vehicle in which those aspects are more salient.

Considered in the light of the definition of ambiguity, the Ortony model's predictions do not appear to account for these results. Glucksberg, et al. (1997) define an ambiguous vehicle as a vehicle which offers a larger range of possible attributions. A sentence fragment including an ambiguous vehicle opens up the possible range of topics that could complete the metaphor. It would seem that the less ambiguous vehicle metaphor should take less time than the more ambiguous vehicle metaphor even in the comparison view; the comparison view depends upon a thorough consideration of the various characteristics of both topic and vehicle, to see where they share space. A less ambiguous vehicle will have fewer relevant characteristics, so that search should take less time. So neither comparison view appears to account for that interaction.

The next option to consider is whether something in the implicit metaphors presented in this study caused this difference between more ambiguous and less ambiguous vehicles. The mean length of sentences containing more ambiguous vehicles was 9.00, while the mean length of sentences containing less ambiguous vehicles was 8.83. The difference of 0.17 words was not significant. Even if it were significant, it is in the opposite direction from the relationship described here: the "longer" sentences took less time. It seems unlikely that sentence length caused these effects.

The question of whether the difference in comprehension latency between the two vehicles might be attributable to some systematic difference in the difficulty level of the two types of sentence cannot be completely answered here. There were no other measures of

other syntactical and semantic influences within sentences on the difficulty of the metaphor besides the metaphor structure, and the aspects of the vehicle prime. However, a superficial review of the metaphors listed in Appendix 2 appears to make this possibility unlikely as well. Without more stringent tests and assessment of these other factors, systematic syntactical or structural differences between the two metaphor types cannot be ruled out.

Each model fails to give an adequate explanation of how all the metaphors used in Experiment 2 were understood. At first glance, this failure may be regarded as possible support for the efficiency hypothesis. However, we also lack any direct positive evidence of the existence of any metaphor processing model, much less two models working in different situations. If the lack of difference between topic and vehicle effects on metaphor processing suggests the equal contribution supported by the comparison model, what does the implicit metaphor interaction mean? How are implicit metaphors understood? These questions will be considered in the General Discussion.

General Discussion

Summary of Results

Experiments 1 and 2 tested three issues: how metaphors are processed (via categorical extension models or comparison models), how familiarity and structures within the metaphor influenced their comprehension, and whether multiple models of processing might be necessary to give a comprehensive account of how metaphors are processed. Experiment 1 tested to see if a familiar metaphor was understood by access of a pre-existing relationship between the concepts, in which the topic was a superordinate member of a basic-level metaphorical category designated by the vehicle. Response latencies indicated that there was no significant advantage for identification of the topic when primed with the vehicle, suggesting that conceptual metaphors were not accessed to understand the

linguistic metaphors used in the study. Experiment 2 looked at internal structural variables, such as topic level of constraint, vehicle ambiguity, and the explicitness versus implicitness of the metaphorical relationship. For explicit metaphors, experiment 2 found no evidence that priming with a topic or vehicle with any level of informativeness facilitated comprehension of a full metaphor. For implicit metaphors, priming with a more ambiguous (what Glucksberg calls a "low informative") vehicle instantiated slightly faster comprehension of the metaphor.

Metaphor Model Assumptions Revisited

These experiments sought a controlled examination of the currently predominant models of metaphor processing, based on certain assumptions about how metaphors are understood. The first assumption was that topic and vehicle contribute differently to the meaning of a metaphor. The research hypothesis favored categorical extension models over the comparison models as an explanation of this effect. However, the experiments failed to affirm this assertion. In Experiment 1, there was no significant difference between the topic and vehicle primes. While the property attribution model might still offer a possible explanation for the results in Experiment 1, taken in congruence with the results of Experiment 2, this pattern of results may best support the comparison model. Under the caveat that null results can not truly be interpreted, the results do indicate that topic and vehicle do not contribute differentially to the understanding of explicit metaphors. On the face of it, the similar actions of topic and prime bear more resemblance to the predictions of the comparison model. From these results, it appears salience imbalance may deserve more attention as a possible source of metaphor irreversibility.

