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The Effects of Metaphorical and Literal Comprehension Processes on Lexical Decision Latency of Sentence Components

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Two lexical decision experiments were conducted to further investigate the notion that metaphor comprehension involves the formation of a new association between topic and vehicle. Experiment 1 was essentially a replication and extension of Camac and Glucksberg (1984) demonstrating that known word associate pairs show a significant lexical decision latency advantage over their randomly paired counterparts, while topic/vehicle word pairs drawn from apt metaphors do not. The results of Experiment 1 confirm their initial findings even when printed word frequency of the two pair types is held equivalent (a factor not controlled for in the original Camac and Glucksberg study). This result suggests that preexisting topic/vehicle similarity is not an important factor in metaphor comprehension. Experiment 2 was an attempt to detect the hypothesized shift in attribute salience that results in the formation of a new association between topic and vehicle during metaphor comprehension. In Experiment 2, subjects made lexical decisions on topic/vehicle word pairs that were preceded by a paragraph designed to induce either a metaphorical or literal interpretation. For many subjects, a latency advantage was observed for topic/vehicle pairs preceded by a metaphorical context as compared to a mismatching literal context. This finding suggests that metaphor comprehension is a dynamic process which modifies preexisting topic/vehicle similarity, and that metaphorical interpretations are facilitated by extended context.

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Interest in the topic of figurative language has grown steadily over the last decade (Dirven & Paprotte, 1985). In particular, the investigation of metaphor production and comprehension has benefited from the development of concepts and experimental techniques used in cognitive psychology and psycholinguistics. Two key issues in figurative language research are the nature of the mental activities used to process a metaphor, as well as its internal representational state. Regarding the latter, several formats have been hypothesized, including the propositional (Anderson, 1978), dual coded visual/verbal (Paivio, 1979), schema (Ortony, 1979), and distributed (McClelland & Rumelhart, 1986; Rumelhart & McClelland, 1986) representations. Unfortunately, the processes that result in metaphor comprehension are not yet fully understood (Glucksberg & Keysar, 1990), nor is there definitive evidence favoring any one of the aforementioned representational formats (Honeck & Kibler, 1985).

Attribute Matching Approach

One conceptualization of metaphor comprehension is the attribute matching approach which provides a general foundation upon which several specific theories have been built. In this approach, a metaphor such as "Life is a game" has three primary components, the *topic* (life), the *vehicle* (game), and the *ground*. Theories of metaphor comprehension typically deal with the relationship between the topic and vehicle in terms of their similarity or associative value, while the ground is a general term denoting the conceptual relationship that binds the topic and vehicle together.

A well-articulated explication of the attribute matching approach is provided by Ortony (1979). His theory may be viewed as an extension of Tversky's (1977) work concerning the connection among word attributes in memory, as applied to metaphor comprehension. From this perspective, the topic and vehicle of a metaphor are each thought to be comprised of a set of specific attributes. These attributes vary in salience and are rank-ordered along this dimension. Figure 1 shows a possible distribution of component attributes for the literal statement: "An airplane is a vehicle."

Within this framework, the comprehension of a given sentence occurs when attributes from both topic and vehicle overlap. To some extent, the assumption is made that words have a default ranking of attributes which prevails unless altered by the particular context in which the sentence is encountered. Thus, the degree to which a given sentence will be interpreted in a literal or metaphorical sense depends upon the relative salience of overlapping attributes. In Figure 1, the sentence is interpreted literally because the overlapping attributes roughly share the same degree of salience. A metaphorical interpretation, however, arises when a salient attribute of the ve-

Airplane	Vehicle
Means of transport	Means of transport
Flies	Moves
Has wings	Carries things
High speed	Transmits
Covers great distances	•
•	•
Is a thing	Is a thing

Fig. 1. Attributes of literal statement "An airplane is a vehicle."

Billboards	Warts
Provide information	Ugly
Large	Bothersome
Colorful	Embarrassing
Near Highways	Hard to get rid of
Ruin the countryside	Disease
Ugly	Round
•	•
•	•
Is a thing	Is a thing

Fig. 2. Attributes of metaphorical sentence "Billboards are warts on the landscape."

hicle overlaps an obscure attribute of the topic. This imbalance in salience requires the topic to be interpreted in a novel fashion. One example is the sentence "Billboards are warts on the landscape" (see Fig. 2).

