The effects of metaphorical and literal processing on subsequent lexical decision latencies of sentence components

James Alvin Hubbell

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The effects of metaphorical and literal processing on subsequent lexical decision latencies of sentence components

Hubbell, James Alvin, Ph.D.
Iowa State University, 1988
The effects of metaphorical and literal processing on subsequent lexical decision latencies of sentence components

by

James Alvin Hubbell

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major: Psychology

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

For the Major Department

Signature was redacted for privacy.

For the Graduate College

Iowa State University
Ames, Iowa

1988
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Introduction

Interest in the production and comprehension of figurative language has grown steadily in the last few decades as evidenced by frequent contributions to the literature made by linguists, philosophers, and psychologists. An elucidation of such processes has the potential to strengthen our theoretical understanding of language use in general, as well as shed considerable light on practical issues, such as the appropriate figurative content to include in children's textbooks.

In terms of psychological and linguistic theory, figurative language has shifted from an exceptional, secondary process to a matter of central importance. In the words of Dirven and Paprotte (1985),

Somehow, the pendulum has now swung back to the other extreme; instead of ostracizing metaphor, based on radical positivist and empiricist convictions, it is now seen as being situated in the deepest and most general processes of human interaction with reality, in assimilating and adapting to the world; and it is claimed that whatever we know about the world, we know on the basis of the "distorting" influences of cognition and language (p. viii).

Theoretical approaches that deal exclusively with metaphor production and comprehension have employed concepts that parallel those commonly used in contemporary cognitive psychology. A key issue concerns the representational format inherent in discourse processing. Such formats include propositional (viz., Anderson, 1978), dual encoded visual and verbal (Paivio, 1979), schema (Ortony, 1979) and distributed representations (Rumelhart and McClelland 1986).

However, the current state-of-the-art in metaphor theory is viewed as primitive (Honeck and Kibler, 1985), with no persuasive evidence favoring
any particular representational format or process. This has been attributed to a lack of detail concerning the precise structure of representation and the process by which an utterance may be comprehended metaphorically as compared to literally.

**Attribute matching theory**

Of the numerous conceptualizations of metaphor comprehension, the attribute matching approach provides a general framework upon which specific theories have been built. Within this framework, a metaphor such as *Life is a game* has three primary components, the topic (life), the vehicle (game), and the ground. Comprehension theories deal with the relationship between the topic and vehicle in terms of their similarity or associative value. The ground is a general term denoting the conceptual relationship that binds the topic and vehicle together.

Precursors of the attribute matching approach include Black's interaction theory (cited in Johnson, 1980), and the comparison theory, usually attributed to Aristotle. Black's interaction theory suggests a "system of associated commonplaces" which provides for the component interactions that allow for a metaphor to be interpreted in a novel, coherent way. The comparison theory assumes that all metaphors are actually latent analogies. Both theories posit the existence of systematic but variable relationships between the topic and vehicle. However, the theories fail to provide a sufficiently detailed account suitable for empirical examination and testing.

A well-articulated explication of the attribute matching process was provided by Ortony (1979). This approach was a modification of work done
by Tversky (1977) concerning the relationships among word attributes. From this approach, the topic and vehicle of a metaphor are each composed of a number of attributes. These attributes vary in salience, and may be rank-ordered along this dimension. Figure 1 shows a possible distribution for the components of a literal statement.

An airplane is a vehicle.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Airplane</th>
<th>Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Means of transport</td>
<td>Means of transport</td>
<td></td>
</tr>
<tr>
<td>Flies</td>
<td>Hangs</td>
<td>Moves</td>
</tr>
<tr>
<td>Has wings</td>
<td></td>
<td>Carries things</td>
</tr>
<tr>
<td>High speed</td>
<td></td>
<td>Transmits</td>
</tr>
<tr>
<td>Covers great distances</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is a thing</td>
<td></td>
<td>Is a thing</td>
</tr>
</tbody>
</table>

Figure 1. Hypothetical distribution of attributes for An airplane is a vehicle

The comprehension of any sentence occurs when attributes from both components overlap. To some extent, the assumption is made that a given word will have a "default" set of attributes which will prevail unless changed by the context in which the word is encountered.

The degree to which a given sentence will be interpreted in a literal or metaphorical sense depends upon the relative salience of the overlapping attributes. In Figure 1, the sentence is interpreted literally because the overlapping attributes share the same degree of salience. A metaphorical interpretation arises when a salient attribute
of the vehicle overlaps with an obscure attribute of the topic. This imbalance of salience across attributes causes the topic to be interpreted in a novel fashion. An example of such a sentence may be found in Figure 2.

**Billboards are warts on the landscape.**

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Salience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billboards</td>
<td>Provide information</td>
</tr>
<tr>
<td>Large</td>
<td>Bothersome</td>
</tr>
<tr>
<td>Colorful</td>
<td>Embarrassing</td>
</tr>
<tr>
<td>Near Highways</td>
<td>Hard to get rid of</td>
</tr>
<tr>
<td>Ruin the countryside</td>
<td>Disease</td>
</tr>
<tr>
<td>Ugly</td>
<td>Round</td>
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<td>.</td>
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</tbody>
</table>

Is a thing

Is a thing

Figure 2. Hypothetical distribution of attributes for **Billboards are warts on the landscape**

The role of extended context is explicated through the concepts of the schema (Ortony, 1979) and the semantic domain (Kelly and Keil, 1984). The attributes for a given component as well as the salience of individual attributes are contained within schemata, which are differentially activated by various contexts. The interpretation of a metaphor involves not only the juxtaposition of topic and vehicle, but also the relationship of the context to the metaphor itself. In a similar fashion, the concept
of a semantic domain contains attributes which allow the vehicle to be effectively mapped onto the topic.

Invoking the schema concept allows for the solution of theoretical problems which were not addressable by other theories. For example, according to Searle (1979), a metaphor must first violate selection restriction rules before an attempt is made at a figurative interpretation. A selection restriction rule is defined as the characteristics of a single lexical entry in an individual's mental lexicon (Traugott and Pratt, 1980). For example, a piece of ribbon is thought to possess the attribute of length because it is a non-rigid object. A statement such as the ribbon is tall violates a selection restriction rule because non-rigid objects do not possess height. In Searle's interpretation, metaphors frequently break these rules because they demand anomalous assignments of lexical entries. However, this theory fails for a sentence such as the old rock became brittle with age, which does not violate any selection restriction rules. The sentence may be interpreted literally in a geological sense, but can also be interpreted metaphorically if it occurs in discourse concerning a professor emeritus. Also, the validity of selection restriction rules becomes dubious when one considers the contexts available in writings of fiction, poetry, and fantasy. As Gibbs (1987) has pointed out, a sentence extracted from The Lord of the Rings ("The tree asked Mervyn to direct it to London.") does not violate any selection restriction rules when context is taken into account, hence individual lexical entries are assignable to
a number of different roles if the surrounding context provides support for the new assignment.

The attribute matching approach has some definite shortcomings in terms of the precise specification of the mechanisms involved in the ordering of attributes within schemata and the dynamic relationship of schemata and context. In addition, not all metaphors come in the "A _____ is a _____" form, which makes the description of schemata and accompanying attributes very difficult. Also, determining the salience of individual attributes is quite difficult (Gibbs, 1987), which weakens the ability of an attribute matching approach to make predictions concerning the comprehensibility of target metaphors.

**Metaphor and context**

The research by Ortony and his colleagues (Ortony, Schallert, Reynolds, and Antos, 1978) was among the first of a series of papers that dealt specifically with the role of extended context in the interpretation of metaphors. Previous studies (Malgady, 1976; Malgady and Johnson, 1976) focused on a unit of discourse that was no larger than the target metaphors themselves. Within this context, an attribute matching approach could be tested by assessing the relationship between the rated quality of target metaphors and the rated degree of similarity found between the topic and vehicle comprising a given metaphor.

An assumption derived from traditional semantic analysis posits that words encountered in a sentence have a default associative relationship. 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 the preexisting relationships between topic-vehicle pairs in metaphors seem to fall somewhere in the middle of the associative strength continuum, with anomalous sentences displaying little associative strength and literal sentences possessing a great deal of component similarity.

Earlier studies (Malgady, 1976; Malgady and Johnson, 1976) revealed that preexisting topic-vehicle similarity was a good predictor of the perceived goodness of metaphors, which is consistent with an attribute matching interpretation. However, McCabe (1983) demonstrated that the predictive strength is found only with similarity judgments drawn from metaphors presented without extended context.

