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THE ROLE OF TOPIC AND VEHICLE IMAGERY IN METAPHOR COMPREHENSION

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A generally accepted psychological view is that metaphor comprehension entails discovery of some conceptual similarity or relation between the subject and predicate terms (topic and vehicle) of the metaphor, based on overlapping semantic memory information activated by the figurative expression. Theorists differ in how they interpret that informational base, the principal alternatives being perceptual characteristics and imagery (e.g., Arnheim, 1969 ; Asch, 1958 ; Langer, 1948 ; see also Miller, 1979), mediating verbal associations (e.g., Koen, 1965), and abstract semantic features or conceptual representations of some kind (e.g., Honeck, Riechmann, & Hoffman, 1975 ; Malgady & Johnson, 1976 ; Ortony, 1979 ; Osgood, 1963 ; Verbrugge & McCarroll, 1977). The theories vary on specific processing assumptions as well, such as imbalance or asymmetry in the contributions of topic and vehicle.

The present studies are based on a dual coding theory of cognition (Paivio, 1971, 1986) that combines some of the features emphasized in perceptual/imaginal and verbal mediational approaches together with a series of assumptions concerning the functional characteristics of nonverbal (including imaginal) and verbal symbolic systems that enable them to contribute jointly and separately to performance in cognitive tasks, including metaphor comprehension and production. First we review the general assumptions, each of which has considerable experimental support (see Paivio, 1986), and then we indicate their specific relevance for metaphor processing and the hypotheses of the present study.

1. Dual Coding Theory.

The verbal and nonverbal systems are assumed to be functionally independent but interconnected. Independence implies that one system can be active without the other or both can be active concurrently. Interconnectedness

means that one system can activate the other via referentially-related pathways that connect verbal and nonverbal representational units. Functional interconnections must be assumed in order to account for our ability to image to words or descriptions and to name objects or describe images. Units are also associatively interconnected within systems, so that activity can spread among verbal representations (as in word association tasks) or nonverbal representations (as when an imagined object reminds us of another).

The activation of the representational systems in particular tasks is probabilistic, being determined by stimulus material properties, experimental procedures, and individual differences in symbolic habits and skills. In the case of language, with which we are concerned here, the words or word sequences directly activate corresponding verbal representations, and indirectly activate images or other verbal associates. The probability of image arousal depends on the concreteness or independently measured image-evoking value of the words and the probability of verbal associations depends on the verbal associative meaningfulness of the words. Instructions to image or to associate, presentation of contextual information such as priming stimuli, and so on, also influence the probability of imagery or verbal associative reactions. The theory assumes that all of these diverse mental reactions contribute to word meaning which, given the probabilistic nature of the reactions, is therefore not a fixed entity but varies with the pattern of activation produced by the total experience.

The differential activation of elements within the verbal and nonverbal systems has important implications for understanding human cognition because the two systems differ in how the representational information is organized and processed. The assumptions of dual coding theory that are most relevant to the present studies concern the sequential, ordered quality of verbal processing and the synchronous, integrated nature of nonverbal processing.

That verbal representations are organized sequentially means that words and other linguistic units cannot be processed simultaneously, but must be attended to successively in some order. One consequence of these sequential constraints is that such tasks as reciting a poem proceed more quickly in the direction conforming to the sequential organization than in the reverse direction. These sequential constraints also have implications for the processing of novel sequences of words. In particular, the order in which words are strung together will partly determine the order in which they will be processed and given the varied and contextual nature of meaning in the dual coding view, influence the ultimate interpretation of the utterance. Other factors also influence order of processing, including function and relational words that serve grammatical purposes.

Nonverbal representations, on the other hand, can be organized

synchronously, so that multiple units are integrated and simultaneously available for processing. For example, instructions to describe from memory such familiar settings as our living rooms typically evoke a synchronous and integrated image of the setting. That nonverbal representations provide an effective means to integrate different units is also manifested, for example, in better associative recall for concrete, high imagery words or sentences than for low imagery abstract materials, and for words learned under imagery instructions than under rote repetition or free strategy instructions. Moreover, in such episodic memory tasks the imagery value of the retrieval cue has more effect on recall than the imagery value of the items to be recalled, which has been interpreted in terms of the hypothesis that high imagery words are especially effective as 'conceptual pegs' for storage and retrieval of associated information. This conceptual peg hypothesis has been extended to the analysis of comprehension (Paivio, 1983) in the sense that high imagery words function as retrieval cues for associated semantic memory information, an hypothesis supported by findings that imagery value correlates with property production (Katz, 1978) and ease of predication (Jones, 1985).

