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ENTITLED Studies of two Combinatorial Semantics of Comm

and Verbs: Metaphorical Extension of Verb Meanings

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science

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# Studies of the Combinatorial Semantics of Nouns and Verbs: Metaphorical Extension of Verb Meanings

BY

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THESIS

for the

DEGREE OF BACHELOR OF SCIENCE

IN

LIBERAL ARTS AND SCIENCES

College of Liberal Arts and Sciences

University of Illinois

Urbana, Illinois

1986

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## Acknowledgement

I would like to acknowledge my advisor, Dedre Gentner, for her help, encouragement and wisdom. I am grateful that one of my early research experiences has been guided by someone whom I have come to truly admire. I would also like to thank Michael Coles and Jack Adams for their guidance. Lastly, I would like to acknowledge all of the members of the Cognition and Language Laboratory-- especially Robert Schumacher for help with data analysis, Michael Jezioreki for assistance with Final Word and with the Macintosh, and Mary Jo Rattermann for her advice throughout the project.

## Abstract

People are constantly encountering novel utterances. Somehow, we are able to interpret the sentences. Some combinatorial rules must govern the combinations of individual words to produce a unified meaning. This research investigates the rules of combinatorial semantics, focusing on the rules governing the combination of nouns and verbs. Two experiments were performed. In both studies, verbs of possession were used. Experiment 1 used a free paraphrase task. Subjects were presented with literal sentences and with nonliteral sentences (e.g. "Oscar bought a book" and "Fritz bought despair", respectively). Subjects were asked to write the meanings of the sentences. Experiment 2 used a forced-choice task, based on the responses collected in Experiment 1. Subjects were presented with sentences together with four possible interpretations of each sentence. They were asked to choose the response closest to the intended meaning of the sentence. Choices were designed to reflect possible strategies of metaphorical extension.

Results showed that (1) subjects showed orderly interpretations strategies for the nonliteral sentences; (2) Meaning adjustment was primarily centered around the verb; (3) Dominant adjustment strategies appear to be minimal subtraction of semantic components. They support the notion that intensive semantic adjustment is involved in the

comprehension of novel noun-verb combinations.

## Studies of the Combinatorial Semantics of Nouns and Verbs: Metaphorical Extension of Verb Meanings

People are constantly bombarded with linguistic stimuli. Talking, reading and listening all involve encoding linguistic information and processing that information so that meaning may be derived from combinations of words. Many, if not most, words that confront us contain a spectrum of meaning senses (Anderson & Ortony, 1975) and therefore any sentence poses a myriad of possible meanings. Yet, people do not find themselves constantly confused by the multiple meanings posed by every sentence encountered. Somehow, the individual words interact with one another and the possible meaning senses of surrounding words. As Shepen (1973) has observed, if every word has a distribution of possible meanings, and every sentence consists of many words, each one with a multitude of meanings, then the number of possible meanings of any sentence is astronomical. It would be implausible to assume that people search through all of these possible meaning senses until they arrive at the correct interpretation. Somehow, combinatorial rules must govern which aspects of meaning are chosen, and which are discounted. People choose meanings systematically, not haphazardly, as is evidenced by the uniformity with which people understand any given sentence. Some systematic combinatorial rules must govern the combinations of individual words, so that they produce a unified, sensical meaning.

These studies investigate the combinatorial rules governing nouns and verbs.

Research on the interpretation of word combinations is just beginning. Work so far has included investigations of noun-adjective combinations (Osherson & Smith, 1984), adverb-adjective combination (Smith, Osherson and Rips, 1985) and adjective-adjective combinations (Anderson, 1971). Our research concerns the combinatorial semantics of nouns and verbs. The noun-verb unit forms the central meaning unit of a sentence. Therefore, an understanding of the combinatorial rules governing nouns and verbs is crucial to our understanding of sentence comprehension.

A key issue in modeling of semantic combination concerns the question of contextual adjustment (e.g. Anderson & Ortony, 1975) versus fixed word meaning. Fixed-meaning models claim that a word has a single, fixed meaning and that sentences are combinations of these meanings. However, researchers began to observe that fixed-meaning models could not account for the richness of language, and that people instantiate meaning by filtering linguistic information through their existing knowledge of the world (Anderson & McGaw, 1973; Halff, Anderson & Ortony, 1976). Anderson and Shifrin (1976) noted that the mental image of "ball" created in response to these three sentences is quite different:

The golfer kicked the ball.

The punter kicked the ball.

The baby kicked the ball.

By the fixed-meaning position, the word "ball" has three distinct meaning senses-- a small hard sphere, a larger pigskin oval, etc.-- and thus the word "ball" accesses separate meaning senses in each of these sentences is actually a near synonym of the word "ball" in each of the other sentences. By the contextual-adjustment account, it is the context-- the words surrounding "ball"-- that determine the meaning sense instantiated. Because we are familiar with what sort of ball is likely to be kicked by different sorts of people, we instantiate different meanings for the word "ball" (Anderson & Shiffrin, 1977; Bentner, 1982).

Verbs, as well as nouns appear to show this context dependency. To see this, contrast the mental images of the act of kicking in these two sentences.

The punter kicked the ball.

The punter kicked the horse.

The particular version of "kick" that we instantiate varies with its agent and object. Similar patterns have been observed with prepositions (Rhegen, 1973) and with adjectives (Rosch & Mervis, 1975; Hall[illegible], Anderson & Ortony, 1976). Experimental evidence tends to support the

change of meaning position over the fixed meaning position (Anderson & Ortony, 1975; Anderson & Shifrin, 1977). It appears that some kind of context-dependency is the best account of the processes by which people instantiate word meaning. Therefore, any plausible model of combinatorial rules will have to achieve a balance between context sensitivity and meaning stability.

But how far should the context-dependency view be taken? In an extreme view, a word would have no inherent meaning at all, and its meaning would be determined entirely by linguistic and experiential context. Although strong context effects are emphasized by some pragmatically centered theorists, the extreme position that words have no inherent meanings has not, to our knowledge, been advocated by anyone. However, the challenge here is to model the interaction between inherent meaning and context effects. These studies attempt (1) to demonstrate that change of meaning does occur; (2) To examine closely the change-of-meaning process; and (3) To describe the constraints on that change of meaning process.