However, the explicit metaphor story is not the entire story. There is a differential action of topic and vehicle in one case: the pattern of responses within the implicit metaphor condition. There is no significant difference between the effects of high and low informative primes in the implicit topic condition; however, in the implicit vehicle

condition, there was a significant effect of high and low informativeness. Ambiguous vehicles made the sentences faster (and presumably, easier) reading for the subjects than unambiguous vehicles. In other words, because in one place there is a pattern of difference, and in the other there is not, I feel this pattern does tentatively suggest that the topic and vehicle are acting differently within an implicit metaphor to enhance understanding of that metaphor.

The second assumption was the accessibility or availability assumption. The strong view of this assumption, the accessibility principle, argued that in order for a model to be treated as a comprehensive theory of metaphor, that metaphor processing mechanism must be active in the understanding of every type of metaphor. The weaker view, availability, argued that one particular model show a clear advantage over any other explanation for how a metaphor was understood in a particular context. Here, the aspects of context that were tested were familiarity in Experiment 1, and aspects of the internal structure of the metaphor in Experiment 2. Both of these tests offered critical tests for the existence and availability of conceptual metaphors in a given context. According to the characteristics of conceptual metaphors set forth by Lakoff and Johnson, the study found no evidence for their existence.

Experiment 2 was designed to compare patterns of results, to see if one particular model of metaphor comprehension was favored over another. The property attribution model was not supported. I failed to replicate Glucksberg's results, and the pattern of explicit metaphors again yields a more or less uninterpretable null result. The conceptual metaphor model was also not supported. The hypothetical basic-level category designators—the vehicles that the subjects were primed with and which I believed would facilitate comprehension—gave the subjects no advantage over the topic primes. Throughout this study, the vehicles and topics of metaphors did not act in the way that conceptual metaphor theory predicted they should act.

Finally, the comparison model must be considered. In the explicit metaphor condition, the comparison model appears to offer the better explanation. The lack of difference between the relative contributions of topic and vehicle indicate that they operate similarly within the metaphor. However, like the other two models, this model has its own Achilles heel in Experiment 2. This model has no mechanism to explain the significant difference between the unambiguous and ambiguous vehicle conditions. I would argue that if anything the comparison model would predict the opposite result. Ambiguous vehicles by definition have more conceptual features that the subject would have to consider in their exhaustive search.

The third assumption asserted that structural aspects of the metaphor affect the way in which the metaphor is understood. In Experiment 2, topic level of constraint and vehicle ambiguity had no facilitating effects for the understanding of an explicit metaphor. However, within the implicit metaphor condition, ambiguous vehicles primed faster reading comprehension than their unambiguous counterparts. This interaction pattern differs qualitatively from the explicit metaphor condition, so that this result suggests that in fact elements of structure may interact to determine how we process the metaphor.

By extension, this result may have ramifications for the efficiency hypothesis. Although no one model finds positive support from a significant result in these experiments, the pattern of results for Experiments 1 and 2 within the explicit metaphor variable resemble what we might expect from metaphors processed through a comparison of features. Meanwhile, the pattern of results within the implicit metaphor variable does not appear to be explained by any of the models, running exactly counter to each of their predictions. Implicit metaphors were understood differently from explicit metaphors: vehicle ambiguity had a facilitating effect on implicit metaphors that it did not have with explicit metaphors.

Putting It All in Context – Questions and Future Directions

However, there are alternate possibilities, which we can evaluate by looking at the ramifications of this study for the two questions asked at the beginning of this thesis: how do we understand metaphors, and why should we care about metaphors in the first place? At first glance, the results of this study may seem to further muddy an already murky picture. How do these pieces fit with the existing literature? The study failed to replicate the results of a similar study supporting the role of category extensions in the understanding of explicitly structured metaphors. It also failed to find comprehensive explanation for how both types of metaphors were understood.

To answer these questions, this study took a specific tack, emphasizing metaphors of a certain type and familiarity. For example, this research asked how aspects of the context and internal structure of a metaphor affected its processing. In only one condition did any of these aspects play a significant role in metaphor processing in this experiment: the structure of the metaphor (explicit or implicit) and the ambiguity of the vehicle in Experiment 2. As described above, it appears the aspects that affect metaphor processing are not necessarily consistent and they are certainly not discrete. Significant contributors to understanding in the Glucksberg, et al. study did not show similar effects in Experiment 2. Vehicle ambiguity appeared to play a role in metaphor understanding only in interaction with implicit metaphors. Given the concerns regarding the stability of the informativeness construct, further research must certainly be done to substantiate any strong conclusions regarding this result.