2. Dual Coding Theory and Metaphors.

We can now examine the implications of the preceding analysis for metaphor comprehension. As a consequence of the sequential manner in which such language units as metaphors are processed as well as linguistic cues to the relation between the parts of the metaphor, the topic and vehicle ought to demonstrate distinct roles in metaphor comprehension. Specifically, the topic precedes the vehicle and the two are connected by a verb (i.e., *is* or *are*) that indicates a directed relation between the terms. We hypothesize that these cues lead the meaning of the vehicle to be searched for properties relevant to the topic, which could produce a different interpretation than a search of the meaning of the topic for properties relevant to the vehicles. Properties of the vehicle must actually be produced from semantic memory, whereas the relation between the produced properties and the topic need only be recognized. One purpose of the present studies was to test the inference from this model that vehicle processing plays a larger role in metaphor comprehension than topic processing, a vehicle dominance view that is shared with other accounts of metaphor comprehension (e.g., Black, 1962 ; Tversky, 1977 ; Verbrugge & McCarrell; 1977).

This conceptualization of topic-vehicle asymmetries differs from semantic memory views of asymmetries that give relatively more emphasis to the different associative networks (e.g., number and salience of properties) of topics and vehicles (e.g., Johnson & Malgady, 1980 ; Tversky, 1977), although dual coding

theory is compatible with such accounts once they are recast into assertions about verbal and perceptual properties. We have emphasized cognitive processing differences between topics and vehicles during the act of comprehension. Consistent with our notion of processing asymmetries as well as semantic memory asymmetries, Connor & Kogan (1980) reported that both the order in which words were presented to subjects and stable properties of the words influenced the directionality of metaphors that subjects constructed from the terms.

The second implication of dual coding theory follows from the conceptual peg hypothesis and concerns the potential for more effective retrieval of semantic memory information for high imagery words than for low imagery words. The general hypothesis was that high imagery values of both topic and vehicle facilitate retrieval of imaginal information and referentially-related verbal information from long-term memory, either of which could provide a common ground for interpretation. Paivio (1979) suggested the following ways in which the nonverbal system could enhance information retrieval :

a) the availability of two independent but interconnected informational codes increases the probability of finding a mediating connection between topic and vehicle from semantic memory ;

b) the imagery system is specialized for synchronous processing, so that its activation permits multiple units of potentially relevant information to be available simultaneously for further processing ; and

c) imagery ensures processing flexibility because its capacity for synchronous processing also entails relative freedom from sequential constraints. Perceptual properties relevant to metaphor interpretation may also be more accessible from the nonverbal system than from the verbal system. These hypotheses lead to the prediction that imagery should benefit metaphor processing, other things being equal and as long as the components of meaning stored with the image are relevant to the metaphor. Note that the proposed hypothetical mechanisms concern retrieval from semantic memory and not integration of discrete metaphor components, which contributes to the effects of imagery on episodic memory.

Joint consideration of the vehicle dominance and conceptual peg hypotheses suggests a more precise prediction than simple beneficial effects of imagery. In particular, topic and vehicle terms both function as retrieval cues for relevant verbal and imaginal information, but retrieval of vehicle information should be more important than retrieval of topic information, according to our analysis and that of other scholars. We would therefore expect vehicle imagery to have more potent effects on metaphor processing than topic imagery. This analysis implies that metaphor processing begins with and is guided by the vehicle, especially if it has high image evoking properties. In metaphorical terms, a high-imagery vehicle functions as a particularly efficient 'conceptual peg'

for retrieval of semantic information.

Consistent with the general hypothesis about beneficial effects of imagery, metaphor rating studies (Katz, Paivio, & Marschark, 1985 ; Marschark, Katz, & Paivio, 1983) have shown that the rated imagery value of the topic and vehicle predicted comprehensibility and interpretability of the metaphors even when a number of other variables were statistically controlled. Moreover and in line with our specific prediction, vehicle imagery was generally the better predictor of comprehensibility. Related memory effects have been reported by Marschark & Hunt (1985).