## Lexical Semantics

### Noun Meanings

Noun words tend to represent concepts. There has been a shift in the modeling of conceptual comprehension from an Aristocracy approach based on necessary and sufficient conditions to prototype models (Rosch, 1975;

Tversky, 1977; Osherson & Smith, 1984; Rips, Shoben & Smith, 1973; Rosch, Simon & Miller, 1976). Although the view of typicality has changed, both types of theories are featural accounts of the comprehension of noun concepts. This view may not be entirely accurate. Nouns are structural as well as featural. For example, the word "robin" implies not only features such as wings, feathers, a beak, etc., but also implies a structure. People do not picture the beak protruding from the top of the head. Although nouns do specify structural relationships, the basic substructure of nouns is featural. For our purposes, a consideration of the featural nature of nouns is important to the examination of the combination of nouns and verbs.

Verbs. The first challenge in building a model of noun-verb combination is centers around the individual meanings of nouns and verbs. Several models of semantics and grammar have been proposed which represent verbs relationally (e.g. Norman & Rumelhart, 1975; Schank, 1972; Chafe, 1970; Fillmore, 1963). The Lindsay, Norman and Rumelhart (LNR) model of verb meanings will be discussed here, although similar models have been advanced (Schank, 1972; Chafe, 1970; Fillmore, 1963). These grammars model verbs as setting up argument frames. The noun arguments are passed down to a semantic relational structure that specifies the events and relations that the noun referents participate in. Therefore, the verb acts as the central organizer of a sentence, while the nouns cluster around the sentence filling verb-specified case

relations. For example, the sentence

Mary gave John a dollar.

can be paraphrased as "Mary has performed some as yet unspecified action which has caused a dollar to change from Mary's possession to John's possession." The argument frame for "give" is:

give[agent, object, recipient, time]

. Given the sentence, "Mary gave John a dollar," we can fill the arguments for the predicate "give." The resulting proposition is:

give[<Mary>, <dollar>, <John>, time].

As the paraphrase suggests, the verb "give" expresses a number of interrelationships among its arguments. Beyond specifying arguments, "give" also expresses (a) causality-- Mary has caused the described transaction, (b) action on the part of Mary-- Mary has performed some action that resulted in John receiving a dollar, and (c) a change of possession from Mary to John.

It appears that the verb "give" can be distilled into underlying components, each expressing a single aspect of "give's" meaning. The components described here derive from the LNR model of grammar (Norman & Rumelhart, 1975), although Schank (1972) has proposed a similar model. According to the LNR model, the most basic component of a verb is the

stative, which "communicates information that a particular state of the world holds for some specified period." The stative underlying "give" is POSS, the stative of possession.

The next level of component which underlies verb meanings is the predicate primitive. Predicate primitives include CAUSE, DO, and CHANGE, a stative of possession. CAUSE denotes causality, and thus must be included in a structural diagram whenever a causal action can be identified. Therefore, CAUSE must be included in the diagram of "give," because Mary's action causes John to receive a dollar. Another predicate primitive is the actional component. Since, in this example, Mary's action is unknown, the dummy actional DO is supplied as the actional component. CHANGE is a primitive that indicates that a change of possession has transpired, and is an important components of the verbs of possession.

Work examining the acquisition of word meanings has provided some of the best evidence for the psychological reality of semantic components. For example, Gentner (1978), has found that if the entire structure of a verb is contained within another verb, the former verb is acquired earlier than the latter verb. Children tended to treat verbs such as "give" and "sell" and "take" and "buy" as if they were synonyms. They had not yet acquired the transfer of money components specified by "buy" and "sell." It is important to note that children did not confuse the directions of the transactions, indicating that they

could correctly understand the object transfer. Later, children add the transfer of money component.

Other evidence for semantic decomposition comes from adults. Gentner (1975) found that recall errors tend to confuse verbs with similar structural networks.

## Combinatorial Semantics

Early models of both conceptual and semantic combination attempted to propose simple rules to account for combinatorial processes. An example is the "minimum rule" proposed as part of Zadeh's (1965) fuzzy set model of meaning. Fuzzy set theory adheres to a minimum rule of conceptual combination. The minimum rule states that the typicality of a conjunction is equal to the minimum typicality value of its constituents. Other simple rules have been proposed, including the maximum rule, in which the typicality of a conjunction is equal to the highest typicality value of a constituent of that conjunction, and averaging rules, such as Anderson's (1971) weighted average model. These models have in common that they derive some important semantic value-- e.g. the typicality or the scale value along some dimension-- of the whole from a linear combination of the values of the typicalities, or the scale values of the parts.

A convincing attack on such simple rule models of conceptual combination has been launched by Osherson & Smith (1981; 1982; Smith &

Osherson, 1984). According to any of the simple rules, a conjunction may be no more typical of the conjunction than it is of its constituents. Therefore, the concept "red apple" may be no more typical of the concept "red apple" than it is of the concept "red" or of the concept "apple." While minimum, maximum and averaging rules all offer a plausible account of such conjunctions, they do not offer a plausible account of all conjunctions. Osherson & Smith (1981; 1982; Smith & Osherson 1984) have pointed out that often the typicality of a conjunction exceeds the typicality of either of its constituents. To illustrate this, they point out that "guppy" is considerably more typical of the conjunction "pet fish" than it is of either "pet" or "fish." They argue that neither minimum, maximum nor averaging models are capable of accounting for conjunctions such as "pet fish." Furthermore, they claim that "pet fish" does not constitute a unique example of a conjunction in which the typicality of the conjunction exceeds the typicality of its constituents, but rather exemplifies a prevalent pattern of noun-adjective conjunctions. They argue that any adequate theory of conceptual combination must include a mechanism which accounts for such conjunctions.

Osherson and Smith argue that previous models have failed because they do not consider the internal features of the concepts in combinatorial calculations. Because noun concepts are understood featurally (Smith & Medin, 1981; Tversky, 1977; Rosch, 1975), they posit

that no simple rule can account for conceptual combination, but that an adequate model of noun-adjective combination must be sensitive to the featural aspects of noun concepts.

In addition to discussing the theoretical problems arising from simple rules of conceptual combination (Osherson & Smith 1981; 1982), Smith and Osherson (1984) have begun to explore conceptual combination empirically. From their experimental results, Osherson and Smith have devised their own model of conceptual combination which is sensitive to featural interactions, and which accounts for conjunctions of the "pet fish" type.