From one point of view, rather than finding one clear pattern amidst the noise, this research appears to have only added to the confusion. However, the inconsistencies in this study may suggest that as researchers in metaphor we are putting our emphases in the wrong place. The research addressed here tried to find the objective influential aspects of a metaphor by looking at what metaphors share: their profile in common usage, and their

structural elements (i.e., linguistic characteristics of the topic and vehicle). This emphasis, while having strong face validity, may be a case of too much emphasis on the details, while ignoring the fact that subjectivity and context-dependence are primary characteristics of metaphor. A metaphor takes its meaning from the situation. Is it possible that replication of results is hard to come by, because we are not attending enough to the situational variables in metaphor comprehension?

Searle (1993) points out that a metaphor is first and foremost a communicative act. In an experiment, we remove those aspects of communication in hopes of isolating other effects. In the computer-based experiments here, the subject has to be aware that the computer is not trying to tell the subject anything. That aspect must be considered a deficit, because it strips the metaphor of much of its resonance, and probably much of its meaning. This deficit runs rampant in the literature, and may be the reason for much of the discrepancies. Compare this deficit with the results from text-based experiments, where something is actually being communicated, and the metaphor becomes more critical to the performance on the task and shows consistent, measurable cognitive effects. In the absence of resonance and meaning, the subject must supply his or her own context, or simply opt out of participation in the metaphor at all. In cases like these, metaphor experiments may take on a Zen air: if a metaphor is not communicated in any kind of meaningful context, is it a metaphor at all?

Instead, Searle (1993) argues that as a speech act, the meaning of the metaphor is not necessarily inherent in the sentence. As pointed out in the beginning of this thesis, the phrase "the architecture of mind" has no literal truth value. Instead, it communicates a truth because the listener understands that the speaker or writer is attempting to say something about the nature of mind. In placing the emphases of study on the atomic study of metaphor—the natural features of the component parts of the sentence, it may be that we are missing the proverbial forest for the trees.

The explicit metaphors used in experiments 1 and 2 are somewhat devoid of specificity. They have a similar structure. One thing is another thing. They make general statements about relationships between topic and vehicle, which may better model a categorical relationship in long term memory, but do not match the imagistic richness of metaphor exposure. The implicit metaphors make more specific statements. Perhaps one possible explanation for why only the implicit metaphor condition showed an interaction effect was because those were the only metaphors that were read for their deeper meaning: not merely for their content, but for their connotation and resonance. As argued in the beginning, it may be that only the most connotative, resonant, and useful metaphors are used to categorize our world.

Therefore, it may be useful to consider other pathways besides structural and syntactical variables to see if category extension or in fact some other mechanism drives metaphor processing. Reemphasizing the study of metaphor usage in context, such as in conversation, text, literature, etc. may be the Rosetta Stone that unlocks the source of meaning for metaphor, and which distinguishes metaphor from other creative language forms, such as irony or joking. The study of metaphors in their "natural state" may finally stabilize our operational definitions of what a metaphor is and how it works.

The systematic testing of different metaphor models, and pitting different metaphor models against one another, with greater attention to contextual variables, may still be crucial to working out how exactly metaphors are understood. Future directions in research assessing this question should examine exactly how the property attribution model and comparison models compare with the conceptual metaphor model in the explanation of a metaphor's effects on a text. Most of the experiments using text have only tested to see whether there were metaphorical effects consistent with the conceptual metaphor model, and not whether those effects might be consistent with other metaphorical models as well.

Still, attempting to find just one answer may chop or extend metaphor on a Procrustean bed, creating an empty category that describes stimuli that are processed in a variety of ways. It may be that the definition of metaphor in psychology must separate further from its definition as a trope in English literature, and instead capture the subtle distinctions between different types of metaphors (i.e., metaphors presented in a text, metaphors with different structures, etc.). Differentiation must be accomplished by testing and re-testing different types of metaphors in different situations to see exactly what drives their processing.

This study proceeded from two major questions: how are metaphors understood, and what implications does metaphor comprehension have for the way we perceive and act in the world? The state of research currently appears to support the position that there may not be one clear answer to either of these questions, and leaves open the possibility that further research may find that metaphors do in fact help us organize the world. Without continued research and stronger substantiation of the stable elements driving our understanding of metaphors, we must still remain open to the possibility that metaphors may be one of the foundation stones in the architecture of the mind.