Paivio (1979, 169–170) described an exploratory study that supported both the vehicle dominance and conceptual peg hypotheses. Participants interpreted the novel metaphor "For the student of language and thought, metaphor is a solar eclipse" and described their thoughts. Several respondents gave interpretations completely in agreement with the intended meaning of the expression, suggesting for example that metaphors and eclipses enlighten while they obscure, or that they cover up the real thing so that you can see it better, or that they block out the central stuff so that you can see the subtle stuff around it better. Others at least emphasized the obscuring as a common characteristic. The reports of most respondents suggested that vehicles were more central to interpretation than topics and also were consistent with the conceptual peg hypothesis in that images of the vehicle were particularly important. For example, one person said that the statement made no sense until he imagined an eclipsed sun. Only one subject reported that imagery was not salient in his analysis and he also was the only one who reported starting with the topic rather than the vehicle, asking himself what metaphor might mean for a student of language.

The specific aims of the present study were the relative priority of the vehicle in metaphor comprehension, and how the contributions of the topic and vehicle might be modified by their image evoking potential. Study 1 tested our hypotheses using a reaction time procedure in which subjects indicated their understanding of a presented metaphor by releasing a key and then writing a paraphrase of the metaphor. The relative importance of the topic and vehicle was determined by a priming procedure in which some subjects were exposed to either the topic or the vehicle prior to presentation of the entire metaphor. Our reasoning was that priming would give subjects a head start in metaphor processing and that priming properties of vehicles should speed up reaction time more than priming properties of topics, if the vehicle is indeed more central to interpretation. The effects of imagery were assessed by independently varying the rated imagery value of the topic and vehicle, with the expectation that reaction times would be related more to vehicle than to topic imagery. Study 1 failed to confirm the predictions about priming, so study 2 included a

method more analogous to the exploratory study reported by Paivio (1979). Subjects in study 2 were asked explicitly about the order and amount of processing devoted to different parts of the metaphor.

3. Study 1.

We predicted for study 1 that vehicle priming would benefit comprehension more than topic priming and that vehicle imagery would be more important than topic imagery for metaphor comprehension. The main dependent variable was interpretation reaction time, but several measures obtained from the written interpretations of the metaphors were examined for effects relevant to the vehicle dominance and conceptual peg hypotheses.

3.1. Method.

3.1.1. Subjects.

The subjects were 48 introductory psychology students who participated as a course requirement.

3.1.2. Materials

We selected 48 metaphors from the 204 poetic metaphors in the Katz *et al.* (1985) norms, deleting a few words from several metaphors to reduce their length. There were 6 metaphors of each of 8 types defined by low and high values on three variables :

a) imagery value of the topic,

b) imagery value of the vehicle, and

c) a dimension that we shall refer to as intelligibility, which was the average of the ease of interpretation, semantic relatedness, and comprehensibility ratings. Normative familiarity and metaphor goodness also correlated with the final intelligibility ratings, which was included to reduce differences on such extraneous but correlated attributes between low and high levels of the imagery variables. One main word from the subject and predicate of each metaphor was selected as a prime with the restriction that a given word was used for only one metaphor. The metaphors appear in the *Appendix* with the subject and predicate prime words underlined, omitted portions in parentheses, and mean normative ratings for the target attributes.

The adequacy of these correlational variables is supported by the fact that, although the final mean differences on the rated dimensions were modest (e.g., some low imagery vehicles have moderate imagery values) and there

were some residual relations among the variables, our dichotomous categories correlated more highly with relevant ratings than with irrelevant ones. For example, vehicle imagery as a dichotomy correlated .75 with rated vehicle imagery and .15 with rated comprehensibility. Nonetheless, caution is always advisable in the interpretation of attribute variables, especially with such complex stimuli as metaphors.

3.1.3. Procedure.

We constructed 16 orders of presentation such that each block of 8 metaphors contained one metaphor of each type defined by factorial combinations of topic imagery, vehicle imagery, and rated intelligibility. Subjects were assigned randomly in blocks of three to one of three conditions (control, topic priming, or vehicle priming) and one subject from each of the three conditions received each order.

The instructions defined metaphors as sentences in which one thing is said to be something else (e.g., "Divorce is the earthquake of the family"). An interpretation of the example was given (e.g., both are destructive) and subjects were instructed to describe, in their own words, the meanings of each of 48 metaphors that would be presented to them. In the primed conditions, one of the words from the metaphor appeared for 2 seconds when subjects pressed a specified key, and was followed by a metaphor which remained on the screen until the key was released. In the unprimed condition, the metaphor appeared immediately following the keypress. Primed subjects were instructed to think of the single word when it was shown and all subjects were told to think of a meaning for the metaphor. When they had a paraphrase for the metaphor, subjects were to release the key and write a brief interpretation. They were told not to be elaborate in their descriptions, but simply to express the idea conveyed by each metaphor. The procedure was illustrated with the "divorce" metaphor and practice with four metaphors was given before the targets. Subjects were also told to release the key and write an "X" if they had no interpretation within a reasonable amount of time.