Since the model is of noun-adjective combination, and is not applicable to noun-verb combination, it will not be described here. However, the model has several important strengths. It is able to account for conjunctions in which the typicality of the conjunction exceeds the typicality of its constituents, it has the ability to predict such conjunctions, to explain conjunctions inexplicable by other models, and it is sensitive to featural interactions. Just as Osherson and Smith have demonstrated that no simple rule will satisfactorily account for noun-adjective combination, no simple rule will satisfactorily account for noun-verb combination. Just as Osherson and Smith have found that a satisfactory model of noun-adjective combinations must be sensitive to the internal featural structure of the concepts, a noun-verb model must also be sensitive to both the internal

featural structure of the noun concept and the internal relational structure of the verb concept.

## Selectional Restrictions

Historically, discussions of noun-verb combination have centered around the phenomenon of selectional restrictions. Sentences consist of a verb, which specifies obligatory case relations as its arguments, and the nouns which satisfy these arguments. Although it may seem that any noun could be assigned to the verb-specified case-slots in a sentence, this does not prove to be true. The sentence, "The moon gave the lake a silvery shine" poses a literal impossibility. The moon is neither literally capable of performing the act of giving, nor is a silvery shine an object capable of being given, nor is a lake literally capable of performing the act of receiving. Chomsky (1965) labelled this phenomenon "selectional restrictions." A function of the verb appears to be not only to specify the relationships which noun concepts may assume, but also to limit the noun concepts that may fill these relationships. According to syntactic theories (Chomsky, 1965) and some generative semantic theories (Katz & Fodor, 1963) sentences which violate selectional restrictions would be rejected by people as uninterpretable. However, the response to a sentence such as "The moon gave the lake a silvery shine" is not a baffled inability to make sense of the sentence, but an attempt to extend word meanings so as to

understand the sentence metaphorically. Furthermore, the interpretations given show uniformity. When asked what that sentence means, an informal sampling shows that people usually report an image of a lake at night, with a moon above it, and the reflection of the moon on the lake's surface causing the lake to appear as if it were silver. A process of metaphorical extension allows people to interpret such sentences meaningfully. Furthermore, the uniformity of people's interpretations of such sentences, despite the fact that they reflect literal impossibilities, suggests that there are rules which govern which words will retain their literal meanings and which will be extended metaphorically. It also suggests that the words that change meaning will do so in an orderly, rule-governed manner. Sentences which violate selectional restrictions provide a means of studying the combinatorial rules governing noun-verb combinations. Because these sentences are unique, any systematic processes uncovered in their interpretation would reflect a process of interpretation rather than a stored manner of handling linguistic information.

The following experiments were designed to more closely examine the mechanisms driving change of meaning. They approach the problem by limiting the verbs included in the sentences to a subset of the verbs of possession. By isolating verbs that share the same stative, POSS (Rumelhart & Norman, 1981), we can more closely examine which primitives and relations are preserved, and which are ignored when subjects

interpret the sentences. The verbs of possession have been chosen because they have been studied previously (Gentner, 1975; Schank, 1972; Fillmore, 1968). For an account of a similar approach using the verbs of location, see Boscolo and Capozza (1983).

Experiment 1 used a free paraphrase task. It was conducted (1) to replicate Gentner's (1981) finding that verbs are less semantically stable than are nouns, (2) to provide an initial examination of the processes by which the change of meaning occurs, and (3) to help in designing stimuli for Experiment 2. On the basis of Gentner's (1981) results, we predicted that people would derive sensical metaphorical interpretations of nonliteral sentences, and that in these interpretations the verbs would show more contextual adjustment than would nouns. We further predicted that subjects would attempt to preserve as many components of verb meaning as possible. These components lost in the metaphorical interpretation would be those components least central to verb meaning. Lastly, we predicted that people would use a semantic strategy when interpreting the sentences. They would attempt to adjust verb meanings rather than to add pragmatic contextual information not specified by the literal meaning of the sentence.

## Experiment 1

### Method

Subjects. Subjects were sixteen University of Illinois undergraduates who were paid $4.00 per hour for their participation.

Materials Sentences were constructed from a set of eight verbs of possession and eight direct objects. The matrix from which the sentences were generated is depicted in Figure 1.

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Insert Figure 1 about here

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All sentences were of the form "The noun verbed the object." Sentence subjects were masculine proper names.

The eight object nouns consisted of two concrete nouns (book and vase), two human nouns (doctor and mechanic), and four abstract nouns. The abstract nouns were divided into two classes, abstract+ nouns and abstract- nouns. The abstract+ nouns were nouns with positive connotations (luck and loyalty) and the abstract- nouns were nouns with negative connotations (poverty and doom). Since the selectional restrictions of verbs of possession demand that the verbs take inanimate direct objects, all nouns except the concrete nouns resulted in nonliteral sentences. Sentences constructed from nouns belonging to a

pair of the same type were assumed to have produced sentences equivalent in semantic strain.

From this matrix, sentences were generated with every combination of verb and object, resulting in a full set of sixty-four stimulus sentences. From this set eight subsets, termed covering sets, were created. Each covering set was composed of the eight verbs, each paired with one object. Thus, a particular subject was exposed to each verb and each object once. The eight covering sets covered the entire matrix of sixty-four sentences. Sixteen filler sentences were also included. The filler sentences were syntactically similar to the test sentences. They consisted of a masculine proper first name, a verb and a direct object. Of the filler sentences, six contained verbs of possession and ten contained other randomly chosen verbs. None of the filler sentences containing verbs of possession violated a selectional restriction of the verb.

Every subject received a booklet containing one of the eight covering sets interspersed with the filler sentences. All subjects received the same filler sentences. Subjects also received a written instruction page. The sixteen subjects covered the full matrix twice, so that every stimulus sentence was seen by two subjects.

Procedure. Subjects were given the test booklets and a written instruction page. The instructions were also read orally by the experimenter. Subjects were instructed to paraphrase each sentence.

They were told to imagine that they had overheard the stimulus sentence while walking through a cafeteria, and that they should write down what they thought the speaker might have intended by the sentence. The instructions emphasized naturalness. Since many of the sentences were not literally interpretable, subjects were told to assume that the speaker did intend something meaningful by each sentence. They were instructed not use words that had appeared in the original sentences, although they were told not to paraphrase the person's name or words such as "a," and "the." No time limits were imposed, but subjects were instructed that they should not to spend too much time on each one. They were told that if they found themselves spending more than a minute or two on each sentence, they were probably thinking too hard.

## Results

Results replicated Gentner's (1981) finding that verbs exhibit more change of meaning than do nouns. Figure 2 shows the adjustment strategies used by paraphrase subjects.

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insert Figure 2 about here

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Verb adjustments occurred much more frequently than did noun adjustments. Although verb meanings were often changed and meanings left intact, nouns seldom changed meaning without a corresponding change in verb meaning.