Metaphor and Context

Regarding metaphor comprehension, the role of extended context is illuminated through the use of concepts like *schema* (Ortony, 1979) and *semantic domain* (Kelly & Keil, 1984). The attributes for a given component as well as the salience of individual attributes are contained within schemata,

and are differentially activated in long-term memory by various contexts. The interpretation of a metaphor then involves not only the juxtaposition of topic and vehicle, but also the relationship of context to the metaphor itself. In a related fashion, the concept of semantic domain restricts the number of potential salient attributes to be activated, allowing the vehicle to be effectively mapped onto the topic.

Invoking the schema concept allows for the reconciliation of several theoretical problems in metaphor comprehension that were not readily addressable by other approaches. For example, according to Searle (1979), a metaphor must first violate selection restriction rules before an attempt is made at a figurative interpretation. For example, a piece of ribbon is thought to possess the attribute of *length* because it is a nonrigid object. A statement such as "The ribbon is tall" violates a selection restriction rule because nonrigid objects do not possess height. In Searle's interpretation, metaphors frequently break these rules because they demand anomalous assignments of lexical entries. However, this notion fails when interpreting a sentence such as "The old rock became brittle with age," which does not ostensibly violate any selection restriction rule, yet may be interpreted literally in a geological sense, but can also be interpreted metaphorically if it occurs in discourse concerning a professor emeritus. Hence, individual lexical entries and their attributes are assignable to a number of different roles if the surrounding context provides support for that new assignment.

Research by Ortony, Schallert, Reynolds, and Antos (1978) was among the first to deal specifically with the role of extended context in the interpretation of metaphors. Previous studies (e.g., Malgady, 1978; Malgady & Johnson, 1976) focused on a unit of discourse that was no larger than the target metaphors themselves (i.e., "A _____ is a _____"). This being the case, the attribute matching model was only tested by assessing the relationship between the rated quality of target metaphors and the rated degree of similarity between the topic and vehicle. In this regard, traditional semantic analysis posits that words encountered in a sentence have a default associative relationship. And, in the case of a given metaphor, the topic and vehicle possess a certain degree of relatedness that allows for accurate interpretation. McCabe (1983) has pointed out that the preexisting relationship between topic/vehicle pairs in metaphors seems to fall somewhere in the middle of the associative strength continuum, with anomalous sentences displaying little associative strength between components (e.g., "A Volkswagen is a telephone") and literal sentences possessing a great deal of component similarity (e.g., "An automobile is a vehicle").

Studies by Malgady (1976) and Malgady and Johnson (1976) revealed that preexisting topic/vehicle similarity is a good predictor of the perceived goodness of metaphors, a finding that is consistent with the attribute match-

ing approach. However, McCabe (1983) has demonstrated that predictive strength is found only with similarity judgments drawn from metaphors that are presented without extended context. Indeed, the predictive value of topic/vehicle similarity has been demonstrated to be *either* high or low, depending upon the amount of context provided (Glucksberg, Gildea, & Bookin, 1982; Katz, 1982; Marschark, Katz, and Paivio, 1983; McCabe, 1983). Such findings, taken in composite, suggest that similarity is strongly correlated with metaphor goodness when no context is present, but the addition of context causes a significant decrease in this correlation. Any attribute matching explanation must account for this reduction in predictive power when context is provided. As stated by McCabe (1983), "Clearly, the resemblance of topic and vehicle concepts does not determine the quality of the metaphor they comprise when that metaphor occurs in extended, natural context" (p. 60).

In a series of experiments, Gildea and Glucksberg (1983) explored the minimum amount of context necessary for metaphor comprehension. Their experiment involved the use of contextual priming in which a target item was immediately preceded by a context which was from a sentence to a paragraph in length. They employed three types of contextual primes that resulted in (1) activation of the figural sense of the metaphor ground, (2) activation of the literal sense of the ground, and (3) activation of the general semantic field of the ground. An example of a target metaphor in this study is "All marriages are iceboxes." The three primes, respectively, were (1) "Some people are cold," (2) "Some winters are cold," and (3) "It was a warm day." Subjects were presented metaphorical and literal statements preceded by either an unrelated, metaphorical, or literal prime and were instructed to categorize the statements as being true or false. It was found that all three primes induced reaction times faster than unprimed control statements. Such results suggest that the ongoing task of metaphor comprehension requires a constant shifting of attributes in accord with the current verbal, visual, and/or cultural context of the perceiver. Therefore, in metaphor comprehension, individual words need not have any fixed set of attributes, nor should any preexisting degree of salience for these attributes be necessary for comprehension. Interestingly, using the same prime types as Gildea and Glucksberg (1983), Shinjo and Myers (1987) produced similar results demonstrating the impact of primes in the absence of extended context. Their findings as well as others (cf. Pollio, Fabrizi, Sills, & Smith, 1984) confirm one of the central points made by Gildea and Glucksberg (1983) that "... people use the same comprehension strategies and mechanisms for understanding literal and nonliteral meanings of sentences, with neither category of meaning having unconditional priority over the other" (p. 87).