The primes appeared centered on the middle line of the screen, the same location at which the verb for the metaphor subsequently appeared. The topic and vehicle were centered above and below the verb. The time from presentation of the metaphor to the release of the key was measured to the nearest 60th of a second by a computer that also controlled presentation of the metaphors on the screen.

3.2. Results and Discussion.

Latencies less than 2.5 seconds or greater than 45 seconds (71 observations or 3.08% in each case) were truncated to those limits. The mean reaction times and other measures are presented in Table 1 as a function of priming condition and in Table 2 as a function of topic imagery, vehicle imagery, and intelligibility. Both normative ratings and priming influenced reaction times. The ratings had the stronger effect, and the effect of priming condition was contrary to predictions in that the group primed with the vehicles produced the slowest rather than the fastest latencies. These effects were confirmed by the following statistical analysis.

	Prime Type		
Measures	None	Topic	Vehicle
Mean RT	14.56	11.84	16.13
Success	4.83	5.12	5.12
Topic	.71	.63	.81
Vehicle	.24	.13	.41

Table 1 : Study 1 Dependent measures as a function of prime type.

			Measure			
	Type		RT	Success	Topic	Vehicle
IL	TL	VL	15.09	5.06	.61	.19
		VH	14.68	4.81	.66	.35
	TH	VL	15.52	4.21	.72	.26
		VH	14.48	4.83	.76	.37
IH	TL	VL	14.72	5.15	.70	.17
		VH	13.92	5.25	.81	.30
	TH	VL	14.83	5.33	.71	.13
		VH	10.17	5.52	.76	.31

Table 2 : Study 1 Dependent measures as a function of low (L) and high (H) levels of intelligibility (I), topic imagery (T), and vehicle imagery (V).

– Priming effects and reaction time

With subjects as a random factor, the effect of prime condition was not significant, $F(2, 45) = 1.94$, $p = .156$, $MS_e = 311.45$, although the difference between vehicle and topic primes was significant using a liberal test, $t(45) = 1.94$, $p = .05$. The reaction times were extremely variable across subjects, so we performed a second analysis using items as a random factor. The effect of prime condition was clearly significant, $F(2, 80) = 56.15$, $p < .001$, $MS_e = 4.03$. The topic prime condition was significantly faster than both the no prime and vehicle prime conditions, $t(80) \geqslant 6.64$, $p < .01$, and these differences remained significant even by a conservative Tukey procedure. The vehicle prime condition was significantly slower than no prime, $t(80) = 3.48$, $p < .01$, but this difference was not significant by the Tukey criterion. All interactions involving priming condition were nonsignificant.

The priming results do not support the vehicle dominance hypothesis, which would require specifically that the vehicle primes be more effective than the topic primes because the vehicle has priority in the understanding of metaphors. The findings do support the general idea that priming one part of a metaphor may facilitate its interpretation, but the topic appears to play the more important role in the comprehension of metaphors, at least to the extent that differential priming is a valid measure of priority. However, we shall argue later that selective priming of metaphor components may not reflect importance, centrality, and related constructs construed more precisely than we have used them.

Examination of the metaphors and the prime words (see *Appendix*) suggested at least two factors that might account for the failure of vehicle priming relative to topic and no priming conditions. First, the predicates were generally longer than the subjects, meaning that the topics were more completely anticipated by their primes than the vehicles were by their primes. Second, the predicates sometimes involved anomalous propositions that are not predictable from the single-word primes. For example, "bird with teeth" would be an improbable thought upon presentation of the prime "bird". To address these hypotheses, a subsidiary study was begun in which entire topics or vehicles occurred as primes. The results for the first 24 subjects indicated that the no priming condition was considerably faster than either of the priming conditions, which did not differ from each another. These results led us to conclude that incompleteness of the priming material was not a major reason behind the failure of vehicle priming in study 1 and the new study was ended.

– Imagery and reaction time.

The effects of the metaphor attributes emerged clearly in the analysis with subjects as a random factor. All main effects and interactions involving the three attribute scales were significant, although the three-way interaction of

topic imagery, vehicle imagery, and intelligibility accounted for most of these effects, $F(1,45) = 4.33$, $p < .05$, $MS_e = .089$. As shown in Table 2, mean reaction times were fairly uniform between 13.92 and 15.52 seconds when any of the three variables had a low value, and were faster by 4 to 5 seconds when all three variables were high ($M = 10.17$). Changes in only one or two of the variables had modest effects on reaction time, but consistent with the hypothesized importance of the vehicle, vehicle imagery showed the strongest effect in the subject analysis and the only significant attribute effect with metaphors as a random factor, $F(1, 40) = 4.09, p < .05, MS_e = 26.17$.