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Table 1.

Cell Means and Standard Deviations (in parentheses) for Experiment 2

		Metaphor Type			
		Explicit		Implicit	
		High Inf.	Low Inf.	High Inf.	Low Inf.
Prime	Topic	2244.49 (1020.47)	2138.28 (852.27)	3283.88 (1143.98)	3482.28 (1142.59)
	Vehicle	2340.58 (1174.03)	2288.74 (1060.57)	3749.70 (1297.82)	3418.09 (1143.83)
No Prime	Topic	2570.51 (965.18)	2681.91 (1029.37)	3328.97 (1108.28)	3422.49 (1088.55)
	Vehicle	2618.91 (2568.95)	2568.95 (1074.90)	3775.86 (995.51)	3382.11 (1028.40)

Table 2.

Complete Report of Results from 2 x 2 x 2 x 2 Analysis of Variance

Source of Variation	SS	DF	MS	F
Prime Informativeness	755051.26	1	755051.26	2.12
Term Type	2634761.30	1	2634761.30	11.26**
Prime	5295186.28	1	5295186.30	7.73**
Structure	189224916.60	1	198224917.00	297.24**
	Two Way Interactions			
Structure x Prime Informativeness	304921.88	1	304921.88	1.18
Structure x Term Type	1053636.30	1	1053636.30	3.23
Structure x Prime	5671513.31	1	5671513.30	12.85**
Prime Informativeness x Term Type	3396728.15	1	3396728.10	10.31**
Prime Informativeness x Prime	7397.58	1	7397.58	0.01
Term Type x Prime	252029.40	1	252029.40	0.47
	Three-Way Interactions			
Structure x Prime Inf x Term Type	2226883.96	1	2226884.00	6.76**
Structure x Prime Inf x Prime	401488.95	1	401488.95	1.85
Structure x Term Type x Prime	268363.00	1	268363.00	0.86
Prime Inf x Term Type x Prime	80412.56	1	80412.56	0.28
	Four-Way Interaction			
Structure x Prime Inf x Term Type x Prime	179536.33	1	179536.33	0.50

**p < 0.01

Table 3.

Report of Significant t-tests from Structure x Prime Informativeness x Term Type Interaction

Variable 1	Variable 1 M (SD)	Variable 2	Variable 2 M (SD)	t-test
ExpHiTop	2407.50 (935.20)	ImpHiTop	3306.43 (1018.08)	-12.22
ExpHiVeh	2479.74 (1056.20)	ImpHiVeh	3762.78 (1066.32)	-12.44
ExpLoTop	2410.09 (824.86)	ImpLoTop	3452.38 (929.50)	-10.99
ExpLoVeh	2428.85 (1014.28)	ImpLoVeh	3400.10 (970.58)	-9.25
ExpHiTop	2407.50 (935.20)	ImpLoTop	3452.38 (929.50)	-11.77
ExpLoTop	2410.09 (824.86)	ImpHiTop	3306.43 (1018.08)	-9.51
ExpHiVeh	2479.74 (1056.20)	ImpLoVeh	3400.10 (970.58)	-8.68
ExpLoVeh	2428.85 (1014.28)	ImpHiVeh	3762.78 (1066.32)	-13.12
ExpHiTop	2407.50 (935.20)	ImpHiVeh	3762.78 (1066.32)	-15.24
ExpLoTop	2410.09 (824.86)	ImpLoVeh	3400.10 (970.59)	-10.76
ExpHiTop	2407.50 (935.20)	ImpLoVeh	3400.10 (970.59)	-11.21
ExpLoTop	2410.09 (824.86)	ImpHiVeh	3762.78 (1066.32)	-14.23
ExpHiVeh	2479.74 (1056.20)	ImpHiTop	3306.43 (1018.08)	-8.91
ExpLoVeh	2428.85 (1014.28)	ImpLoTop	3452.38 (929.50)	-10.84
ExpHiVeh	2479.74 (1056.19)	ImpLoTop	3452.32 (929.50)	-10.12
ExpLoVeh	3306.43 (1018.08)	ImpHiTop	2428.85 (1018.08)	-8.74
ImpHiVeh	3762.78 (1066.32)	ImpLoVeh	3400.10 (970.58)	3.36