The predictive value of topic-vehicle similarity has been demonstrated to be high or low, depending upon the amount of context taken into account (Marschark, Katz, and Paivio, 1983; McCabe, 1983; Katz, 1982; Glucksberg, Gildea, and Bookin, 1982). These studies, taken in composite, indicate that similarity is strongly correlated with goodness when no context is present, with the addition of context causing a significant decrease in this correlation. Any attribute matching approach must explain the loss of predictive power when such contexts are taken into account. 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 parameters of the minimum amount of context necessary for immediate, automatic metaphor comprehension. Their experiments involved the use of
contextual priming, in which a target item is immediately preceded by a context which can be from a sentence to a paragraph in length. They employed three types of contextual primes that resulted in the; 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 (in the order listed above) are 1) "some people are cold," 2) "some winters are cold," and 3) "it was a warm day." Subjects were presented metaphor and literal target statements preceded by either a unrelated, metaphorical, or literal prime and were instructed to categorize the targets as being true or false. It was found that all three primes induced reaction times faster than unprimed control targets.

These results suggest that the attribute matching (or the semantic domain) approach needs to address the dynamic character of discourse comprehension. Stimulus items which are only a word or sentence in length should be replaced by longer sections of discourse in order to more closely approximate daily language usage. It is possible that the ongoing task of comprehension requires the constant shifting of attributes in accord with the current verbal, visual, and cultural context in which the perceiver is located. Therefore, in verbal discourse, the individual words need not have any fixed set of attributes, nor are preexisting degrees of salience for the attributes necessary for comprehension.

Using the same prime types as Gildea and Glucksberg (1983), Shinjo and Myers (1987) produced results confirming the effectiveness of the
primes in the absence of additional, extended context. This led to agreement concerning one of the central points made by Gildea and Glucksberg (1983); "...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). The central debate concerning the psychological reality of a processing difference for the comprehension of literal and metaphorical language is discussed in a later section.

If the processing of metaphors and ambiguous literal sentences requires context to constrain the possible interpretations, the point at which context exerts its influence is not clear. It is possible that presentation of a word automatically activates all of the attributes associated with it, with context then limiting the appropriate attributes used in discourse interpretation (Onifer and Swinney, 1981). On the other hand, context may restrict which attributes may be active in an ongoing matter, with only those select attributes receiving activation (Marlsen-Wilson and Welsh, 1978; Simpson, 1981). The incorporation of attribute matching theories into spreading activation or parallel distributed processing models will necessitate a resolution of this issue.

**Attribute matching and semantic network theory**

The attribute matching theories outlined in earlier expositions of metaphor processing relied on the overlap of features from the topic and vehicle. As was previously suggested, a given word is defined as a set of features, or attributes, that vary in salience. One problem with earlier models is the absence of a precise mechanism that would allow for the
prediction and explanation of experimental findings. The spreading activation theory of semantic memory as outlined by Collins and Loftus (1975) provides a detailed model which may account for some aspects of metaphor processing. Within this framework, the meaning of an individual concept is contained within a node or group of nodes in a network. The node for the concept "dog", for example, is linked to other nodes that supply relational and identification information. The notion of associative strength or similarity is identified by the distances and strengths of connections between nodes. Strongly associated nodes are found in close proximity to each other, and the activation of a single node causes the subsequent activation of proximal nodes. As the activation spreads, it dissipates because each node has its own set of connections to many other nodes. The activation pattern "fans out" so that distally connected nodes are weakly activated, and nodes with no relation to the originally activated site are not affected.

When multiple nodes are activated simultaneously (as would happen in discourse), their activation spreads in such a way that an intersection of activation occurs if the concepts are related. This intersection is evaluated in terms of syntactical and contextual constraints, and processing continues as further nodes are activated. As Collins and Loftus (1975) note, any featural model may be represented as a network, thus the featural models invoked in earlier metaphor theories may be reinterpreted within a network framework. In such a reinterpretation, the topic and vehicle of a metaphor each consist of one node, with closely related attributes being clustered around each node. When a metaphor is
processed, spreading activation occurs to the extent that salient pathways between such nodes intersect. Thus a metaphor is interpreted according to the net activation pattern it produces, which is influenced by contextual constraints.

**Priming as a measure of associative strength**

As was mentioned earlier, the activation of a node causes nearby nodes to become temporarily activated. This activation decays over a short period of time and with the activation of other nodes. Immediately after such activation, further activation of related nodes occurs more rapidly. This phenomenon, known as associative priming, was demonstrated by Meyer and Schvaneveldt (1971) in the context of the lexical decision task. In this task, subjects view a letter string which is followed in time by another letter string. The subject must decide as quickly as possible whether or not the second letter string is an actual English word. Typically, a word is responded to more quickly if it is preceded by a semantically associated prime than if it is preceded by an unrelated prime. The reaction time advantage for related primes is due to the fact that the pathways for activation of each string have been partially activated. Hence, search time for the target is decreased. In light of these facts, the lexical decision task is considered an indirect measure of associative strength.

**The distinction between metaphorical and literal processing**

In order to address metaphor processing theoretically, it is necessary to establish differences between literal and metaphorical processing. This distinction, however, runs into problems in the face of
current empirical research. The distinction between literal and
metaphorical language use has been clearly outlined since the time of
Aristotle, and has served an important role in rhetoric and literary
review (criticism). Unfortunately, it appears that this distinction has
slipped into the thinking of linguists and psychologists in such a way
that two separate mechanisms are invoked to explain the processing of
metaphorical and figurative utterances.

The reason for this is unclear, but the literature abounds with dual
process explanations for language processing. Prime examples are Searle
(1979), and Clark and Lucy (1975) which state that processing for
figurative or indirect meaning occurs only after a primary, literal
interpretation fails. Such theories lead to the prediction that metaphors
should take longer to process than literal statements of comparable
length. However, recent research on this issue has revealed that target
metaphors demand no extra processing time than literal statements as long
as the metaphors are accompanied by sentential contexts that provide
interpretive guidance (Ortony et al., 1978; Inhoff, Lima, and Carrol,
1984). Also, Pollio and his colleagues have reported (Pollio, Fabrizi,
Sills, and Smith, 1984) that subjects classify sentences as metaphors with
equal speed as compared to literal statements, showing that metaphor
comprehension is not a derivative process. Metaphors are evidently
perceived immediately and unavoidably (Glucksberg, Gildea, and Bookin,
1982), without the inclusion of a secondary, figurative interpretation
process.
With other figures of speech, Kemper (1981) as well as Swinney and Cutler (1979) have found that idioms take less time to process than their literal counterparts. However, the question remains as to whether or not metaphorical and literal interpretation involve exclusive psychological processes. Any findings which reveal longer processing time for metaphors might be explained through a multi-stage process, as proposed by Searle (1979). However, the primary determinant of such processing time may not be the metaphorical or literal nature of the sentence, but may instead be the amount of ambiguity that must be resolved to allow for proper interpretation. Hence, a finding that isolated metaphors take longer to process than literal sentences may result from the fact that metaphors may simply possess a greater degree of ambiguity than literal sentences.

Throughout this dissertation, the processes to be examined are held to be general in nature, and not restricted to the processing of metaphors alone. This may be in conflict with intuitive approaches to language comprehension, but it is in accord with the literature, which shows no reason to postulate separate processors for metaphorical and literal targets. As Rumelhart (1979) mentioned, discriminating between the metaphorical and literal may be on the same level as separating formal and informal discourse; we seem to be able to reliably label such discourse, yet there is not a phenomenal nor an empirical need to postulate separate formal and informal language processors.

A closer inspection of Rumelhart's (1979) argument reveals a possible explanation for the popularity of dual process (figurative/literal) comprehension models. Traditional approaches to semantics, such as the
one provided by Katz and Fodor (1963), find the meaning of a sentence to be the result of the combination of individual lexemes in accordance with rules of composition. Similarly, the overall meaning of a particular discourse is derived from the combination of individual sentences.

This process may be categorized as being "bottom-up" due to the fact that comprehension is the result of the linear combination of atomic units (lexemes for sentences, sentences for discourse). Such an account provides an acontextual basis for comprehension, meaning that the process involved provides only for the literal interpretation of discourse. This presents problems when the intended meaning of the speaker is embodied in a sentence which may be interpreted in numerous ways, such as, "must you leave the window open" which may be a question or an assertion that the room is too drafty.