The beneficial effects of topic and vehicle imagery on metaphor comprehension time are consistent with the conceptual peg hypothesis, which gives imagery a significant role in information retrieval from semantic memory. The imagery variables had effects over and above the collection of attributes captured by our intelligibility variable, although interactions among the metaphor variables demonstrate that topic imagery, vehicle imagery, and intelligibility remained functionally interrelated in this study despite our efforts to separate them. Part of this effect may be due to uncontrolled variation in intelligibility, the scale most directly related conceptually to our criterion task, but imperfect matching could account for only a small portion of the observed effects given the relative independence of the metaphor variables. A more plausible hypothesis is that the processes influenced by these nominally distinct attributes are intimately connected in some functional manner.

That the effect of vehicle imagery was more robust than the effect of topic imagery is consistent with the more specific prediction that arose from joint consideration of the vehicle dominance and conceptual peg hypotheses. Therefore, this finding appears to be inconsistent with the priming results, which led us to conclude that vehicles are not more important than topics for metaphor comprehension. The greater effect of vehicle imagery cannot readily be attributed to a weaker manipulation of topic imagery because variation in topic imagery as measured by differences in mean ratings was actually ~~in topic imagery as measured by differences in mean ratings was actually~~ greater than variation in vehicle imagery.

– Protocol measures.

The interpretations were scored for number of successful interpretations, proportion of successful interpretations that contained the topic, and proportion that contained the vehicle. Means for these variables appear in Table 1 as a function of prime condition and in Table 2 as a function of metaphor type. We also counted the number of words in successful interpretations as a possible measure of interpretive fluency (cf., Reynolds & Paivio, 1968), but the complicated results suggested that length sometimes measured fluency and sometimes complexity. This measure is not discussed below and, even for the

other measures, we consider only effects with direct relevance to our hypotheses.

The mean number of successes was slightly higher for the two priming conditions than for the no prime condition, but the main effect was not significant, $F(2, 45) = .72, p = .49, MS_e = 4.92$. These findings are consistent with the reaction time results in failing to demonstrate notable beneficial effects of vehicle priming. Intelligibility was the major determinant of success, but the most interesting effect was a 3-way interaction of topic imagery, vehicle imagery, and intelligibility, $F(1, 45) = 7.45, p = .009, MS_e = .50$. As shown in Table 2, this effect was primarily due to an interaction between topic and vehicle imagery for low intelligibility metaphors but not high. The fewest successful interpretations of low intelligibility metaphors occurred when a high imagery topic was paired with a low imagery vehicle (e.g., "The sky is a parliament"). The overall positive effect of vehicle imagery was marginally significant, whereas the effect of topic imagery was in fact negative because of the interaction just described. These findings again demonstrate the importance of vehicle imagery in comprehension despite the negative priming results.

An overall analysis of the proportion of interpretations that contained topic or vehicle prime words showed that the topic ($M = .72$) was more likely to appear than the vehicle ($M = .26$), $F(1, 45) = 102.12, p = .000, MS_e = .39$. The difference might be expected, given that metaphors are about topics, but it obviously provides no support for the vehicle dominance hypothesis. However, the differences shown in Table 1 as a function of prime produced a significant effect favoring vehicle primes, $F(2, 45) = 5.56, p = .007, MS_e = .62$: Relative to no primes, the proportion of interpretations that contained either topics or vehicles was increased about 14% by the vehicle primes, but unexpectedly decreased about 10% by the topic primes. The importance of the vehicle was also shown by a more pronounced effect for vehicle imagery, $F(1, 45) = 37.23$, $p = .000, MS_e = .055$, than for topic imagery, $F(1, 45) = 5.30, p = .026, MS_e = .035$ (see Table 2). The presence of the topic was even increased more by vehicle imagery (6.3%) than by topic imagery (4.5%).

In summary, vehicle priming facilitated the inclusion of both topic and vehicle primes in the interpretations, showing that our manipulation had some effect, but it did not speed interpretation of the metaphors or increase the likelihood of success. The absence of such comprehension effects is inconsistent with our interpretation of the vehicle dominance hypothesis. The metaphor properties interacted, but vehicle imagery generally had stronger effects than topic imagery, as predicted by the conceptual peg hypothesis and the assumption of vehicle centrality. Vehicle imagery shortened interpretation time, produced more successful interpretations, and was also a better predictor of topic and vehicle inclusion than topic imagery, consistent with the idea that the

concrete properties of the high imagery vehicles were being attached to their respective topics.