Another strategy sometimes used was a rote synonym-by-synonym paraphrase. This strategy was adopted often for sentences containing a concrete object. Since concrete objects are literally acceptable, no adjustment is necessary to produce a coherent meaning, and thus the high rate of rote responses. However, the number of rote paraphrases dropped sharply for sentences containing non-literally acceptable object types, reflecting a process of metaphorical extension for selectionally restrictive sentences. The proportion of rote responses for each object type is depicted in Figure 3.

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insert Figure 3 about here

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Furthermore, the pattern of verb adjustments suggested systematic processes underlying the metaphorical extension of verb meanings. When extending verb meaning, certain components were likely to be subtracted from the verbs literal meaning, (e.g. tise, 2nd agent), while other

components (e.g. volition, contract) were rarely subtracted. These components least susceptible to collapse under paraphrase are hypothesized to be the components most central to verb meaning. Conversely, those components most susceptible to collapse under paraphrase are hypothesized to be components more peripheral to meaning. The importance of this finding is that systematic rules appear to govern the process of metaphorical extension. Subject responses do not appear to be a random attempt to make sense from nonsense, but reflect an orderly, rule-governed process.

## Discussion

The result that the verbs showed greater change of meaning than did nouns is particularly surprising in view of the independent agreement that the verb serves as the central unit of meaning in a sentence. Grammarians (Chafe, 1970; Fillmore, 1968) have predicted that in a sentence which violates selectional restrictions, the verb would be the element of a sentence least likely to exhibit a change of meaning. Several compelling arguments exist for the view that verbs should be more stable than nouns. Fillmore (1968) points out that it is the verb that specifies case relationships. It is the verb that exercises selectional restrictions on the noun (Chomsky, 1965; Katz & Fodor, 1963), and structural grammars depict the verb as specifying relationships between concepts (Herman & Rumelhart, 1975; Schank, 1972).

Chafe has explicitly predicted that given a sentence which violates a selectional restriction, the noun will display change of meaning, and the verb will retain its literal meaning. Despite the appeal of these arguments, Gentner (1981) has found that it is the verb that is most mutable under paraphrase, not the noun. The incorrect predictions made by Chafe (1970) arise from a confusion between sentence function and word meaning. Verbs can function as the central organizers of a sentence, but this need not imply that they are more semantically stable than nouns.

We believe that the verb's function as a central organizer is precisely what accounts for its mutability under paraphrase. If the job of the verb is to link all the nouns into one coherent assertion, then this may mean suspending one or more of the normal subrelations specified by the verb when interpreting sentences which exhibit semantic strain. Moreover, we suspect that in adjusting verb meaning, people extend the verb meaning to preserve as many of the relationships specified by that verb as possible.

Any adequate model of noun-verb combination must be sensitive to the differences between nouns and verbs. Gentner (1981) has pointed out that nouns and verbs differ in aspects which cannot be attributed solely to differences in syntactic function. Verbs are remembered less well than are nouns, they are acquired later by children, and once acquired usage errors persist longer than for verbs. Verbs have a greater

breadth of meaning than do nouns, they are more mutable under paraphrase, their meanings vary more cross-linguistically, and relative translatability is lower for verbs than for nouns.

Subjects attempted to preserve as many components of verb meaning as possible. Those components lost in the metaphorical interpretation seemed to be those components least central to verb meaning. Lastly, people seemed to use a semantic strategy when interpreting the sentences. They attempted to adjust verb meanings rather than to add pragmatic contextual information not specified by the literal meaning of the sentence.

## Experiment 2

On the basis of the findings from Experiment 1, it seemed that four possible views might exist to account for the process underlying the change of meaning. The first view would be that adopted by syntactic theories (Chomsky, 1965) and by Katz and Fodor's (1963) generative semantics theory. According to this view, sentences that violate selectional restrictions are completely nonsensical, and would be rejected as uninterpretable. Evidence from experiment 1 shows, however, that subjects do not categorically reject these sentences, but interpret them metaphorically in a systematic manner. This view would predict that subjects would not be able to respond in an orderly manner on a forced choice task, because if the stimulus sentence is wholly

meaningless, no response would be able to capture the meaning of the sentence. Therefore, this view would predict a random response pattern of the forced-choice task.

A weaker version of this view might predict that, although selectionally restrictive sentences are nonsensical, subjects might be able to preserve the most basic components of the verb's meaning. The verb of possession would distill down to a general change of state, but would lose all other aspects of its meaning.

These views reject the position that sentences which violate selectional restrictions will be interpreted metaphorically. If one does accept that metaphorical extension occurs, two views offer explanations of the processes underlying the metaphorical extension. One plausible position is that subjects make pragmatic adjustments to sentence meaning. People might make sense from the non-literal sentences by adding world-knowledge based contextual information not specified by the literal meaning of the sentence. Many investigators have observed that pragmatics play an important role in metaphor.

The last view, and the position that we take, is that subjects interpret the sentences by making semantic adjustments to the verb. According to this view, people interpret the sentences by adjusting verb meaning, rather than by adding pragmatic information. We predicted that subjects would adopt a semantic strategy of metaphorical extension.

Experiment 2 used a forced-choice task in order to establish

tighter experimental control, and to eliminate the problem of the subjective interpretation of paraphrase data. It sought to more closely examine the process of verb metaphorical extension.

The response choices constructed for this task were designed to reflect the predictions that would be made by these views.

## Method

### Materials

Sentences for this experiment were similar to that used in Experiment 1, with a few exceptions. First, the verbs "owned" and "traded" were eliminated to reduce the number of stimuli.

The objects were of the same basic types as in experiment 1. However, because no differences were found between abstract+ and abstract- nouns, this distinction was eliminated.[1] Thus, three types of nouns remained. Concrete objects resulted in literal sentences, while human and abstract nouns resulted in non-literal sentences. Six nouns of each type were selected. The three matrices from which the sentences were constructed are depicted in Figures 4-6.

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1. "Owned" was eliminated because of its semantic simplicity. Because it specifies only a very basic state of possession , designing stimuli which subtracted semantic components posed a problem. "Traded" was eliminated because it specifies a two-way exchange, but does not specify the direction of transfer. The responses from Experiment 1 showed large variability as to whether subjects interpreted the primary transfer to be a gain of possession or a loss of possession.

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Insert Figures 4-6 about here

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The response choices. Every sentence was followed by four response choices. The responses were designed to reflect the predictions that would be made by different views of metaphorical extension.