In a similar fashion, the processing of figurative utterances within this bottom-up framework is problematic, because the lexemes within a given metaphor must either 1) be "figurative" as opposed to "literal", or 2) violate rules of composition so as to force an alternate interpretation. The latter option is not supported by the literature (Ortony et al., 1978; Inhoff, Lima, and Carrol, 1984) and the former is not supported by traditional semantic analysis (Katz and Fodor, 1963) i.e., there are no "figurative" or "literal" lexemes.

Purpose and general method

The purpose of this dissertation is to shed light on the dynamic processes involved in the proposed shift that occurs in the similarity of topic-vehicle components when comprehending metaphors. It has been shown
in previous sections that research in metaphor comprehension has progressed from acontextual approaches (Malgady and Johnson, 1976) to approaches which deal specifically with context effects (McCabe, 1983; Ortony et al, 1978).

A study by Camac and Glucksberg (1984) clearly demonstrated the dynamic nature of metaphor comprehension. In this study, subjects were required to perform a lexical decision task with 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. In this case, the strings are presented to the left and right of a central fixation point. A "yes" response is required if both strings constitute acceptable English words, while a "no" response is required if either or both of the strings are nonwords.

The lexical decision task is known to be sensitive to the associative strength of positive string pairs (Meyer and Schvaneveldt, 1971), with highly associated pairs eliciting a quicker lexical decision and subject response than unrelated pairs. Camac and Glucksberg (1984) used this task to index the amount of similarity (in terms of associative strength) found among topic-vehicle pairs drawn from apt metaphors. They asserted that metaphors do not require preexisting associations in order to be interpreted, rather, the interpretation process forces a new set of associations to be created.

Specifically, their study employed two sets of stimulus materials. 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 a different vehicle. The other set consisted of a list of highly associated word pairs along with an accompanying list of their scrambled counterparts. Camac and Glucksberg predicted that reaction times for lexical decisions of the highly associated pairs should be faster than those for their scrambled counterparts, which is the typical result for such a task (Meyer and Schvaneveldt, 1971). If metaphor comprehension relies upon the preexisting associative strength of the topic and vehicle, then components drawn from apt metaphors should show a similar reaction time (RT) advantage over their scrambled counterparts. Since Camac and Glucksberg did not believe preexisting similarity was an important factor in comprehension, they anticipated no such latency advantage would be found.

The results were consistent with their predictions. The metaphor pairs showed no significant latency advantage over their scrambled counterparts, while the associate pairs were responded to much more quickly than their scrambled counterparts. Hence, to the extent that the lexical decision task is an accurate measure of associative strength, Camac and Glucksberg provide evidence that preexisting similarity is not an important factor in metaphor comprehension.

However, this evidence only supports half of their claim, the one which asserts that preexisting associative strength is not an important factor in metaphor comprehension. Their study does not address the other half of the issue, i.e., metaphor comprehension might require the dynamic rearrangement of the topic-vehicle associative strength. Given that the
technique described above provides a sensitive measure of associative strength, a latency advantage in lexical decisions should be found for topic-vehicle pairs drawn from sentences that were interpreted metaphorically immediately prior to the subject's decision.

An important aspect of the Camac and Glucksberg study is that subjects saw only letter string pairs, hence comprehension of complete literal or metaphorical sentences was never required. In order to more rigorously test the claim that new associations result from metaphor comprehension, subjects should first be forced to make metaphorical interpretations, and then be tested for residual associative influence.

The experiments conducted herein were designed to investigate two issues; 1) the replicability of the Camac and Glucksberg (1984) results and 2) an extension of their work which addresses the dynamic aspects of metaphor comprehension. In the present study, Experiment 1 was a replication of the original Camac and Glucksberg work, with materials and procedures reproduced as faithfully as possible.

Experiment 2 addressed a possible confound encountered in the original Camac and Glucksberg (1984) study. Specifically, when their metaphor and associate lists are examined in terms of printed frequency (Kucera and Francis, 1967), the mean printed frequency for the metaphor pairs was far less (42 per million) than that of the associate pairs (94 per million). Hence, the fact that Camac and Glucksberg found no lexical decision advantage for the metaphor pairs over their scrambled counterparts may be due to the relative infrequency of the words comprising these pairs rather than their metaphorical origin.
To address this problem, Experiment 2 employed a new set of metaphor pairs that were more closely matched to the associate pairs in terms of frequency of occurrence. Camac and Glucksberg's (1984) contention that preexisting similarity is not an important comprehension factor will be supported if Experiment 2 yields results virtually the same as those of Experiment 1.

Experiment 3 attempted to detect the shift in associative value that might take place if metaphor comprehension actually involves the restructuring of association values. In this experiment, subjects were required to judge the lexical status of letter string pairs immediately after the pairs were encountered in a literal or a metaphorical context. In Experiment 3, two types of context served to prime the letter string pairs in qualitatively different ways. For metaphorical contexts, the string pair was embedded in a metaphor which was easily interpreted when context was taken into account. The literal contexts served as a control condition, allowing the letter string pairs to be encountered before lexical status was determined. This arrangement controlled for the possibility that merely seeing the target pair twice would decrease the lexical decision latency (word repetition effect). If the process of interpreting a metaphor causes an increase in the amount of association of the topic and vehicle, the metaphorically primed strings should show a consistent latency advantage over their literal counterparts. Conversely, if associational values are not altered during metaphor processing, no latency advantage should be found.
Experiment 1

Method

Subjects. Twenty Iowa State University undergraduates served as subjects in return for class credit. All subjects spoke English as their native language, and had not previously participated in any of the other lexical decision experiments outlined in this dissertation.

Stimulus Materials. In Experiment 1, subjects were required to perform a lexical decision task. Therefore, the stimulus materials (listed below) were 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 drawn from Camac and Glucksberg (1984). These pairs were found to be as easily understood as metaphors relative to their randomly scrambled counterparts (below).
2. Forty-eight Scrambled Metaphor pairs, which were merely randomly paired words derived from the Metaphor pair list. Scrambled Metaphors were not themselves readily interpreted in a metaphorical sense.
3. Forty-eight Standard Associates drawn from the Camac and Glucksberg (1984) study. These were word pairs derived from word association norms developed by Palermo and Jenkins (1964), and Postman and Keppel (1970).
4. Forty-eight Scrambled Associates, which were randomly repaired words from the Standard Associate list.
The mean reported length for the Metaphor words was 6 letters, ranging from 4 to 10, with a mean printed frequency of 42 per million, and ranging from 1 to 289 per million (Kucera and Francis, 1967). For the Standard Associates, the mean length was 5 letters, ranging from 3 to 9 letters, with an average printed frequency of 94 million, and ranging from 1 to 847 per million. A list of the positive response pairs may be found in Appendix A.

Three types of negative response pairs were used in this study:

1. Nonword-Nonword (e.g., pilg-durcept)
2. Word-Nonword (e.g., closet-pobeld)
3. Nonword-Word (e.g., gration-desk)

The negative response pairs were 4-6 letters in length and pronounceable, as in the Camac and Glucksberg (1984) study.

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. Half of the subjects saw only List 1, while the other half saw only List 2.

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 one time. For lists 1 and 2, each had Metaphor and Associate pairs along with their scrambled counterparts. To avoid repetition, the scrambled pairs from List 1 were switched with those
in List 2. This allowed each subject to see every type of string pair without repetition.

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 pair types (i.e., 12 positive and 12 negative response types). A different randomized block order was used for each subject, and within each block, stimulus items were randomized for each subject.

A practice list was constructed containing 36 items; 9 Associate pairs, 9 Scrambled Associate pairs, and 6 of each of the three Nonword pair types described above. In addition, each 96 item sublist was preceded by 14 warm-up items, consisting of two trials of each pair type.

**Procedure and Design.** Each subject was seated in front of an Apple II microcomputer, with the center of the CRT being at eye-level. The microcomputer was equipped with a clock card 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 which finger was 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 occur only if both 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 point 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 the fixation point, and the subject was required to make his/her 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 point which marked the beginning of the next trial. After the practice list was completed, subjects were asked if they needed any clarification concerning the experimental task. After the first block of 96-pairs, the subjects were allowed a brief rest period.

In summary, the design of the study is a 2 X 2 X 2 mixed design, with Word Type (Associate vs. Metaphor) and Pair Relation (Related vs. Scrambled) as within-subjects factors, and List (List 1 and List 2) as a between-subjects factor.