4. Study 2.

The results for study 1 are paradoxical. Vehicle imagery was a stronger correlate of metaphor comprehension latency and other measures than was topic imagery, but the expected superiority of vehicle priming over topic priming or no priming did not appear. The vehicle priming condition actually produced the longest reaction times. One explanation for these findings is that unconstrained consideration of the properties of the vehicle does not facilitate metaphor interpretation and may even interfere with it because many of the properties being considered during the priming phase are irrelevant to the metaphor (Paivio, 1986, pp. 237–238). Interference may be especially likely when the dominant properties of the vehicles are not those relevant to the metaphor. This analysis suggests that our predictions about vehicle priming erred in not taking account of the amount of processing devoted to each part as well as the order in which metaphor components were processed.

Study 2 examined the relative importance of topic and vehicle processing with measures designed to test the revised model. Subjects interpreted the same metaphors used in study 1 and then indicated which part of the metaphor they thought about first and which part they thought about more after reading the metaphor. The amount of thought devoted to different parts of the metaphor should be a better indicator of centrality or importance than such indirect measures as priming. We predicted that subjects would indicate that they usually started with the topic but thought most about the vehicle.

4.1. Method.

4.1.1. Subjects.

The 16 subjects were primarily undergraduates in summer courses who were paid $5 for their participation, but included three people associated with the psychology department at Western who participated voluntarily. One volunteer did not answer questions for a number of the metaphors that he interpreted and his results were not used.

4.1.2. Materials and procedure.

The 48 metaphors and 4 practice metaphors from study 1 were used, but we included the few words deleted in study 1 and indicated by parentheses

in the *Appendix*. The metaphors were arranged in booklets in orders that corresponded to 8 of the presentation orders used in study 1, with two subjects receiving each order. Eight metaphors appeared on each page, one metaphor of each type. Instructions were presented on the first page of the booklet and the 4 practice metaphors on the second page. The instructions about metaphor interpretation were identical to those given in study 1 except for changes required by the medium of presentation. In addition, subjects were instructed to rate on a 7-point scale how difficult it was to interpret the metaphor, where 1 represented *not at all difficult* and 7 represented *very difficult* to interpret. This scale appeared at the top of each page. Subjects also indicated which part of each metaphor they thought about first and which part they thought about most, after reading the metaphor. Each of the 48 metaphors was followed by the words "First ?" and "More ?" accompanied by spaces for the responses.

4.2. Results and Discussion.

For each subject, we determined separately for the "first ?" and "more ?" questions the proportion of nominated terms that were the same as the words that had been used as topic and vehicle primes in study 1. The pattern of results, presented in Table 3 as a function of metaphor type and question, is fully consistent with the idea that subjects initially consider the topic of the metaphor, but then spend more time thinking about the meaning of the vehicle. Subjects reported that they thought first about the vehicles in only 16.84% of the metaphors and thought first about the topic words in 71.43% of the metaphors. Conversely, their responses to the "more ?" question indicated that 41.08% of the time they thought more about the vehicles as compared to 12.96% for the topics. Analysis of variance with question (first or more), part (topic or vehicle), and the three metaphor attributes confirmed that this predicted interaction between question and part was significant, $F(1, 14) = 54.18, p = .000, MS_e = .38$.

The above proportions count only a specific word in the topic or vehicle and are therefore conservative with respect to the vehicle dominance hypothesis, which would be supported by the nomination of any term from the vehicle in response to the "more ?" question. To obtain more liberal proportions, we classified all nominated terms as coming from the topic or vehicle and the results with this more liberal measure supported the hypothesis even more dramatically than the conservative scores : Subjects thought first about a word from the vehicle for 24.6% of the metaphors and first about a word from the topic for 75.4% of the metaphors, whereas they thought more about a word from the vehicle for 81.9% of the metaphors and more about a word from the topic

only 18.1% of the time. Since the proportions necessarily sum to one and are correlated perfectly negatively, an analysis was not done to confirm the obvious interaction.

A number of other effects were also significant in the overall analysis of the conservative scores. Particularly relevant to the present study was the finding that the only attribute variable to demonstrate a reliable main effect was vehicle imagery, $F(1, 14) = 13.70$, $p = .002$, $MS_e = .0061$, which had an especially marked influence on the nomination of the vehicle in response to the "more ?" question. This finding is consistent with the conceptual peg hypothesis, especially as qualified by a consideration of vehicle dominance.