If the processing of metaphors requires context to constrain possible interpretations, the point at which context exerts its influence is not yet clear. It is possible that presentation of a word automatically activates all of the attributes associated with it, with context then limiting the attributes to be used for interpretation (Onifer & Swinney, 1981). On the other hand, context may restrict attribute selection, with only a small subset of such attributes receiving activation (Inhoff, Lima, & Carrol, 1984; Marlsen-Wilson & Welsh, 1978; Simpson, 1981).

Topic/Vehicle Association

A study by Camac and Glucksberg (1984) was one of the first designed to investigate the dynamic processes involved in the proposed shift that occurs in the similarity of topic/vehicle components when comprehending metaphors. In their study, subjects were required to perform a lexical decision task on materials of varying literal or metaphorical quality. The lexical decision task requires the subject to ascertain whether or not a given pair of letter strings form acceptable English words. This task is known to be sensitive to the associative strength of positive string pairs (Meyer & Schvaneveldt, 1971), with highly associated pairs eliciting a quicker lexical decision time than unrelated pairs. Camac and Glucksberg used this task to index the amount of similarity (in terms of associative strength) found between topic/vehicle pairs drawn from apt metaphors. They asserted that metaphors do not require preexisting associations in order to be interpreted, but rather that the interpretation process forces new associations to be created.

In their study, two sets of stimulus materials were employed. One set consisted of a list of topic/vehicle pairs drawn from apt metaphors along with a list of scrambled topic/vehicle pairs. This scrambled list was merely the original list with each topic randomly assigned to a different vehicle. The other set consisted of lists of highly associated word pairs along with an accompanying list of their scrambled counterparts. They predicted that reaction times for lexical decisions of the highly associated pairs should be faster than those for their scrambled counterparts, the typical finding in such a task. If metaphor comprehension relies upon the preexisting associative strength between topic and vehicle, then components drawn from apt metaphors should show a similar reaction time advantage over their scrambled counterparts. However, since Camac and Glucksberg (1984) did not believe preexisting similarity to be an important factor in metaphor comprehension, they anticipated no such latency advantage would be found.

The results obtained were consistent with their predictions. The metaphor pairs showed no significant reaction time advantage over their scrambled counterparts, while the associate pairs were responded to significantly

more quickly than their scrambled counterparts. Hence, Camac and Glucksberg (1984) provided evidence that preexisting similarity is not an important factor in metaphor comprehension. However, this evidence buttressed only part of their claim. Their study did not address the issue of whether or not metaphor comprehension requires a dynamic rearrangement and strengthening of topic/vehicle association and/or similarity. Moreover, in the Camac and Glucksberg study only letter string pairs were presented and thus comprehension of complete literal or metaphorical statements was never required. In order to more rigorously test the claim that new associations arise from metaphor comprehension, subjects should first be forced to make metaphorical interpretations of complete statements, and then be tested for residual associative strength.

The Present Study

The two experiments conducted here were designed to investigate the following issues: (1) the replicability (and an extension) of the Camac and Glucksberg (1984) findings and (2) a more direct investigation of the dynamic aspects of the metaphor comprehension process. Thus, Experiment 1 addressed a potential confound in the original Camac and Glucksberg work. Specifically, when their metaphor and associate lists are evaluated in terms of printed frequency (Kucera & Francis, 1967), the mean value for the metaphor pairs was far less (42 per million) than that of the associate pairs (94 per million). Perhaps the fact that no lexical decision advantage was found for metaphor pairs as compared to their scrambled counterparts was due to the relative infrequency of the words comprising these pairs rather than their metaphorical nature per se. To address this problem, Experiment 1 utilized a new set of metaphor pairs that were matched to the associate pairs in terms of frequency. Camac and Glucksberg's contention that preexisting similarity is not an important comprehension factor would be supported if Experiment 1 yielded similar results.