**Results**

Means RTs for each trial type were computed for the correct responses, with RTs less than 250 msec or greater than 4000 msec being discarded from the data set (these were considered to be errors). The average error rate for Experiment 1 was less than eight percent across subjects. As in the Camac and Glucksberg (1984) study, responses to
nonword stimuli were treated as filler items, and hence were not included in the analysis. A preliminary 2 X 2 X 2 analysis of variance (ANOVA) was conducted on these RT data. This analysis revealed no significant main effect for List, nor did the List factor interact with the Pair Relation factor (related vs. scrambled), or the Type factor (Associate vs. Metaphor). Consequently, the data were collapsed across Lists and analyzed using a 2 X 2 (Pair Relation X Type) ANOVA. The means for the four trial types are presented in Table 1.

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

<table>
<thead>
<tr>
<th>Word Type</th>
<th>Related</th>
<th>Scrambled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metaphor</td>
<td>1110 (198)</td>
<td>1118 (179)</td>
</tr>
<tr>
<td>Associate</td>
<td>870 (131)</td>
<td>960 (159)</td>
</tr>
</tbody>
</table>

In general, the related pairs yielded faster RTs than scrambled pairs ($F (1, 19) = 27.76, p < .001$), while associate pairs and their counterparts yielded faster RTs than the metaphor pairs and their scrambled counterparts ($F (1,19) = 126.20, p < .001$).

The critical comparison in Experiment 1 involves the RT facilitation found between the associate pairs and their corresponding scrambled pairs, as contrasted with the metaphor pairs and their scrambles. The analysis
revealed a significant Relation Type X Word Type interaction ($F\ (1,19) = 16.67, P < .001$). A resultant comparison of ordered means using Duncan's multiple-range test (alpha = .05) showed that the associate pairs were responded to more quickly than their scrambled counterparts, while the metaphor pairs showed no such lexical decision advantage over their scrambles.

**Discussion**

Experiment 1 was essentially a replication of the Camac and Glucksberg (1984) study. The critical comparison in both studies involved the contrast between associates and their scrambles, as compared to metaphors and their scrambles. Both studies found reliable facilitation (in terms of processing) for the associates over their scrambles while no such facilitation was found for the metaphor counterparts over their scrambles. The replicability of this effect lends support to the contention that components drawn from apt metaphors do not require a high degree of preexisting associative strength in order to be comprehended. In terms of attribute matching theory, this suggests the juxtaposition of topic and vehicle attributes occurs as a dynamic process which is influenced by the current cultural, social, and conversational context as opposed to a static process involving the mere matching of preexisting, acontextual attributes.

Camac and Glucksberg (1984) did not interpret their data as disconfirming evidence of attribute matching theory in general. Rather, they argue that metaphors, as well as all other types of language, are meant to convey information and therefore the listener actively (not
necessarily consciously) attempts to match vehicle attributes to the topic that are congruent with the current context. The process of metaphor comprehension involves the disambiguation of the overlap of attributes between the topic and vehicle, a process which relies heavily on surrounding sentential context. Earlier studies (e.g., Malgady and Johnson, 1976; McCabe 1983) found a strong correlation between topic-vehicle similarity and perceived metaphor goodness, but this holds only for metaphors presented out of context. Apparently, individuals must rely on preexisting associative strength if additional contextual support is not present for the disambiguation of the sentence.

One other effect of importance found in Experiment 1 was the overall RT advantage for associates and their scrambles over metaphors and their scrambled counterparts. The Camac and Glucksberg study yielded this same result, which they explained by pointing to the difference between the mean printed frequency of the metaphor and associate lists. This explanation is reasonable if one assumes that words that are encountered relatively infrequently might take longer to process than common words. Another contributor to the observed pattern may be the mean length of the items, with longer stimulus items requiring more time to scan and encode. (In Experiment 1, the metaphor list had a mean word length of 6.33 (SD = 1.65), while the associate list had a mean word length of 5.10 (SD = 1.30).)
Experiment 2

Experiment 1 was a successful replication of the Camac and Glucksberg (1984) study using identical stimulus materials. As was pointed out earlier, however, it is difficult to determine the reason for the observed effect, due to the presence of differing printed frequencies for the metaphor and associate lists. This potential confound is dealt with in Experiment 2, which employs lists of both stimulus types with comparable mean printed frequencies.

Method

Subjects. Twenty Iowa State University undergraduates served as subjects in return for class credit. As in Experiment 1, all subjects in Experiment 2 spoke English as their native language, and had not previously participated in the lexical decision experiments outlined in this dissertation.

Stimulus Materials. Generation of stimulus materials for Experiment 2 was identical to that of Experiment 1, with one important exception. The set of Metaphor pairs in Experiment 2 (and hence their scrambled counterparts) were replaced by a set that was of a mean rated printed frequency (Kucera and Francis, 1967) that approximated the mean rated printed frequency of the Associates.

In order for a new set to be generated, a pilot group of 15 subjects was asked to rate the aptness of a set of metaphors. From the 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 lessen the difference in printed frequency.
and word length between the trial types groups. The resultant stimulus set (see Appendix B for a listing) 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). The mean word length for the metaphor and associate lists were 6.61 (SD = 2.12) and 5.62 (SD = 1.48) letters, respectively. The formation and blocking of List 1 and List 2 were identical to that of Experiment 1. Each subject made lexical decisions for a total of 192 pairs.

Procedure and Design. Procedurally, this experiment was identical to Experiment 1. The design is again a 2 X 2 X 2 mixed design, with Word Type (Associate vs. Metaphor) and Relation Type (Related vs. Scrambled) as within-subjects factors, and List (List 1 and List 2) as a between-subjects factor.

Results

Means for each pair type were computed for correct responses. As in Experiment 1, RTs less than 250 msec or greater than 4000 msec were discarded as errors, with the average error rate being less than 9 percent across subjects. Responses to nonword stimuli were treated as filler items and were also not included in the analysis. A preliminary 2 X 2 X 2 (ANOVA) was conducted using the mean RT data for each subject. The between-subjects factor (List 1 vs. List 2) did not display a main effect ($F_{1,18} = 1.17, p = .294$), however List did interact with Relation Type ($F_{1,18} = 6.10, p = .022$) and displayed a marginally reliable three-way interaction with the Relation Type and Word Type factors ($F_{1,18} = 3.745, p = .066$). Consequently, List 1 and List 2 were analyzed independently in
two separate 2 X 2 (Pair Relation X Type) ANOVAs. The means for the four trial pair types for List 1 are presented in Table 2.

Table 2. Mean Reaction Times (in msec) for the Four Trial Pair Types of Experiment 2, List 1 (Standard Deviations in Parentheses)

<table>
<thead>
<tr>
<th>Pair Relation Type</th>
<th>Word Type</th>
<th>Related</th>
<th>Scrambled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metaphor</td>
<td>996 (135)</td>
<td>993 (119)</td>
</tr>
<tr>
<td></td>
<td>Associate</td>
<td>942 (96)</td>
<td>906 (108)</td>
</tr>
</tbody>
</table>

For List 1, in general, lexical decisions for related pairs yielded faster RTs than those involving scrambled word pairs ($F(1, 9) = 6.75, p = .027$). Lexical decisions for associate pairs yielded faster RTs than the metaphor pairs ($F(1,9) = 65.03, p < .001$).

As in Experiment 1, the critical comparison in Experiment 2 involves the RT facilitation found between the associate pairs and their scrambled counterparts, as contrasted to the metaphor pairs and their scrambles. The analysis revealed a significant Relation Type X Word Type interaction ($F(1,9) = 8.38, p = .017$). The resultant comparison of means using Duncan's multiple-range test (alpha = .05) showed that the associate pairs were responded to more quickly than their scrambled counterparts, while the metaphor pairs showed no such RT advantage over their scrambled
counterparts. The means for the four trial types for List 2 are presented in Table 3.