1. Minimal Subtraction. The Minimal Subtraction choice preserved the verb's meaning as closely as possible. In the literal sentences, it served as a rote synonym-by-synonym paraphrase. In the metaphorical sentences, the minimal number of components were subtracted in order to produce a plausible metaphorical meaning. The Minimal Subtraction response reflected a semantic adjustment strategy, and it was predicted that it would be the response chosen most frequently.
2. Pragmatic Amplification. The Pragmatic Amplification choice contained the subtraction from the minimal subtraction choice, but also added additional contextual information not specified by the literal meaning of the sentence. This information was added to make the extension plausible.

3. General Change of State. In the General Change of State case, all components of the verb meaning, except for the change of state, were subtracted. This interpretation was correct, but extremely underspecified. The weak version of the strict syntactic (Chomsky, 1965) and generative semantic (1963) positions would predict that this response would be chosen most frequently. Since this response reflects an extreme semantic adjustment, a semantic adjustment view would predict that this response would be chosen less frequently than the Minimal Subtraction response, but more frequently than the Pragmatic Amplification response.
4. Semantic Anomaly. The Semantically Anomalous choice served as a catch response. This response was a sentence related only in a highly implausible way to the stimulus sentence. The Semantically Anomalous response was included, because according to theories which view non-literal sentences as completely uninterpretable, all possible responses would be viewed as equally anomalous, and the semantically anomalous response would be chosen equally as frequently as the other responses.

The response choices were constructed with the noun synonym held constant for all choices to insure that subjects were not responding on the basis of the noun. Stimuli constructed with a particular verb were constructed to be parallel for all objects of the same type. Twelve filler sentences were also constructed. Of these, 6 contained verbs of

possession, while 6 did not. All of the sentences containing verbs of possession had concrete objects. Of the other fillers, 3 violated selectional restrictions, while 3 did not. Sample stimuli are shown in Table 1.

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insert Table 1 about here

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Design. As in experiment 1, sentences were generated using all of the verbs and all of the objects. Each subject saw all six verbs three times, once with a noun of each object type. Six groups of subjects were required to cover the matrix fully. Counterbalancing was achieved by means of a Latin Square. The full matrices were covered eight times, so that every verb was seen four times in a forward order and four times in a reverse order.

Subjects. Subjects were 48 University of Illinois undergraduates enrolled in an introductory psychology course who participated in the experiment as part of a course requirement.

Procedure. Subjects were given booklets containing two sentences per page. Test sentences were interspersed with filler sentences. The

verbs were presented in random order, with the constraint that a verb could not appear within two times of itself. One half of the subjects received the verbs in a forward order, and one half of the subjects received the verbs in a reverse order. Subjects were given written instructions which were also read orally by the experimenter. Instructions were similar to those given in experiment 1. There was no time limit imposed on the task.

## Results

Subject almost never chose the Semantically Anomalous response. This rules out an extreme selectional restriction view, which predicts that since the nonliteral sentences are nonsensical, the Semantically Anomalous response should account for at least 25% of subject responses. This leaves three possible strategies. One possibility would be that subjects would try to create a plausible pragmatic context, as would be predicted by a pragmatically oriented context-dependency view. If this were the case, subjects would have frequently chosen the Pragmatic Amplification response. However, this was not the case. This leave the two versions of the semantic-adjustment strategy. The General Change of State strategy reflects a kind of "starting up from the ground" strategy in which only the change of state is preserved. In contrast, the Minimal Subtraction response retains as much of the literal meaning as possible. The

Minimal Subtraction was the response most frequently chosen by subjects. The proportion of responses of each type is depicted in Figure 7.

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insert Figure 7 about here

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The difference between subtraction and general was highly significant, $t(47)=11.36$, $p<.001$. The difference between the general change of state and the pragmatic amplification responses was also significant. $t(47)= -.32$, $p<.001$. Lastly, the difference between the pragmatic amplification response and the semantic anomaly was highly significant. $t(47) = 6.39$, $p<.001$.

Subject responses varied across the different object types. The proportion of responses for each object type is shown in Figure 8.

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insert Figure 8 about here

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In order to test the differences between different types of objects, four one-way analyses of variance were calculated, one for each response type. Results of these showed that the concrete objects generally differed from the non-literal object types, but that the non-literal object types did not differ from one another. The F values were significant for all response types, except the Semantic Anomaly. The Minimal Subtraction response and the General Change of State were highly significant. $F(2,141)=20.590$, $p<.001$, and $F(2,141) = 11.488$, $p<.001$, respectively. The Pragmatic Amplification response was also significant. $F(2,141) = 5.666$, $p<.01$. The F value for the Semantically Anomalous response was not significant.

Post-hoc Scheffe tests revealed that for the Minimal Subtraction response the difference between the literal and non-literal object types was significant at the $p < .01$ level. For the general change of state response, this difference was significant at the $p < .05$ level. For neither of these response types was a significant difference found between the human and concrete objects. For the Pragmatic Amplification response, differences between concrete objects and human objects, and between human and abstract objects were significant at the $p < .05$ level, although the difference between human and abstract objects was marginal. No difference was found between human and abstract objects.

## Discussion

The general finding from these experiments is that subjects chose the Minimal Subtraction response more frequently than any of the other responses, followed by the General Change of State response. Subjects almost never chose the Semantically Anomalous response choice.

These results show, first, that orderly processes govern the interpretation of novel noun-verb combinations. The failure of subjects to choose the Semantically Anomalous response demonstrates that these sentences are not completely uninterpretable as would be predicted by syntactic (Chomsky, 1965) and some semantic (Katz & Fodor, 1963) theories. If these sentences were wholly meaningless, no response choice would be able to reflect the intended meaning of the sentence. Therefore, all response choices would be equally anomalous, and the semantically anomalous response would be chosen equally as often as the other response choices. The finding that subject's responses are not random indicates that there is a process of metaphorical extension.

The weaker version of this view which states that subjects would be able to preserve only the most fundamental component of meaning, the general change of state, would predict a high rate of General Change of State responses. This view also fails to account for these results. Subject were able to preserve more aspects of a verb's meaning than a general change of state.