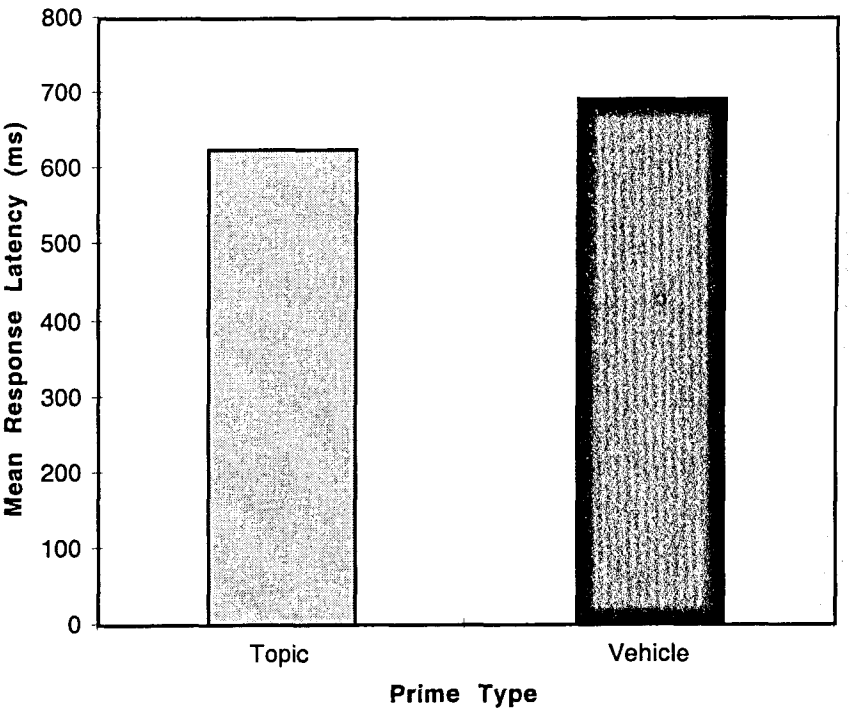
Figure Captions

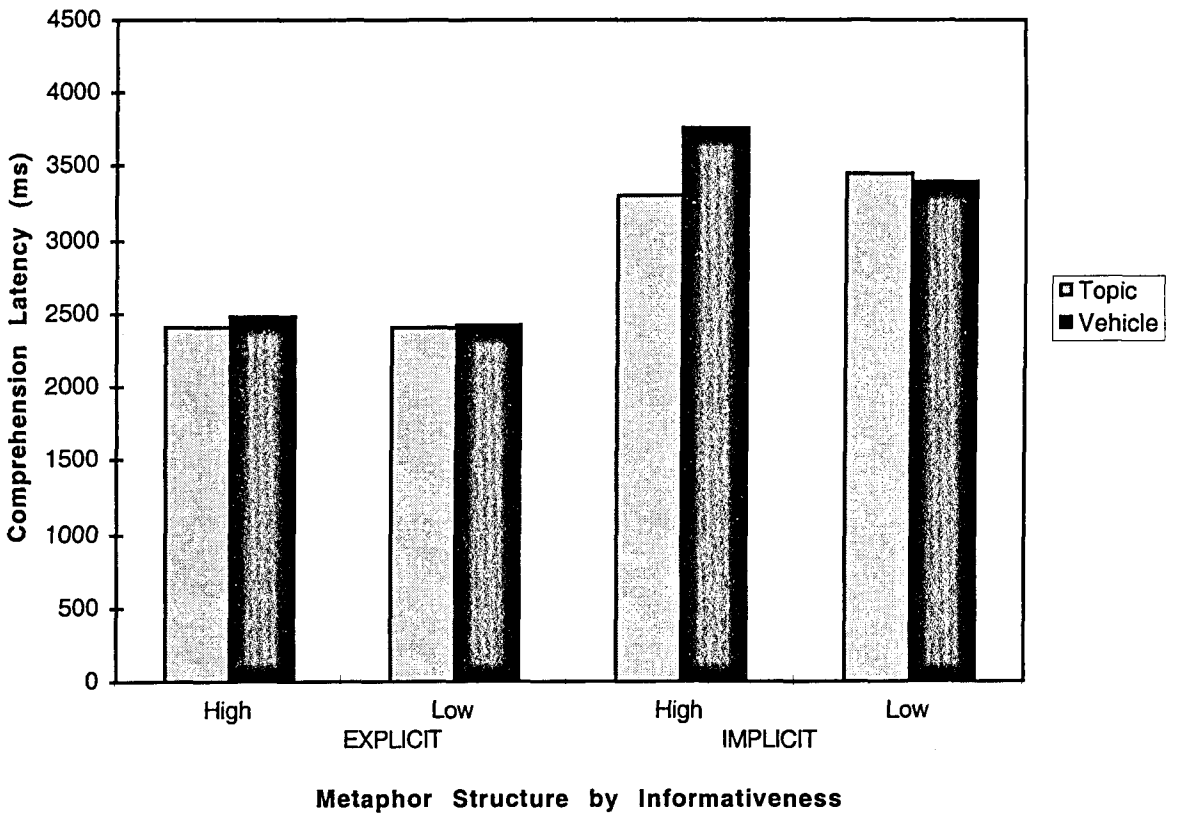
Figure 1. Mean response latencies for topic and vehicle prime conditions in Experiment 1.