The findings provide strong confirmation for the hypothesis that subjects spend more time thinking about the meaning of the vehicles, but that this added processing is normally preceded by a preliminary consideration of the topic (Paivio, 1986, 237–238). Subjects first activate information associated with the topic concept and then process information about the vehicle to discover overlapping elements, processes that may operate either deliberately or in some more automatic, content-driven manner. This general pattern was influenced by the imageability and intelligibility of the metaphors, with vehicle imagery being a particularly important attribute with respect to the nomination of terms.

			First ?		More ?	
	Type		Topic	Vehicle	Topic	Vehicle
IL	TL	VL	.70	.23	.12	.28
		VH	.73	.27	.16	.54
	TH	VL	.64	.15	.18	.37
		VH	.70	.16	.13	.48
IH	TL	VL	.77	.10	.10	.37
		VH	.74	.17	.12	.32
	TH	VL	.74	.19	.10	.44
		VH	.69	.08	.14	.48

Table 3 : Nominated terms in Study 2 as a function of question and part for low (L) and high (H) levels of intelligibility (I), topic imagery (T), and vehicle imagery (V).

– Supplementary observations.

We describe briefly and without inferential statistics a number of findings reported in study 1 and replicated in study 2 despite different procedures and fewer subjects. Mean difficulty ratings showed : (a) vehicle imagery was more potent than topic imagery, which in fact increased difficulty ; (b) metaphors that were high on all three attributes were least difficult to comprehend, although the three-way interaction was not significant ; and (c) metaphors with high topic imagery and low vehicle imagery were rated as particularly difficult to interpret. The number of successful interpretations demonstrated again that high imagery topics paired with low imagery vehicles produced fewer successes than other combinations of imagery value, but this effect was present for both low and high intelligibility metaphors in study 2, whereas it only occurred for low intelligibility metaphors in study 1.

5. General Discussion.

Our studies have confirmed several predicted effects and revealed additional important aspects of metaphor processing that require further investigation. First, study 2 demonstrated the relatively greater importance of the vehicles when subjects nominated the part of the metaphor that they had spent more time processing. This conclusion is strengthened by our consistent finding that vehicle imagery had stronger effects than topic imagery. The one negative result with respect to vehicle dominance concerned the priming manipulation, since the priming effects in study 1 were generally weak and favoured the topic priming condition. However, the second study suggested that vehicle priming was ineffective because vehicle processing normally follows some preliminary processing of the topic, so that unconstrained prior activation of vehicles by primes may actually interfere with metaphor comprehension by permitting irrelevant attributes of the vehicles to become and perhaps remain dominant. The priming hypothesis might still be confirmed if some procedure for selective priming of vehicles' properties could be developed. Adjectives in vehicles probably served this selective priming function (e.g., "transparent web"), but even complete vehicles that included such biasing modifiers did not facilitate comprehension in the supplementary study, indicating that our analysis may still be inadequate.

Our predictions about vehicle dominance were deduced from basic assumptions in dual coding theory about the sequential nature of verbal processes, in conjunction with the different order of presentation for topics and vehicles, as well as the directional relations implied by the verbs *is* and *are*. This explanation emphasizes differential processing of topics and vehicles during interpretation rather than different semantic information being stored

permanently with the topic and vehicle. However, a semantic memory explanation could account for our results because our metaphors are adaptions of poetic metaphors and words appeared consistently as either topic or vehicle and never the reverse. The poet who originally produced the metaphors may have selected the topics and vehicles for their distinct semantic properties. Research with reversible metaphors and more adequate measures of the semantic networks associated with the topics and vehicles should enable us to separate processing and semantic memory contributions to the asymmetries that we have reported. However, most words can probably function as either a topic or a vehicle in *some* metaphor, thereby weakening the notion of absolute differences between words used as topics and those used as vehicles.

Our second conclusion concerns the conceptual peg hypothesis about the role of imagery in metaphor comprehension. Latencies, number of successful interpretations, and rated difficulty were all affected by rated imagery value, in particular of the vehicle, even with intelligibility reasonably controlled. The effects were not always simple ones and we still eventually need to disentangle the interactions involved and to determine whether or not other confounded attributes might account for the effects. Nonetheless, we are justified in concluding for the present that the effects of vehicle imagery were generally stronger than the effect of topic imagery, and that combining high imagery topics with low imagery vehicles made comprehension especially difficult.