Experiment 2 attempted to detect the hypothesized shift that takes place if metaphor comprehension actually involves the rearrangement of attribute salience and the subsequent strengthening of association values between topic and vehicle. In Experiment 2, subjects were required to judge the lexical status of letter string pairs immediately after the pairs were encountered in either a literal or a metaphorical context. In this way the two types of context served to prime the letter strings in qualitatively different ways. For metaphorical contexts, the string pair was embedded in a metaphor which was easily interpreted when the appropriate paragraph (figurative context) was provided. The literal paragraphs served as a contrast condition. If the process of interpreting a metaphor strengthens the association between

topic and vehicle, then metaphorically primed strings should show a consistent latency advantage over the same letter pairs preceded by a literal (mismatching) context. Conversely, if associational values of topic and vehicle attributes are not altered during metaphor processing, no such latency difference should be obtained.

EXPERIMENT 1

Method

Subjects. Twenty undergraduates at Iowa State University served as subjects in return for extra credit. All subjects spoke English as their native language.

Stimulus Materials. Subjects were required to perform a lexical decision task and, therefore, the stimulus materials were all letter string pairs. If both strings were acceptable English words, a *yes* decision was made. A *no* decision resulted if either or both letter strings were nonwords. There were four types of positive response pairs:

1. Forty-eight metaphor pairs similar to those found in the Camac and Glucksberg (1984) study.
2. Forty-eight scrambled metaphor pairs which were merely randomly paired words derived from the original metaphor list. Scrambled pairs were not in themselves readily interpreted in any metaphorical sense.
3. Forty-eight standard associates similar to those found in Camac and Glucksberg (1984). These word pairs were derived from word association norms developed by Kucera and Francis (1967).
4. Forty-eight scrambled associates which were randomly paired words from the associate list.

Notably, the stimulus materials used in Experiment 1 were essentially identical to those of Camac and Glucksberg (1984) with one important exception: The set of metaphor pairs in the present study (and hence their scrambled counterparts) was replaced by a set that had a mean printed frequency which approximated that of the standard associates. In order for this new set to be generated, a pilot group of 15 subjects was asked to rate the aptness of a pool of metaphors. From these ratings, 48 of the top-rated metaphors were selected, and their topic/vehicle pairs were extracted to form the new stimulus set. Also, new associate pairs were selected in an attempt to minimize any differences in printed frequency and word length between the two word types. The resultant set contained metaphor pairs with a mean

printed frequency of 81.99 per million (*SD* = 103.24) and associate pairs with a mean printed frequency of 75.09 per million (*SD* = 127.72). Mean word lengths for the metaphor and associate lists were 6.61 (*SD* = 2.12) and 5.62 (*SD* = 1.48) letters, respectively. Three types of negative response pairs were used in the study: nonword–nonword (e.g., pilg–durcept), word–nonword (e.g., closet–pobeld), and nonword–word (e.g., gration–desk). The negative response pairs were 4 to 6 letters in length and were all pronounceable.

From the materials listed above, two 192-item lists were constructed. Each list contained 24 metaphor pairs, 24 scrambled metaphor pairs, 24 associate pairs, and 24 scrambled associate pairs. In addition, each list contained 32 nonword–nonword pairs, 32 word–nonword pairs, and 32 nonword -word pairs. Because the lexical decision task is known to be sensitive to repeated word exposure, separate lists were constructed so that no subject saw the same words more than once. Half of the subjects saw only List 1, while the other half saw only List 2. Each list had its own respective metaphor and associate pairs, along with their scrambled counterparts. To avoid repetition, however, the scrambled pairs from List 1 were switched with those in List 2. This again ensured that each subject would see each type of string pair without repetition.

Design. The two 192-pair lists were each divided in half (96 pairs), with each half partitioned into four randomized blocks. Each block contained an equal number of word pair types (i.e., 12 positive and 12 negative). A different randomized block order was used for each subject, and within each block, stimulus items were randomized. A practice list was constructed containing 36 items: nine associate pairs, nine scrambled associate pairs, and six of each of the three nonword pair types described earlier. In addition, each 96-item block was preceded by 14 warmup trials, consisting of two instances of each pair type.