Furthermore, the results indicate that intensive semantic

processing is involved in the comprehension of novel sentences. The subjects chose the Minimal Subtraction and General Change of State responses most frequently. Both of these responses reflect semantic strategies. The minimal subtraction case preserves literal meaning as closely as possible, subtracting only the minimum number of components in order to make the metaphorical extension plausible. This is a minimum semantic adjustment. In contrast, the general change of state was an extreme semantic adjustment. The finding that the minimal subtraction response was chosen so overwhelmingly over any other response shows that people, when metaphorically extending verb meanings, attempt to preserve the verb's literal meaning as closely as possible. Note that the Minimal Subtraction strategy requires the person to use more information in effecting the semantic adjustment. Since these adjustments often appear to occur without much effort, one might have expected the simpler General Change of State strategy would have been adopted.

Although the pragmatic amplification view remains a plausible explanation for the metaphorical interpretation of non-literal sentences, the subjects chose the semantic adjustment strategies over the Pragmatic Amplification strategy. This finding is an interesting one, suggesting that when confronted with novel noun-verb combinations, people prefer to make semantic adjustments to the verb, rather than to add pragmatic contextual information not specified by the literal

meaning of the sentence. Because our Minimal Subtraction choice was also somewhat pragmatic, this finding is somewhat inconclusive, although the results do imply a semantic subtraction, rather than a pragmatic amplification strategy.

In all cases, except for Semantic Anomaly, differences were found between literal and non-literal object types. This result is consistent with the minimal semantic subtraction strategy. While it is not surprising that subjects do not change meaning unless demanded by context, they were always able to make the degree of adjustment required. Words seem to have a core meaning which is preserved as closely as possible, but that can be adjusted when necessary. In the case of non-literal sentences, subjects are forced to adjust literal word meaning in some way in order to extract a coherent meaning from the sentence, while in the literal sentences this adjustment is unnecessary. The difference evidenced between literal and non-literal object types in this experiment demonstrate that subjects extend word meaning for metaphorical sentences and do not do so for literal sentences.

The results do not, however, allow us to posit a distinction between the different non-literal object types. It may be that there is difference only between literal and metaphorical sentences, and that this difference is not a function of increasing degree of semantic strain. Another possibility is that these stimuli did not adequately

vary the degrees of semantic strain between non-literal object types. Although we believe the former explanation, we cannot conclude on the basis of these results.

These findings bear on the fixed meaning versus change of meaning debate. They support a change of meaning model, but also indicate that this change of meaning occurs only within certain constraints imposed by the verb's inherent literal meaning. If verb meaning were entirely fixed, subjects would not be able to adjust verb meaning to create a metaphorical interpretation of non-literal sentences. The fact that certain components which are literally specified by a verb's meaning can be subtracted when context imposes semantic strain shows that literal meaning is not fixed, but is context-dependent. Yet, meaning does not fluctuate wildly from context to context with no inherent core meaning. Subject responses from Experiment 1 indicate that verbs of possession retain some of their components, even when other aspects of the verb's meaning are lost or altered. The finding that subjects so strongly prefer the Minimal Subtraction response shows that they try to preserve as many components of verb meaning as possible. Change of meaning does occur to accommodate contextual constraints, but that change involves computation analogous to the computations set forth by Gohorsen & Smith (1984) for noun-adjective combination. Like the Gohorsen & Smith model, these computations rely on the internal structure of the verb. It appears that a rather fine-tuned semantic adjustment view provides the

best account of novel noun-verb combinations. This is somewhat surprising given how easily we make adjustments.

These experiments support a semantic subtraction view of sentence comprehension. Because the noun-verb unit is the central unit of meaning in a sentence an understanding of the combinatorial rules governing noun-verb combination is crucial to the understanding of the processes underlying the comprehension of novel sentences.

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Table 1

Example stimuli constructed with the verb "lost"

M.S. = Minimal Subtraction P.A. = Pragmatic Amplification Gen = General Change of State S.A. = Semantic Anomaly

Concrete Object:

Ernie lost a book.

1. Ernie misplaced a volume, and now he could not find it. (M.S.)
2. Ernie was not a good badminton player, but he liked to read. (S.A.)
3. Ernie did not have a volume. (Gen.)
4. Ernie ripped a volume. (P.A.)

Human Object:

Keith lost a teacher.

1. Keith's instructor got mad and stopped working for him, which was very inconvenient. (P.A.)
2. Keith's instructor stopped working for him, despite Keith's wishes. (M.S.)
3. Keith no longer has the same instructor. (Gen)
4. Keith boiled some potatoes before class. (S.A.)

Abstract Object:

Joe lost hope.

1. Joe was once very unhappy, but no longer is. (M.S.)
2. Something very good happened to Joe, and he is no longer unhappy. (P.A.)
3. Joe does not have ill fortune. (Gen.)
4. Joe lived in a brick house which he liked. (S.A.)

Sample stimuli constructed with the verb "stole" and human objects

Barry stole an accountant.

1. Barry had a CPA do some work for him. (Gen)
2. Barry gave up seeking and worked on an adding machine. (S.A.)

3. Barry hired a CPA away from another employer. (M.S.)

4. Barry paid a very high salary and hired away his rival's best CPA. (P.A.)

Jerome stole a mailman.

1. Jerome went to a convention, and sent postcards to his friends. (S.A.)

2. Jerome paid a very high salary and hired away his rival's best mail carrier. (P.A.)

3. Jerome went to a mail carrier for his services. (Gen.)

4. Jerome hired a mail carrier away from another employer. (M.S.)

Chuck stole a plumber.

1. Chuck had a plumbing specialist do some work for him. (Gen.)

2. Chuck paid a very high salary and hired away his rival's best plumbing specialist. (P.A.)

3. Chuck lived by the beach and had a toolbox. (S.A.)

4. Chuck hired a plumbing specialist away from another employer. (M.S.)

Figure 1

# 4 Noun Types

| 8 verbs of possession | Concrete<br>book<br>vase | Human<br>doctor<br>mechanic | Abstract+<br>loyalty<br>luck | Abstract-<br>poverty<br>doom |
|---|---|---|---|---|
| owned | Wayne owned a book. | | | |
| kept | | | | |
| bought | | Nick bought a doctor. | | |
| borrowed | | | | |
| traded | | | Dan traded loyalty. | |
| stole | | | | |
| lost | | | | Jerry lost poverty. |
| discarded | | | | |
| | Predicted literal verb meaning | Predicted metaphorical extension | | |