Figure 2. Two-way interaction between prime informativeness and term type.

Figure 3. Two-way interaction between metaphor structure and prime.

Figure 4. Three-way interaction between metaphor structure, term type, and prime informativeness.


800
700
600
500
400
300
200
100
0
Mean Response Latency (ms)
Topic
Vehicle
Prime Type


4500
4000
3500
3000
2500
2000
1500
1000
500
0
Comprehension Latency (ms)
Topic
Vehicle
High
Low
High
Low
EXPLICIT
IMPLICIT
Metaphor Structure by Informativeness

Appendix 1:

Metaphor List from Experiment 1

"Life is a journey."

"The mind is a machine."

"Time is money."

"Words are weapons"

"Desire is hunger."

"Anger is heat."

"Intelligence is a light."

"History is a mirror."

"Loneliness is a desert."

"Happiness is gold."

"Responsibility is a weight."

"Power is a drug."

"An argument is war."

"Love is a madness."

"Babies are angels."

Explicit Metaphors (from Glucksberg, et al., 1997)

Low Constraint Topics

"Some people are puzzles."

"Her family is an anchor."

"The Earth is a beehive."

"Some countries are pressure cookers."

"Crime is a disease."

"Dancers are butterflies."

High Constraint Topics

"Some computer programs are labyrinths."

"The mind is a landscape."

"Some ideas are diamonds."

"A smile is a magnet."

"Some tempers are volcanoes."

"Beauty is a passport."

Ambiguous Vehicles

"Their relationship is a desert."

"Love is a journey."

"A rumor is a virus."

"A dream is a river."

"A child is a puppy."

"A young girl is a television."

Unambiguous Vehicles

"This job is a prison."

"An education is a doorway."

"Their divorce is an earthquake."

"His angry words were daggers."

"Smoking is a timebomb."

"Faith is a fortress."

Implicit Metaphors

Low Constraint Topics

"Psychologists can have trouble putting the pieces of clients together."

"Home kept her safe in rough waters."

"This planet buzzes with activity."

"The Middle East situation is ready to boil over."

"The police have trouble stopping the plague on the streets."

"It is incredible to watch ballerinas flutter around during a performance."

High Constraint Topics

"This software leads around all kinds of twists and turns."

"People can look out across the expanse of their memories."

"Some people's creativity must be appreciated for its rare and sparkling quality."

"A friendly expression draws everyone toward you."

"You can tell when some anger is about to erupt."

"Attractiveness allows passage across many closed borders in Hollywood."

Ambiguous Vehicles

"Their relationship leaves them dry and thirsty for emotion."

"They feel their love has taken them as far as it can go."

"The rumor infects the office quickly."

"The dream flows on toward a waterfall of images."

"The child barks and yips at his mother's ankles."

"Emotions flicker on the screen of her face."

Unambiguous vehicles

"At 5:00 that guard of a manager will set me loose from this desk."

"The college diploma unlocks all kinds of possibilities."

"Their divorce shook the house to its foundations."

"His angry words stabbed me to the heart."

"Smoking finally explodes in the lungs."

"She rests secure behind the walls of her faith."