Procedure. Subjects were seated in front of a microcomputer, with the center of the monitor positioned at eye level. The computer was equipped with an internal clock system to allow for millisecond timing. With the left hand, a key was pressed to initiate each pair presentation. With the right hand, two adjacent keys were utilized, one signifying a *yes* response and the other a *no*. Subjects were counterbalanced concerning the finger used to make the *yes* response; half used the index finger, the other half used the middle finger. The instructions specified that a *yes* response should be made only if both letter strings were legitimate English words, and that half the pairs presented would be of this type. At this point, the word *yes* or *no* was presented randomly in the center of the screen for 20 repetitions to allow subjects to select the appropriate keys and become familiar with the response setup. Subjects were then instructed to view a fixation symbol in the center

of the screen. When ready, 14 practice trials were presented with one trial consisting of the presentation of an asterisk in the center of the screen for 2000 msec followed by the presentation of a letter string pair. The pairs were centered with one string to the right and the other to the left of fixation and subjects were required to make their decision (and subsequent key-press) as quickly as possible. The pair remained visible until the key-press was executed. Subsequently, the string pair was replaced by the fixation symbol which marked the beginning of the next trial. When the practice list was completed, subjects were asked if they needed any clarification concerning the experimental task. After the first block of 96 pairs, subjects were allowed a brief rest period.

Results

The mean latencies for each pair type were computed only for correct responses; Reaction times (RT) less than 250 msec (i.e., anticipation) or greater than 4000 msec (i.e., open-ended searching) were treated as errors and not included in the analyses. The average error rate, including the aforementioned deletions, was less than 9%. Responses to nonword stimuli were treated as filler items and were not analyzed. A preliminary 2 (List: List 1/List 2) × 2 (Relation Type: Related/Scrambled) × 2 (Word Type: Metaphor/Associate) analysis of variance (ANOVA) was conducted using the mean RT data. The between-subjects factor (list) was significant in the main [F (1, 18) = 6.10, p <.02] and displayed a marginally reliable three-way interaction with the relation type and word type factors [F (1, 18) = 3.74, p < .06]. Consequently, List 1 and List 2 data were analyzed independently in two separate 2 × 2 (Relation Type × Word Type) ANOVAs. The means for each pair type from List 1 and List 2 are presented in Table I.

For List 1, lexical decisions for related pairs yielded faster RTs than those involving scrambled word pairs [F (1, 9) = 6.75, p < .02]. Lexical

Table I. Mean Reaction Times in msec (Standard Deviations in Parentheses) for the Four Trial Types of Experiment 1

	Pair relation	
Word type	Related	Scrambled
List 1		
Metaphor	996 (135)	993 (119)
Associate	842 (96)	906 (108)
List 2		
Metaphor	1047 (135)	1051 (119)
Associate	868 (96)	1028 (108)

decisions for associate pairs yielded faster RTs than the metaphor pairs [F (1, 9) = 65.03, $p < .001$]. As in Camac and Glucksberg (1984), the critical comparison involved the RT advantage found between the associate pairs and their scrambled counterparts, as contrasted to metaphor pairs and their scrambles. The analysis revealed a significant Relation Type × Word Type interaction [F (1, 9) = 8.38, $p < .01$]. *Post hoc* comparisons of these means using Duncan's (1955) multiple-range test ($p < .05$) showed that the associate pairs were responded to more quickly then their scrambled counterparts, while the metaphor pairs showed no such latency advantage over their scrambled counterparts.

The means of List 2 show a similar pattern to those of List 1, except that the differences are somewhat more pronounced, and thus are the source of the three-way interaction. Again, related pairs yielded faster RTs than scrambled pairs [F (1, 9) = 23.62, $p < 001$] and associate pairs yielded faster RTs than the metaphor pairs [F (1, 9) = 39.91, $p < .001$]. The analysis also revealed a significant Relation Type × Word Type interaction [F (1, 9) = 16.31, $p < .003$]. *Post hoc* comparisons showed that, as in List 1, the associate pairs were responded to more quickly then their scrambled counterparts while the metaphor pairs showed no such RT advantage over their scrambles.