**32 cells x 2 sentences/cell = 64 stimulus sentences**

Figure 2

# Adjustment strategies used by paraphrase subjects

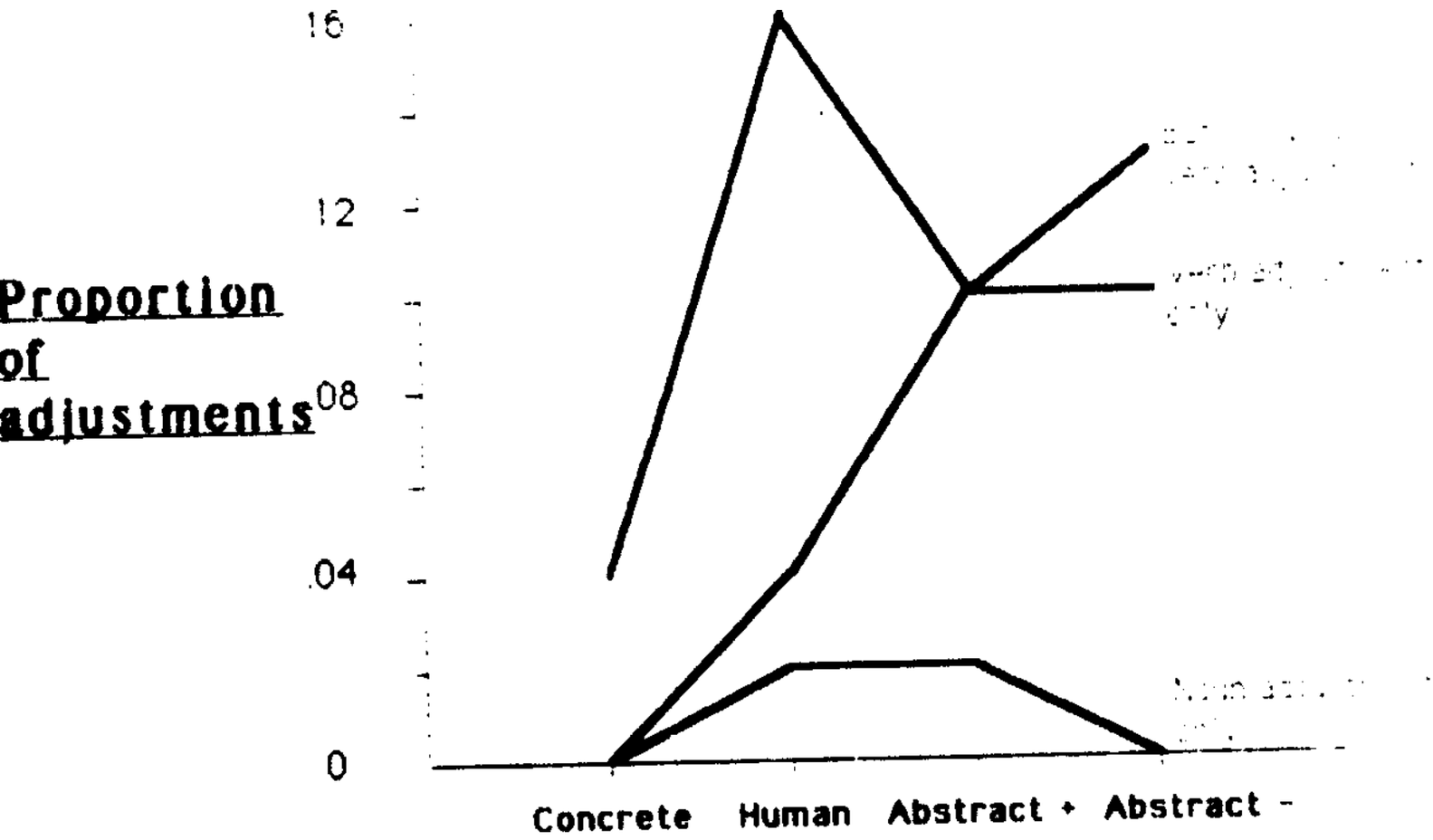


Figure 3

# *Proportion rote (no adjustment) responses by paraphrase subjects*

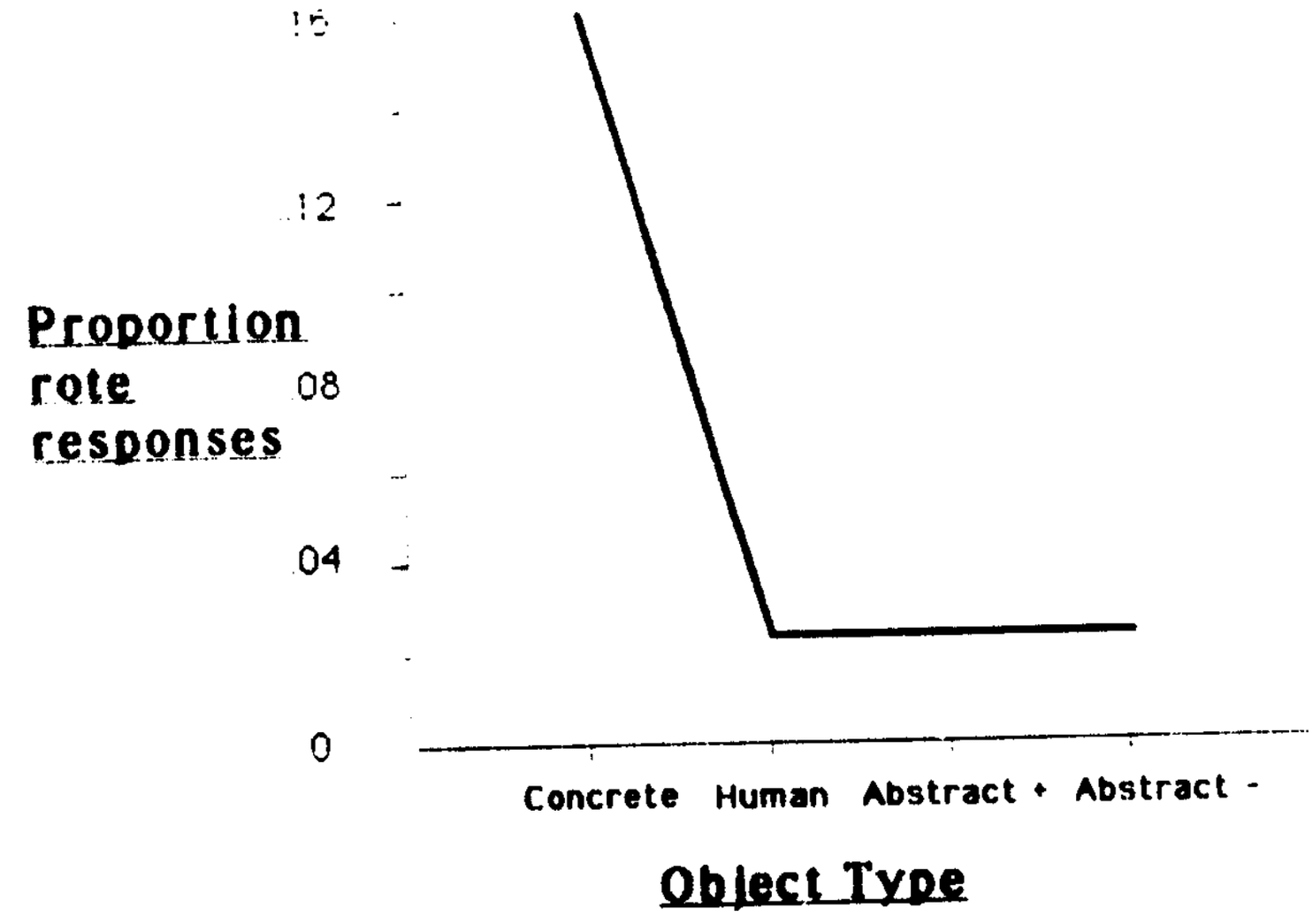


Figure 4

# Stimuli constructed with Concrete Objects

6 verbs of Possession

| | book | vase | lamp | chair | hammer | coat |
|---|---|---|---|---|---|---|
| kept | Stuart kept a book. | | | | | |
| bought | | Ned bought a vase. | | | | |
| borrowed | | | Simon borrowed a lamp | | | |
| stole | | | | Bud stole a chair. | | |
| lost | | | | | Daryl lost a hammer. | |
| discarded | | | | | | Marty discarded a coat. |

Figure 5

# Stimuli constructed with Human Objects

6 Verbs of Possession

| | doctor | mechanic | accountant | teacher | plumber | mailman |