Table 3. Mean Reaction Times (in Msec) for the Four Trial Types of Experiment 2, List 2 (Standard Deviations in Parentheses)

<table>
<thead>
<tr>
<th>Pair Relation Type</th>
<th>Word Type</th>
<th>Related</th>
<th>Scrambled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metaphor</td>
<td>1047 (135)</td>
<td>1051 (119)</td>
<td></td>
</tr>
<tr>
<td>Associate</td>
<td>868 (96)</td>
<td>1028 (108)</td>
<td></td>
</tr>
</tbody>
</table>

The means of List 2 show a similar pattern to those of List 1, except the differences are somewhat more pronounced. Again, the related pairs yielded faster RTs than scrambled pairs ($F_{(1,9)} = 23.62, p = .001$). Also, associate pairs yielded faster RTs than the metaphor pairs ($F_{(1,9)} = 39.91, p < .001$). The analysis also revealed a significant Relation Type X Word Type interaction ($F_{(1,9)} = 16.31, p = .003$). The resultant comparison of means using Duncan's multiple-range test (alpha = .05) showed that the associate pairs were responded to more quickly than their scrambled counterparts, while the metaphor pairs showed no such RT advantage. Thus, the overall Relation Type X Word Type interaction reflects a larger difference between the associate and scrambled pairs of List 2 over the difference of the associate and scrambled pairs of List 1, with the pattern of means being identical.
Discussion

The results of Experiment 2 demonstrate the replicability of the Camac and Glucksberg results using slightly altered stimulus materials. Specifically, the difference between the mean printed frequencies for the associate and metaphor lists was reduced by the selection of high frequency metaphor pairs. Even with comparable printed frequency, known associates show a reliable RT advantage over their scrambled counterparts while metaphors show no such advantage. Thus, the data lend credence to the contention that printed frequency per se was not a direct contributor to the pattern of results found in Experiment 1, nor the original Camac and Glucksberg (1984) study. The absence of a latency advantage for metaphor components in Experiments 1 and 2 again support the contention that preexisting similarity is not a necessary factor in the comprehension of metaphors.

One problematic issue still remains, however, which is the fact that associate pairs and their scrambles yielded faster RTs on average than did the metaphor pairs and their scrambles. Camac and Glucksberg (1984) originally attributed this effect to the difference in printed frequency of the metaphor and associate lists, but this interpretation is no longer tenable in the present experiment, which specifically controlled this variable. One viable explanation for this effect may lie in the mean difference of word length for the two list types. Even though an effort was made to equate the two lists on this factor, the words comprising the metaphor list were slightly longer on average than those comprising the associate list. Hence, it still may be that the observed effect in
Experiment 2 is related to the increased scanning time required for the longer words of the metaphor list.
Experiment 3

In the Camac and Glucksberg (1984) study as well as Experiments 1 and 2, no lexical decision latency advantage was found for components drawn from metaphors over their randomly scrambled counterparts. However, the Camac and Glucksberg study as well as the present experiments provide no experimental evidence for the notion that the processing of a metaphor actually creates new associations that allow for comprehension. In addition, none of these studies required subjects to engage in the processing of complete metaphorical sentences, as only topic-vehicle pairs drawn from apt metaphors were viewed.

Experiment 3 was designed to provide some positive evidence for this dynamic shift in topic-vehicle similarity that is hypothesized to accompany the processing of metaphorical sentences. The primary task in Experiment 3 required subjects to make lexical decisions for topic-vehicle pairs contextually primed by both metaphorical and literal target paragraphs. These pairs were presented immediately after the target paragraph in order to detect any residual effect such processing may entail. If metaphor comprehension results in new associations that are temporarily formed due to the activation of related nodes, they should be detected as a RT advantage for pairs following a metaphorical as compared to a literal interpretation.

Method

Subjects. Forty Iowa State University undergraduates served as subjects in return for class credit. All subjects had English as their
native language, and had not previously participated in the lexical
decision experiments outlined in this dissertation.

**Stimulus Materials.** A stimulus set of 144 items was produced
utilizing some of the materials presented in Experiments 1 and 2. An item
consisted of a three to five sentence paragraph followed by a letter
string pair. Subsequently, the pair was subjected to a lexical decision
identical that described in Experiments 1 and 2.

The 72 paragraphs followed by letter strings requiring a "yes"
response were of two types. The first type consisted of a brief
description of an object or situation in which a metaphorical comparison
was induced. The following is an example of such a paragraph that
accompanies the target metaphor, "History is a 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.

Immediately after the presentation of this paragraph, the letter
string pair "history-clock" was presented in the lexical decision task.
The second paragraph type included a descriptive paragraph in which the
same components were used, but they did not require a metaphorical
interpretation. Consequently, there were 36 strings requiring a "yes"
response, with each string having a complementary literal and a
metaphorical paragraph. Below is an example of the literal counterpart of the above paragraph:

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.

These two types of paragraphs were designed to induce either a metaphorical or literal juxtaposition of the words. Hence, the lexical decision task following each paragraph presentation should be affected by the nature of the biasing paragraph and the subsequent literal or metaphorical interpretation. Such a contextual priming technique has been employed by Ortony et al. (1978), in which it was demonstrated that sentential context can influence the time required to interpret target sentences, with interpretation occurring more quickly for contextual metaphors in contrast to isolated metaphors.

For the 72 string pairs that require a "no" response, paragraphs were constructed that were of the same mean length as the experimental paragraphs. Since subjects saw either List 1 or List 2, 36 paragraphs and letter string pairs were constructed and used for both lists. Care was taken to assure that these paragraphs contained minimal repetitions of the letter strings, since repeated exposure to such target words may inadvertently cause a latency advantage. Half of the paragraphs preceding nonword target strings contained some kind of metaphorical comparison,
while the other half were composed of simple literal statements. The response strings were of the same type as outlined in Experiment 1, i.e., consisting of 24 nonword-nonword pairs, 24 word-nonword pairs, and 24 nonword-word pairs.

The materials were arranged so that a subject responded to equal numbers of "yes" and "no" strings, as well as equal numbers of literal and metaphorical paragraphs. This was accomplished by dividing the 72 positive and 72 negative response items into two lists consisting of 18 literal, 18 figurative, and 36 nonword items each. The division was made so that each list contained target strings for which only the literal or the metaphorical priming paragraphs may be found. In other words, no target string was repeated in a list. In addition to the 36 "yes" items in each list, the "no" items consisted of the following:

<table>
<thead>
<tr>
<th>Literal</th>
<th>Metaphorical</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 word-nonword</td>
<td>6 nonword-word</td>
</tr>
<tr>
<td>6 nonword-word</td>
<td>6 nonword-word</td>
</tr>
<tr>
<td>6 nonword-nonword</td>
<td>6 nonword-nonword</td>
</tr>
</tbody>
</table>

All context paragraphs were constructed so that a number of critical factors remained constant across paragraphs and lists. For paragraphs with metaphorical target sentences, the number of words between the topic and vehicle was kept within a narrow range and was matched for paragraphs containing literal target sentences. Also, the number of words between the last target word and the end of the sentence were matched for both paragraph types. Lists 1 and 2 contained no systematic differences in terms of mean paragraph length nor did they differ in any of the other factors described above.
Procedure and Design. Each subject was seated in front of an Apple II microcomputer, with the center of the CRT at eye-level. The microcomputer was equipped with a clock card to allow for millisecond timing. Before any practice or experimental trials were presented, the word "yes" or "no" was presented randomly in the center of the screen for 20 trials to allow subjects to select the appropriate keys and become familiar with the response setup. A single trial began with the presentation of a context paragraph. The paragraph appeared on the screen and remained there until the subject pressed either response key to signify that he/she was finished reading the paragraph. With the right hand, two 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. Subjects then saw a fixation point in the center of the screen, which was replaced after 2000 msec by the target string. Subjects were instructed to make a lexical decision as quickly as possible. When their key-press was executed, the screen went blank for 2000 msec followed by the start of the next trial which corresponded to the presentation of another context paragraph. Two practice trials preceded the experimental trials. In summary, Experiment 3 consisted of a 2 x 3 mixed design, with List (List 1 vs. List 2) serving as a between subjects factor and Pair Type (literal, metaphorical and nonword) being the within-subjects factor.
Results

Mean RTs for each pair type were computed for the correct responses of each subject, with RTs less than 250 msec or greater than 4000 msec being excluded from the data set. The average error rate across subjects was less than 10 percent. A preliminary 2 X 3 analysis of variance (ANOVA) was conducted. This analysis revealed a significant main effect for Pair Type ($F_{2,76} = 18.95, p < .001$), with the Nonword pairs yielding longer RTs than the Metaphor and Literal pairs, which were not different from each other. The between-subjects factor (List 1 vs. List 2) did not display a main effect ($F_{1,38} = 2.19, p > .144$), however, List 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 for the three word pair types for List 1 and List 2 are presented in Table 4.