Discussion

The results of Experiment 1 replicated those of Camac and Glucksberg (1984) using more fully controlled stimulus items (i.e., the difference between the mean printed frequencies for the associate and metaphor lists were equivalent). Even with comparable printed frequency, known associates showed a significant RT advantage over their scrambled counterparts while metaphor components did not. The absence of such an advantage supports the notion that preexisting similarity is *not* a necessary factor for metaphor comprehension. In terms of attribute matching, this suggests the juxtaposition of topic and vehicle attributes occurs as a dynamic process and is not a static one involving the mere matching of preexisting, acontextual attributes.

The data from Experiment 1 and those of Camac and Glucksberg (1984) should not necessarily be interpreted as disconfirming the notion of attribute matching. Rather, metaphors, as well as other types of language, are meant to convey information and therefore the listener actively (though perhaps not consciously) may attempt to associate vehicle attributes to topic attributes that are congruent with the context provided. The process of metaphor comprehension may then involve the disambiguation of overlapping attributes in the topic and vehicle, a process which relies heavily on sur-

rounding sentential context. Earlier studies (e.g., Malgady & Johnson, 1976; McCabe 1983) found a strong correlation between topic/vehicle similarity and perceived metaphor goodness, but this only held true for metaphors presented out of context. Apparently, individuals must rely solely on pre-existing associative strength if extended context is not provided.

One other aspect of importance in Experiment 1 is the overall RT advantage for associates and their scrambles over metaphors and their scrambled counterparts. The Camac and Glucksberg (1984) study yielded an identical pattern which the authors attempted to explain by pointing to the difference between the mean printed frequency of the metaphor and associate lists. However, this interpretation is no longer tenable as this difference was controlled for in Experiment 1. One possible explanation for the persistence of this effect may be related to a mean difference in word length of the items comprising the two lists. Even though an effort was made to equate on the word length factor, the words comprising the metaphor list were slightly longer on average than those comprising the associate list. By way of speculation, it may be that the observed difference is related to the increase in the time required for processing longer words.

EXPERIMENT 2

In the Camac and Glucksberg (1984) study as well as Experiment 1, no lexical decision advantage was found for topic/vehicle pairs drawn from apt metaphors as compared to their scrambled counterparts. However, neither the Camac and Glucksberg study nor Experiment 1 provided experimental evidence suggesting that the processing of a metaphor actually creates new associations, resulting in subsequent comprehension. In addition, neither study required subjects to engage in the analysis of complete metaphorical statements within extended context, as the target materials were presented solely as isolated topic/vehicle pairs. Thus, Experiment 2 was designed to provide evidence for the dynamic shift in topic/vehicle similarity that is hypothesized to accompany the comprehension of a metaphor, and to look at how extended context might influence this process.

The primary task in Experiment 2 was to again make lexical decisions about topic/vehicle pairs drawn from apt metaphors, but this time they were contextually primed by a paragraph designed to induce either a metaphorical or a literal interpretation. Thus, in Experiment 2, letter string pairs were presented immediately following the presentation of a biasing paragraph in order to detect any residual associative strength. If the metaphor comprehension process produced a new association that was temporarily formed because of the activation of previously unrelated attributes, one should detect

a priming effect, with a lexical decision advantage for the topic/vehicle pairs preceded by a metaphorical as compared to a (mismatching) literal context. Intuitively, nonword pairs should be processed slowest of all as they would be unrelated to, and thus unaffected by, such context.

Method

Subjects. Forty undergraduates served as subjects in exchange for extra class credit. All subjects spoke English as their native language.

Stimulus Materials. A stimulus set of 144 items was produced by expanding upon the materials used in Experiment 1. In Experiment 2, an item consisted of a three- to five-sentence paragraph followed by a letter string pair. The 72 paragraphs preceding the letter string pairs requiring a *yes* response were of two types. The first paragraph type consisted of a brief description of a context in which a metaphorical interpretation was induced. Immediately after the presentation of this paragraph, a letter string pair was presented for a lexical decision. The following is an example of a metaphorical context paragraph accompanying the target word pair, *History-Clock:*

> Throughout the ages, prominent people and events have shaped the world in which we now live. One need only look to the past to discover that human civilization has gone through a series of orderly, almost predictable stages. History is a clock which reveals the predictability and cyclic nature of human civilization.