Finally, we have considered a variety of independent and dependent measures in an attempt to develop a more adequate description of metaphor comprehension processes. Modest content analyses of the metaphor interpretations demonstrated the potential usefulness of this approach, but also raised basic questions about the meaning of some of the measures. For example, the numbers of words in the interpretations would represent ease (i.e., fluency after Reynolds & Paivio, 1968) or difficulty (i.e., complexity) of comprehension, while the tendency to include more topics than vehicles in the interpretations contrast with our finding that subjects reported thinking more about the vehicles. Direct indicators of such theoretically motivated processes as imagery could also be obtained from the interpretations with more refined measures of, for example, the use of concrete words or such specific phrases as "looks like" that might reflect imaginal processes.

In conclusion, our findings have demonstrated the centrality of the vehicle for metaphor comprehension, in that subjects spent a greater amount of time thinking about the metaphor vehicle than about the topic, but only following some initial consideration of the topic. We also found that the imagery value of the vehicle influenced various indicators of metaphor processing. Vehicle dominance is consistent with a dual coding characterization of the verbal processes involved in metaphor comprehension and with related models of

metaphor asymmetries. The imagery findings confirm the conceptual peg hypothesis of dual coding theory as it relates to semantic memory.

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Appendix.

Metaphors classified as low (L) and high (H) on topic imagery (T), vehicle imagery (V), and intelligibility (I) (primes underlined, deletions in parentheses, and mean ratings in brackets for topic imagery, vehicle imagery, ease of interpretation, semantic relatedness, and comprehensibility).

TL VL IL [2.81 3.11 3.69 2.42 4.21]

1. *Contemplation* is a transparent (spider) *web*.
2. *Memory* is a heap of broken *images*.
3. *The past* is a sterile *track* of dried up tears.
4. *Maturity* is the *wreck* of happiness.
5. *History* is the devil's *scripture*.
6. All *prayers* are the same *grief* flying.

TL VL IH [2.91 3.43 4.88 3.46 4.67]

7. *Death* with duty is immortal *beauty*.
8. *Truth* is a pair of eternal *doors*.
9. *Words* are the *seeds* of misery.
10. The *soul* is a voiceless *thought*.
11. *Martyrdom* is a terrible *loveliness*.
12. *Poetry* is the *palate* of the mind.

TL VH IL [2.89 4.11 3.75 2.65 3.76]

13. *Humiliation* is a *curtain*.
14. *Doubt* is a *sword*.
15. Artistic *jealousy* is the *sting* of the bee.
16. *Genius* is an *eagle*.
17. *Refusal* is the tolling of a *bell* under water.
18. *Ignorance* is a man on a *toboggan*.

TL VH IH [3.29 4.33 4.80 3.48 4.93]

19. *Peace* is a wild *wood-dove*.
20. The *spirit* is a *sailor*.
21. *Fear* is a *worm* devouring living clay.
22. *Despair* is a living *tree* feeding on death.
23. *Time* is a transforming *chisel*.
24. *Conscience* is a burrowing *mole*.

TH VL IL [3.92 3.08 3.49 2.15 3.60]

25. A lover's *hands* are a flaming *pyre*.
26. The *moon* is a dancing *cat*.
27. A *tower* is *hope* standing on stilts.
28. *Winter* is a *bird* with teeth.
29. *Humans* are *strips* of stuff that tatter (as they move).

30. The *sky* is a *parliament.*

TH VL IH [4.28 3.58 4,79 3.61 4.95]

31. *Dew* is the last *gold* of perished stars.
32. The *brain* is the *prisoner* of thought.
33. *Tears* are a mother's *weakness.*
34. A *photograph* is a one-sided *skin* of truth.
35. *Spring* is a *weaving* that ends unravelled.
36. The *rifle* is a *stutterer.*

TH VH IL [4.03 3.93 4.01 2.43 3.99]

37. *Night* is a *castle.*
38. The *sun* is a *huntsman* roused to the chase.
39. The human *face* is a sealed *furnace.*
40. An *army* is a living *sea.*
41. Rocking *buoys* are lost cathedral *chimes.*
42. *Wine* is the warm *south.*

TH VH IH [4.66 4.61 5.38 3.92 5.71]

43. The *stars* are *beads* strung on one string.
44. *Clouds* are tossed *pillows.*
45. *Waves* are the sailor's *steed.*
46. An *avalanche* is a *thunderbolt* of snow.
47. The *body* is a fading *mansion.*
48. *Books* are (the) full-ripened *grain* (of a poet's mind).