Table 4. Mean Reaction Times (in Msec) for the Three Word-Pair Types of Experiment 3, List 1 and List 2 (Standard Deviations in Parentheses)

<table>
<thead>
<tr>
<th>Pair Relation Type</th>
<th>List 1</th>
<th>List 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metaphor</td>
<td>1024 (339)</td>
<td>1069 (309)</td>
</tr>
<tr>
<td>Literal</td>
<td>1164 (416)</td>
<td>936 (199)</td>
</tr>
<tr>
<td>Nonword</td>
<td>1407 (442)</td>
<td>1165 (299)</td>
</tr>
</tbody>
</table>
List 1 displayed a reliable effect for Pair Type ($F_{2,38} = 17.51, p < .001$). A Duncan's multiple range test (alpha = .05) revealed that the pairs following a metaphorical interpretation were responded to most quickly, followed by pairs encountered after a literal interpretation, with nonword pairs requiring the longest time for response. List 2 displayed a different trend, however, with pairs following a literal interpretation yielding the quickest average RT, followed by the metaphor and nonword pairs, which were not reliably different from each other.

**Discussion**

Experiment 3 was an attempt to demonstrate the relationship proposed by Camac and Glucksberg (1984). Specifically, they proposed that the act of interpreting a metaphor actually causes new associations to be formed between the topic and vehicle components. If this is the case, an overall latency advantage for the lexical decision task should have been found for those strings which were preceded by a metaphorical interpretation. Such a latency advantage would support the contention that the process of interpretation involves the temporary adjustment of associative strength between these components.

Experiment 3 yielded mixed results, with List 1 producing the predicted pattern of means. RTs for target pairs preceded by a metaphorical context were indeed judged faster than the same pairs preceded by a literal context. To varying degrees, both the metaphorical and literal pairs exhibited priming effects. For the literal pairs, this priming may be due to simple word repetition effects, while the metaphor pairs may have been affected by both word repetition and the hypothesized
additional facilitation caused by the temporary strengthening of associations due to the metaphorical juxtaposition of topic and vehicle.

The results of List 2 were not in accord with this prediction, however, and their interpretation leads to the examination of a number of factors. One immediate explanation for the differences between List 1 and 2 might be that the lists were somehow different in some systematic fashion. A detailed examination of the lists, however revealed no differences in terms of mean target word length, printed frequency, or paragraph length. Also, since many of the items from Experiment 2 were used as target items in Experiment 3, a RT comparison was done to assure that the metaphorically and literally primed groups had comparable baseline RTs. The means for the available RTs were 1015 msec for the literally primed group and 1050 msec for the metaphorically primed items, respectively. These means were not reliably different ($t(38) = 0.621$, $p = .54$), indicating that an item bias per se was not a contributor to the differences between Lists 1 and 2.

Interestingly, mean RT for nonword pairs was 1165 msec for List 2, which is 242 msec less than the nonword pairs of List 1. This result is puzzling because the nonword paragraphs, target sentences, and target strings were exactly the same for the two lists. This suggests that the subject populations may have been different in some regard, in spite of the fact that they were assigned randomly. However, examination of the error data revealed no significant differences among subjects' performance on the lists, as the List 1 and 2 percentages for correct responses were 91% and 93%, respectively.
Perhaps the lexical decision task lacks the sensitivity needed to detect temporary changes in associative strength induced by previously read context. It is possible that such activation decays rapidly between the presentation of the context paragraph and the presentation of the target letter strings. Thus, the temporary activation caused by the interpretive process may not be detectable by lexical decision task because the temporal parameters of the task are too long to detect a rapidly changing pattern of activation. The differing outcomes for each list casts some doubt on the reliability of the trend found in List 1. It is not possible with the present data set to determine which list is showing the true state if affairs.
General Discussion

The three experiments conducted here shed light on the underlying processes used in the comprehension of metaphor. 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 associated pairs. Experiment 2 provided evidence discounting differences in mean printed frequency as a contributing factor, and Experiment 3 provided mixed support for the contention that the processing of a metaphor causes the formation of new, temporary associations. In terms of the theoretical aspects of metaphor comprehension, the present experiments, along with others dealing with context effects, suggest that the comprehension process is dynamic and flexible, rather than a simple enumeration and juxtaposition of topic and vehicle attributes. At a given moment, the perceiver is influenced by a number of internal and external variables which all contribute to the interpretation of figurative discourse.

When interpreted in terms of spreading activation theory, the processing of a metaphor involves the activation of nodes in a network which correspond to the topic and vehicle. Current context greatly influences the dynamics of the activation process by increasing the activation of nodes relevant to the intended metaphorical interpretation. There is not a simple qualitative distinction to be made concerning the way a network processes figurative or literal utterances. Figurative utterances seem to benefit more from contextual support (see Ortony et
al., 1978) than literal utterances because they possess a greater degree of ambiguity. In fact, some sentences may be interpreted both literally and figuratively depending upon the context in which they occur. Metaphors seem to temporarily strengthen the activation between nodes that are rarely activated in the description of a literal concept. The figurative quality of a sentence, therefore, is not contained in the structure or semantic content of the sentence alone; rather only when context is included may the intended interpretation of a sentence be determined.

The present experiments also indicate that stimulus materials used in the laboratory should approximate normal discourse to as great an extent as possible. Experiments 1 and 2 utilized materials which consisted of only the topic-vehicle pairs drawn from apt metaphors. Since no context (not even the length of a sentence) was provided, the lexical decisions were based on whatever context the laboratory provided and the current mental state of the subject. Otherwise, the lexical decisions were based on the acontextual activation of nodes. If the comprehension of a metaphor involves the reduction of ambiguity, the presence of context is a vital component whose contribution should be carefully assessed. Experiment 3 provided partial evidence for the contention that the presence of context, even as little as the target metaphor itself, can temporarily influence nodal activation so that usually disparate concepts are activated. Thus the act of interpreting a metaphor allows for context to influence its processing by requiring the resolution of ambiguity. The subject can rely on extended context when provided, but when confronted
with isolated metaphors, the subject must provide his/her own interpretive context. Extended context exerts a gradual, global priming effect which selectively activates areas of a network that allow for the intersections of topic-vehicle activation to take place.

**Metaphor processing and parallel distributed processing**

In the elucidation of metaphor comprehension, the characteristics of the cognitive representation(s) for such processes has been a critical defining aspect. This paper has briefly outlined the attribute matching (featural) and spreading activation (network) models and their relationship to metaphor comprehension. Parallel distributed processing (PDP) is a relatively new approach which is actually a set of connectionist models that deal with various cognitive processes (Rumelhart and McClelland, 1986; McClelland and Rumelhart, 1986). On one important point, PDP models differ from network models on the issue of representational format, with PDP models stressing the distribution of a concept over many processing units instead of being contained as a local, unitary entity, as is found in most network models. In the PDP framework, information is distributed over a large matrix of interconnected points. Unlike the network model, each connection point does not contain information per se, but information is contained in the connections between points in the form of strength weightings. Thus, the location of a given concept can not be directly determined, rather, it can only be inferred from the output (or behavior) of the information matrix.

As inputs are received by the matrix, the weights between connections are adjusted via a **learning rule** which differs according to the purpose of
the matrix. For example, a matrix designed to make simple perceptual matches receives a pattern of input activation which is processed into an output activation pattern. In the learning phase, this output is compared to the original input pattern. Early in learning, the matrix will only provide a rough approximation to the desired output, so the learning rule essentially compares the actual output to the desired output and adjusts the weights in the matrix to more closely match the desired output. After a number of learning cycles, the network arrives at a stable state where a given input produces the desired output. One of the powerful aspects of this system concerns the ability of a single weight matrix to contain the information for a number of discrete patterns, making it an economical storage medium. Another aspect of such matrices is termed graceful degradation, which refers to the ability of a matrix to produce the correct output even if the portion of a matrix is removed. Network models do not display this characteristic, for the removal of localized information is irreplaceable by other nodes in the network.

A general model of semantic memory has not yet been formulated using the PDP framework, but it is possible to briefly sketch some aspects of PDP which make it readily applicable to metaphor processing. In a hypothetical PDP semantic network, the input of discourse serves to 1) activate input units relative to appropriate discourse and 2) constrain the possible interpretation of the discourse. Activation occurs as various elements of discourse impinge upon the receiving network. The constraints on interpretation are provided by the individual words and by the general context. As discourse proceeds, the activation state of the
network biases the possible interpretation of subsequent input so that potential ambiguities are resolved concerning the intended meaning of the speaker. A network will fail to make a proper interpretation only if the preceding context provides an insufficient number of constraints to allow for a given interpretation to be selected. In such a case, the network may vacillate among two or more interpretations, hence the meaning of the discourse would be unclear.