The second paragraph type was comprised of similar descriptive statements but designed to induce a literal interpretation. The following is an example of the literal context paragraph for the same word pair, *History-Clock:*

> Throughout the ages, prominent people and events have shaped the world in which we now live. One need only look to the past to discover that human civilization has gone through a series of orderly, almost predictable stages. Even though the clock ticks onward, history is an important subject which must not be neglected.

Thus, the two paragraph types were designed to induce either a metaphorical or literal interpretation of the very same word pairs. Intuitively, the lexical decision task should be affected by the nature of the biasing paragraph, with a metaphorical context producing generally faster lexical decision latencies for the topic/vehicle pairs in light of the fact that latter are drawn from apt metaphors. Theoretically, the mismatch between the literal context and topic/vehicle pairs should produce little (or no) priming relative to the matching metaphorical context (for an in-depth discussion of this priming rationale see Neely, 1991).

Design. In Experiment 2, stimulus materials were arranged so that a subject responded to equal numbers of *yes* and *no* letter string pairs, as well as equal numbers of literal and metaphorical paragraphs. This was accomplished by dividing 72 positive and 72 negative items into two random lists consisting of 18 literal, 18 metaphorical, and 36 nonword trials each. This division was made so that each list contained target strings for which only the literal *or* the metaphorical priming paragraphs were presented. Care was taken to ensure that these paragraphs contained minimal repetitions of the target words, since repeated exposure may inadvertently create residual associative strength, resulting in an artifactual latency advantage.

All context paragraphs were constructed so that a number of critical factors remained constant across paragraphs and lists; for the paragraphs inducing a metaphorical interpretation, the number of words between the topic and vehicle was kept within a narrow range and matched in the literal context paragraphs. Moreover, the number of words between the last target word and the end of the sentence in which the word pair was presented was identical in both paragraph types.

Procedure. Before any practice or experimental trials were presented, the word *yes* or *no* was presented randomly in the center of the monitor for 20 trials to allow subjects to find the appropriate computer keys and to become familiar with the response setup. A single experimental trial began with the presentation of a context paragraph. The paragraph appeared on the monitor and remained there until the subject pressed either response key to signify that he/she had finished reading the paragraph. With the right hand, two keys were utilized, one signifying a *yes* response and the other a *no*. The finger used to make the *yes* response was counterbalanced; half the subjects used the index finger, the other half used the middle finger of the right hand. Subjects then saw a fixation symbol in the center of the screen that was replaced after 2000 msec by the target string, and they were instructed to make a lexical decision as quickly as possible. Immediately after their key-press was executed, the monitor went blank for 2000 msec followed by the start of the next trial, which corresponded to the appearance of a new context paragraph. The presentation sequence for each context and trial type was random.

Results

Mean RTs for each condition were computed for the correct responses. RTs less than 250 msec or greater than 4000 msec were again treated as errors and excluded from the analysis. The average error rate across subjects was less than 10%. A preliminary 2 (List: List 1/List 2) × 3 (Pair Type: Literal, Metaphorical, Nonword) mixed-design ANOVA was conducted, re-

Table II. Mean Reaction Times in msec (Standard Deviations in Parentheses) for the Three Word Pair Types of Experiment 2

	Pair relation		
List	Metaphor	Literal	Nonword
List 1	1024 (339)	1164 (416)	1407 (442)
List 2	1069 (309)	936 (199)	1165 (299)

vealing a significant main effect for pair type [F (2, 76) = 18.95, $p < .001$], with the nonword pairs yielding longer RTs than metaphor and literal pairs, which in turn were not different from each other. The between-subjects factor (List 1 vs. List 2) was not significant in the main; however, the list variable did interact with pair type [F = (2, 76) = 6.58, $p < .002$]. Consequently, List 1 and List 2 were analyzed independently in two separate one-way ANOVAs. The means of each trial type for List 1 and 2 are presented in Table II.

List 1 data reveal a reliable main effect for pair type [F (2, 88) = 17.51, $p < .001$]. *Post hoc* analysis indicated that the word pairs following a metaphorical paragraph were responded to most quickly, followed by word pairs encountered after a literal interpretation, with nonword pairs requiring the longest response time. List 2 displayed a different pattern, however, with pairs following a literal interpretation yielding the quickest RT, followed by the metaphor and nonword pairs, which were not reliably different from each other.

Discussion

Experiment 2 was an attempt to gather evidence in support of the hypothesis of Camac and Glucksberg (1984) that the act of interpreting a metaphor causes a new association to be formed between topic and vehicle. If this is indeed the case, an overall latency advantage in the lexical decision task would have been found for topic/vehicle pairs preceded by a paragraph inducing a metaphorical interpretation. Such a latency advantage would support the contention that the process of metaphor comprehension involves the temporary adjustment of associative strength between component attributes. However, Experiment 2 yielded mixed results: List 1 produced the predicted pattern, with RTs for topic/vehicle pairs preceded by a metaphorical context being faster than the same word pairs preceded by a literal context. Unfortunately, the results of List 2 were not in accord with this pattern, and their interpretation leads to the examination of a number of potential contributing factors.

Post hoc examination of the two lists revealed no disparity in terms of target word length, printed frequency, or paragraph length. Also, since many of the items from Experiment 1 were used as target items in Experiment 2, a RT comparison was done to ensure that the two lists, when collapsed across metaphorical and literal conditions, had comparable RTs. The mean RT for List 1 was 1094 msec while for List 2 it was 1003 msec. Using a *t*-test, these latencies were not reliably different from one another. And although not definitive, the finding suggests that item bias per se was not a contributor to the observed difference in list performance.

Somewhat surprising was the fact that mean RT for nonword pairs of List 1 was 242 msec slower than the nonword pairs of List 2. This result is puzzling because the nonword–nonword pairs were exactly the same for the two lists. This suggests that the subject populations viewing each list may have differed in some systematic way despite the fact that they were randomly assigned. Detailed examination of the error data, however, revealed no significant differences between the lists in error rate (9% and 7% for List 1 and 2, respectively). Of some importance, however, is the fact that List 1 performance was slightly more variable than List 2, which undoubtedly influenced the pattern of performance obtained.

In retrospect, the lexical decision task may lack the sensitivity needed to detect temporary changes in associative strength induced by a preceding context. For example, it may be the case that the resultant activation that occurs during metaphor comprehension decays very rapidly between the presentation of the context paragraph and the subsequent appearance of the target letter strings. Thus, the temporary shift in activation associated with the interpretive process may not be readily detectable by the lexical decision task. Presumably this would take place because the temporal parameters of the latter task are too slow to capture the rapidly dissipating pattern of activation involved in the interpretation process.

GENERAL DISCUSSION

The two experiments conducted here shed additional light on the underlying processes associated with the comprehension of metaphors. In Experiment 1, a replication of the original Camac and Glucksberg (1984) study yielded similar results, with metaphor components failing to show a lexical decision advantage over their scrambled counterparts, this in contrast to standard associate pairs and their counterparts. Moreover, this pattern was unaffected by mean printed frequency of the stimulus items. Experiment 2 provided partial support for the contention that the processing of a metaphor causes the formation of a new temporary association between topic and

vehicle. In terms of attribute matching theory, our List 1 findings suggest that the metaphor comprehension process is dynamic and flexible, and involves more than a simple enumeration and juxtaposition of topic and vehicle attributes. Moreover, extended context seems to play a prominent facilitative role in metaphorical interpretation. It must be emphasized, however, that in light of the results obtained for List 2, these conclusions should be treated as tentative and viewed with caution.

The present experiments also suggest that the stimulus materials used in the investigation of metaphor comprehension should more closely approximate those found in normal discourse. Experiment 1 utilized materials which consisted of only the topic/vehicle pairs drawn from apt metaphors. Because no context (not even the length of a metaphorical sentence) was provided, subsequent lexical decisions were based solely on preexisting word similarity and whatever interpretive backdrop the laboratory setting and/or the current mental state of the subject provided. To the extent that the comprehension of a metaphor involves the reduction of topic/vehicle ambiguity and the subsequent enhancement of their associative strength, the presence of context appears to be an important contributor to the process, perhaps by delimiting the number and type of possible topic/vehicle attributes to be activated.

Experiment 2 provided partial evidence for the contention that the presence of context can temporarily enhance activation among usually disparate topic/vehicle attributes. It may be that extended context exerts a gradual, global priming effect which selectively activates previously unrelated attributes of topic/vehicle pairs, resulting in a new association being formed, and thus aiding the interpretive process. Clearly, however, in light of the conflicting patterns of performance obtained for Lists 1 and List 2, further research is required to verify that such theorizing is indeed correct.

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