When discourse comprehension is viewed as a case of constraint satisfaction, the concept of discrete metaphorical or literal meanings becomes blurred. The process of comprehension becomes heavily dependent upon the resolution (or constraint) of ambiguity. A given word can be described as having a constellation of meanings that are constrained by the words surrounding it in discourse and the intentions of the speaker and listener. Thus the processing of what are ostensively referred to as metaphors is not qualitatively different than processing of ostensively defined literal statements.

Within the PDP framework, the concept of semantic priming is retained in a slightly modified form from its implementation in spreading activation models. In a PDP matrix, the activation of pathways quickly decays as a function of a pre-defined constant. Before this level decays to zero, additional excitation from related concepts combines with existing activation to increase the overall level. This increases the likelihood for the output of the item, and since less time is required for the buildup of activation, this is revealed as a decrease in RT for primed items.
The present experiments are interpretable from a PDP perspective, with Experiments 1 and 2 demonstrating the pattern of activation achieved when isolated components are presented. Associate pairs yield a faster lexical decision time than randomly paired words because of the buildup of excitation described above. The lack of a RT advantage for the metaphor pairs relates to the fact that the topic and vehicle have no degree of prior relatedness in the matrix; the activation of one concept (the topic) has little or no influence on the activation of the other concept (the vehicle).

The addition of context in Experiment 3 selectively activates or accentuates aspects of the topic that relate to the vehicle. By the time the metaphorical sentence is actually encountered, the context has established a temporary relationship among the topic and vehicle through the activation of intermediately related concepts. This explanation is similar in its general form to that provided for the spreading activation model. However, the distributed nature of PDP representations is better suited to handle the many nuances of meaning that would prove to be cumbersome in a spreading activation (featural) model.

The advancements in PDP theory, as well as other approaches to language comprehension must be able to accommodate the flexibility of cognitive processing by specifying representational frameworks that are malleable when influenced by context. PDP offers a format which promises such flexibility, as well as provides a computational framework which may be used in the simulation of such processes as metaphor comprehension. Further research into metaphor comprehension using the PDP approach has
the potential to shift the way we view metaphor use in particular, and
type of processing in general.
Concluding Remarks

The study of metaphor processing may be approached from many different orientations. This dissertation demonstrates the application of cognitive psychology to understand a process that is somewhat ill-defined. Such an interdisciplinary approach brings a clearer conceptualization of the process of metaphor comprehension. In this case, metaphor processing has been shown to be amenable to the application of the lexical decision task. Experiments 1 and 2 revealed the applicability of this task, and it was found that the preexisting similarity of the topic and vehicle of a metaphor does not play a large role in the comprehension process. Experiment 3 provided partial evidence for the shift in associative strength that must temporarily take place in order to comprehend a metaphor.

Future studies should be undertaken to elucidate the dynamic nature of the comprehension process. Techniques such as the lexical decision task should be employed to provide for an accurate, indirect measure of associative strength. The area of metaphor comprehension is relatively unexplored compared to the realm of literal usage, but the potential contributions of the study of metaphor comprehension should not be undervalued.
References


Acknowledgments

I am indebted to Dr. Michael W. O'Boyle for his involvement in the substance and style of this dissertation. His assistance in the formulation of the theoretical and procedural aspects of this work is greatly appreciated. Special thanks also go to Dr. Veronica J. Dark for her comments on the theoretical aspects of this work, as well as her assistance with the use of microcomputers for the collection and analysis of data. The involvement of my committee members, Drs. Thomas Andre, Lloyd L. Avant, Donald H. Schuster, and Horabail Venkatagiri is greatly appreciated.

The experiments outlined in this dissertation were reviewed and approved by the Human Subjects Committee of Iowa State University.
Appendix A:
Stimulus Materials for Experiment 1

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Appendix B:
Stimulus Materials
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Appendix C:
Contexts and Target Metaphors
for Experiment 3

For the following materials, the target string used in each lexical decision task is listed next to the numeral. The context paragraph is then listed. For paragraphs that were used for both the literal and metaphorical interpretations, the root of the paragraph is followed by the metaphorical target sentence and then by the literal target sentence. In cases where separate paragraphs were constructed for each condition, the metaphorical context with target is followed by the literal context with target. For the nonword targets, identical context paragraphs were used in the two lists.

1) 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.

Even though the clock ticks onward, history is an important subject which must not be neglected.
2) Schools-Zoos
Especially in the larger cities, attending or teaching classes is becoming a dangerous affair. With the problems of drug abuse and broken families, some of today's youth are not well suited to the discipline involved in learning.

Increasingly, schools are zoos full of dangerous and unpredictable inhabitants.

It seems to make little difference whether or not a child spends his/her time in schools, zoos, or shopping malls; they all offer about the same quality of instruction.

3) President-Actor
The highest elected office in America is usually held by a person who is very skillful at projecting a popular image to the people. This may be true even at the expense of being clear and forthright on important issues. In this age of intense media coverage, looking good is extremely important.

A president is an actor in terms of getting and keeping the job.

It is not uncommon for a president to hire an actor or some other celebrity to promote his/her cause.
4) Language-River
Most people take our ability to communicate for granted. This ability seems to be second-nature, but few realize what a complex accomplishment a simple conversation is. Our thoughts flow easily from one person to another, only when this flow is disrupted do we realize the complexity involved in communicating.

Language is a river upon which our thoughts flow to others.

Even a trip down the length of the Mississippi River will reveal the language differences at both ends.

5) Crowd-Forest
At any large gathering or social event, a large number of people may find themselves located in a small space. Navigating through such a situation may be a little tricky, for one might have to take some detours to get where he/she wants to go. Also the possibility of getting lost is great because so many people are difficult to see around.

A crowd is a forest of people which must be approached skillfully and patiently.

Many people prefer the serenity of a forest rather than a crowd with all of its trivial distractions.
6) Gun-Insurance

One of the major controversies brewing today concerns the right of an individual to own and use a weapon. With the amount of violent and gang-related crime on the increase, it has become more difficult for metropolitan police forces to maintain law and order.

Many people think that a gun is insurance against personal loss and injury.

Owning a gun can increase insurance rates for liability and personal medical coverage.

7) Loneliness-Island

Even in our contemporary, hi-tech world with instant communication and easy transportation, most people find that they are by themselves some of the time. The availability of easy communication does not automatically give people interesting things to talk about.

Loneliness is an island from which escape is difficult, but not impossible.

If stranded on an island with others, loneliness may still result if you are not compatible with the group.
8) Wednesday-Hilltop

The average work week seems to be a series of ups and downs that are quite predictable. Monday usually starts slowly, with momentum gradually building into Tuesday. The goal is to make it to the weekend as quickly as possible without expending too much energy. Wednesday is a hilltop that must be reached before we coast into the weekend.

One of the best ways to relax is to find a place that is removed from people and city noises, and to sit quietly and enjoy the view. Such a simple relaxation technique can increase one's productivity and tolerance to stress if practiced on a regular basis. An example of the implementation of this technique is to retreat to a solitary hilltop every Wednesday for one hour; the results can be surprising.

9) Eye-Camera

The process of vision is quite a complicated one, involving the focusing of light onto the retina, which sends images back to the brain. To focus the light, an adjustable lens is required to accommodate objects at different distances and an iris is required to accommodate different light intensities.

The eye is a camera that is very flexible and automatic.

When a special camera is focused on the eye, the images show the retina to be very complex.
10) Diplomas-Money

One of the great debates in modern education concerns the role of the university in society. Some argue that universities should provide a general, well rounded program, while others say that vocational support should come first.

Some universities have been turned into vocational institutes based on the notion that diplomas are money, and many students agree with this point of view.

Thousands of people sink a lot of money into getting their diplomas every year, and statistics show that this expense has paid off for many.

11) Pond-Mirror

Even though pollution has taken its toll on the nation's rivers and lakes, there are still many small bodies of water in the midwest that are relatively unspoiled. If conditions are perfect, that is, there is no wind, the surface of water becomes reflective. A pond is a mirror which provides a beautiful duplicate of the surrounding scenery.

There has been growing concern that we are polluting the water to such an extent that cleaning the mess up may not be possible if we wait too long. Even the smallest bodies of water are becoming polluted, and it is estimated that the underground water supplies we count on for drinking
water are in danger. Society must take a good look in the mirror and decide if cleaning every pond, lake, and ocean is worthwhile.

12) Flattery-Tool
People try to influence other people in many ways. Sometimes influence comes in an open, obvious form which is meant to be acknowledged. Other times influence come in very subtle, covert ways which may never be picked up by observers. Many attempts at influence involve making someone feel good about him/herself. For example, flattery is a tool that has been used to obtain a wide variety of goods and services.

It is interesting to watch a master woodworker plan and complete a project. The slightest mistake can result in the loss of time and materials. This type of work seems to be good for a person with a perfectionistic streak in him/her. One of the ways to ascertain the competency of a woodworker is to inspect the materials that he/she uses. If you use a little flattery, any tool in the woodworker's collection may be open for inspection.

13) Library-Maze
It's quite a transition from using a small-town library to using the one at Iowa State University. With 4.5 million volumes of information, tracking down a particular piece of information can be very difficult. After finding whether or not a particular book is available, one must search through the stacks to find it.
A library is a maze that requires some practice to get into and out of efficiently.

One can find a book on any subject at this library, from maze construction to the application of herbicides to soybean fields.

14) Laughter-Medicine
The last two decades have been marked with a number of alternatives to traditional health care techniques. Greater emphasis has been put on the psychological dimension and its effects on a person's physical health. The use of positive thinking seems to be of some benefit, and a sense of humor is very important when dealing with illness.

As it turns out, laughter is medicine which is easy to dispense and does not need a prescription.

However, the psychological dimension of medicine has met with laughter and skepticism in some areas of science.

15) Muscles-Motors
The modern fitness trend has emphasized the need for the use of proper warm-up techniques before engaging in strenuous activities. Generally, a person should start with stretching exercises to loosen up, and then gradually work up to the desired level of activity.
Just as one would start a car on a cold winter's morning, muscles are motors that must be started and warmed up slowly to avoid damage.

With an increased emphasis on walking, jogging, and cycling, muscles rather than motors are becoming the chief source of locomotion.

16) Minds-Sponges
The brain can store a huge amount of information. No one knows for sure if there is any limitation to the brain's capacity. Also, much of the time we seem to learn things without consciously trying, which is called incidental learning. It seems that minds are sponges that absorb great quantities of information during our waking hours.

There are a number of strange phobias in existence, one of the strangest being the fear of artificial items or ingredients. This is different from the preference for all natural foods and clothing because a person with this phobia will practically panic if confronted with artificial goods. If one minds using sponges that are artificial over the real thing to the point of panic, he/she needs help.

17) Kitchen-Factory
The average kitchen is full of devices that have specialized purposes. There are simple tools which are commonly used, like knives, spoons, and measuring cups, and there are also more complex devices such as mixers and food processors. All of this allows food to be processed easier than ever
before, making the kitchen a factory in which great quantities of food may be prepared with ease.

In some of the larger companies, small groups of people are fighting the proliferation of vending machines filled with junk food. Even though people may bring their own food, the machines are a constant temptation which can cause frustration. Some groups have even suggested that a small kitchen be built in each factory so that people can eat in a healthier fashion.

18) Teacher-Student

In preparing for a class, an instructor must make sure that he/she knows the material thoroughly and can communicate this knowledge in an understandable fashion. In many instances, the instructor must actually learn or relearn certain parts of the lecture.

In many ways, a teacher is a student who must constantly master the material to be presented.

A good teacher always must keep the student and his/her needs in mind when preparing a lecture.

19) Doctors-Mechanics

Modern health care involves both preventative and corrective aspects, with a growing concern for the promotion of preventive medicine. Preventative
medicine requires each individual to monitor his/her health and to be examined by health professionals on a regular basis.

In many ways, doctors are mechanics who must periodically inspect machinery and fix problems when they arise.

In addition to being knowledgeable of bodily functions and mechanics, doctors must be sensitive to a wide range of mental health and social issues.

20) Divorce-Earthquake

The termination of a marriage results in a great deal of disorientation for most of the people involved. All of the sudden a whole new set of roles is required for the woman and man to which adjustment can be difficult. The stable foundation crumbles, resulting in a loss of identity. In many ways, divorce is an earthquake which results in a devastating situation for everyone involved.

In different cultures, the concept of marriage is much different than that found in industrialized, western nations. Marriage in other cultures is frequently viewed as an important social, not individual contract, that is vital to the unity and survival of the culture. The odds of getting a divorce or being in an earthquake are about the same; people simply do not separate.
21) Dreams-Movies

It is said that everyone dreams, but we don't all remember the dreams when we wake up. Even though many dreams are bizarre, those that we remember seem to make enough sense to describe to others. Such dreams have a stable set of characters, some kind of plot, and some conclusion if we don't wake up too soon. Dreams are movies that are a combination of our experiences and our imagination.

After a number of years of decline, the motion picture industry has had some record breaking years in terms of profits. The proliferation of pay-cable services has not sealed the doom of theatres, in fact many theatres are also video rental outlets. Anyone who dreams that movies shown in theatres are a thing of the past is sadly mistaken.

22) Politics-Game

Every four years, this nation is put through the incredible task of selecting a new president and vice-president. The toughest part of the process starts after the conventions, when the candidates hit the campaign trail. At that point, each candidate tries to skillfully outplay the other in terms of trying to promote his/her point of view and tarnish the opponent's views.

Politics is a game in which winning is everything and mistakes are not tolerated.
Just about any weakness is fair game in politics, which can be a ruthless pursuit.

23) Sleep-Escape
When people are put under a great deal of stress for a prolonged period of time, it is obvious that some will become depressed. One interesting reaction is that some of these people will stay in bed much more than usual, sometimes up to 16 hours per day. This allows for less energy to be expended, and it keeps a person away from stressors. For these people, sleep is escape which allows them to cope with a hostile environment.

One of the oldest means of prolonged interrogation is to deprive the subject of food and rest over a period of days while constantly questioning him/her. This method leaves no external physical signs, and is usually very effective. Not only does the subject reveal the information, but the lack of sleep prevents escape or attempts of deceiving the questioners.

24) Friends-Guideposts
To some extent, people we know have exert an influence on the important decisions we must make. When a decision must be made, we turn those close to us for advice and encouragement, which can take a great deal of stress out of decision making.

Friends are guideposts who contribute advice an stability to our lives.
As we approach and interpret the guideposts in our lives, friends are good to have around for advice and support.

25) Imagination-Invention

Much of the creative thinking that results in new ideas or devices can occur when least expected. For example, the sewing machine needle was first thought of in a dream. Other important advances have occurred when people daydream or think of situations that are far removed from reality.

Imagination is invention and should be engaged in whenever possible.

The application of an invention is limited only by the imagination of those that must put it to use.

26) Sky-Dome

On a clear night and with the proper conditions, quite a few stars and planets may be seen with the unaided eye. One common illusion involved in star gazing involves lying still and staring at a group of stars for at least five minutes. After this time, one may get the feeling that he/she is lying under a large circular roof, with the stars being tiny holes in the ceiling. The sky is a dome which contains a ever-changing series of designs.

The Cistine Chapel is an excellent example of the combination of practical architecture and beautiful artwork. Many early cathedrals and chapels had
great amounts of wall and ceiling space which were used for artwork. Even though most of the artwork is traditional, in a few instances, different ideas have been attempted. Some chapel domes were painted as the night sky, with star positions accurately recorded.

27) Books—Lights
As each new generation of children becomes dependent upon television for its entertainment and knowledge, the motivation to read good literature may diminish. This can be detrimental, for not only are reading skills potentially affected, but many interesting cultural and historical facts may be missed.

Books are lights which help brighten the path in a very high-tech society.

Regardless of whether one is raised in the country or under city lights, books are a very valuable source of knowledge in a high-tech society.

28) Tradition—Rock
Most cultures establish various social and religious customs partly to insure the survival of cultural identity and allow for information to be transmitted to new generations. Even though young people usually question these customs, it is hard to imagine life without them.

Tradition is a rock upon which we build our identities and our futures.
It is usually a bad idea to rock the boat and criticize tradition, except when exceptional circumstances make it necessary.

29) Memory-Photograph

There have been reports of people who can look at a complex scene and then later report objects in that scene as if they were still looking at them. These people report having an exact copy of the scene in memory, with all shapes and colors intact.

For these people, a memory is a photograph that yields precise reports of every detail contained in the scene.

After being presented a photograph, their memory for every detail is precise, and they score around 100% on recognition tests.

30) Words-Daggers

Traditionally, most of the emphasis in child abuse cases has been placed on physical violence. However, concern has been growing over the use of verbal or psychological violence in the home. Telling a child that he/she is worthless can cause untold damage. Coming from a bitter parent, words are daggers that can cause damage that takes many years to heal.

About three years ago, a collection of ancient Egyptian artifacts was exhibited at a number of museums around the country. Among the collection was the mummified remains of a pharaoh and his sarcophagus. The most