|---|---|---|---|---|---|---|
| kept | Steve kept a doctor. | | | | | |
| bought | | Jim bought a mechanic. | | | | |
| borrowed | | | Bob borrowed an accountant. | | | |
| stole | | | | William stole a teacher. | | |
| lost | | | | | Ivan lost a plumber. | |
| discarded | | | | | | Herbert discarded a mailman. |

Figure 6

# Stimuli constructed with Abstract Objects

| 6 Verbs of Possession | luck | loyalty | poverty | doom | freedom | despair |
|---|---|---|---|---|---|---|
| kept | Tom kept luck. | | | | | |
| bought | | Ted bought loyalty. | | | | |
| borrowed | | | Larry borrowed poverty. | | | |
| stole | | | | Harry stole doom. | | |
| lost | | | | | Irving lost freeedom. | |
| discarded | | | | | | Wally discarded despair. |

Figure 7

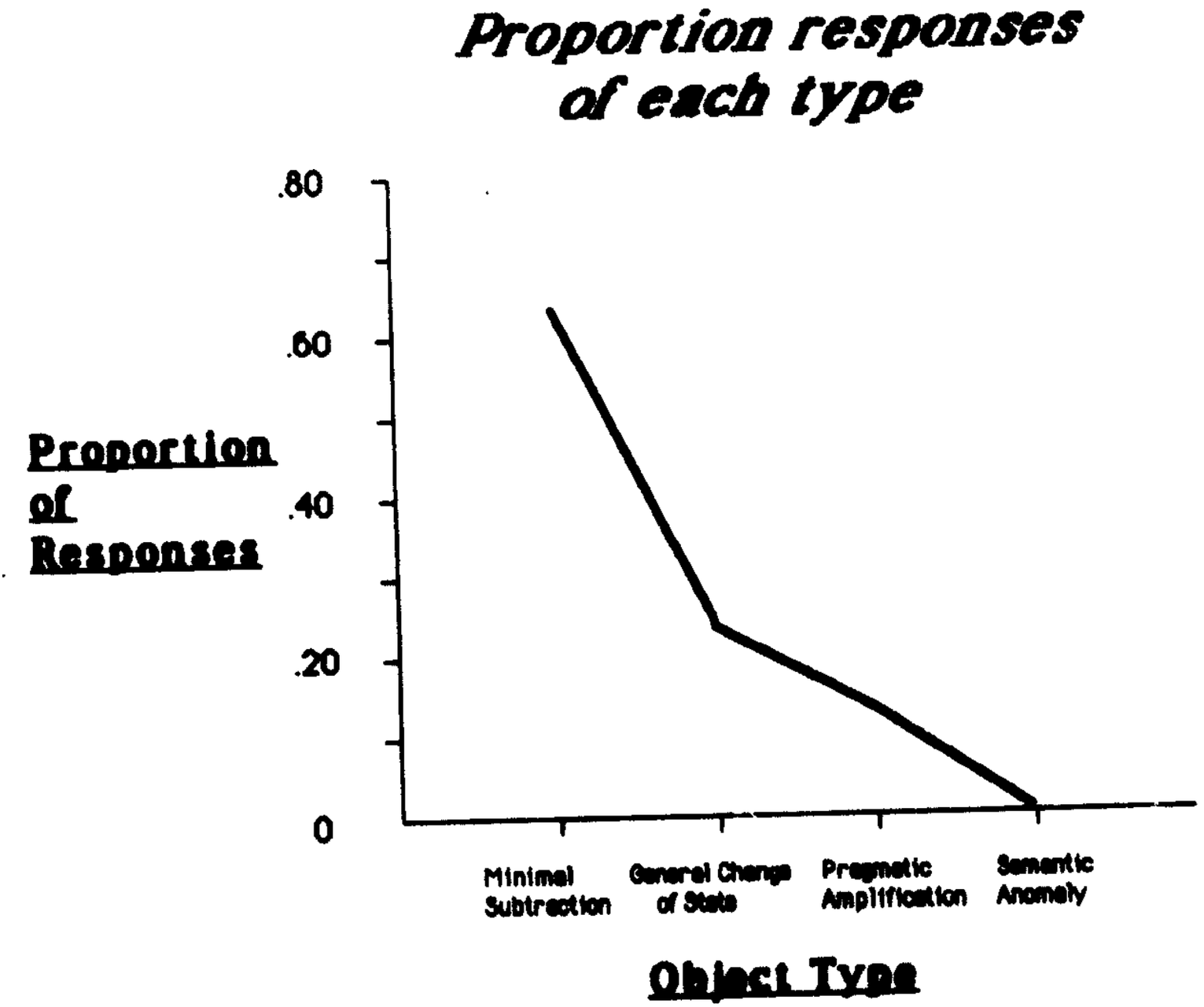
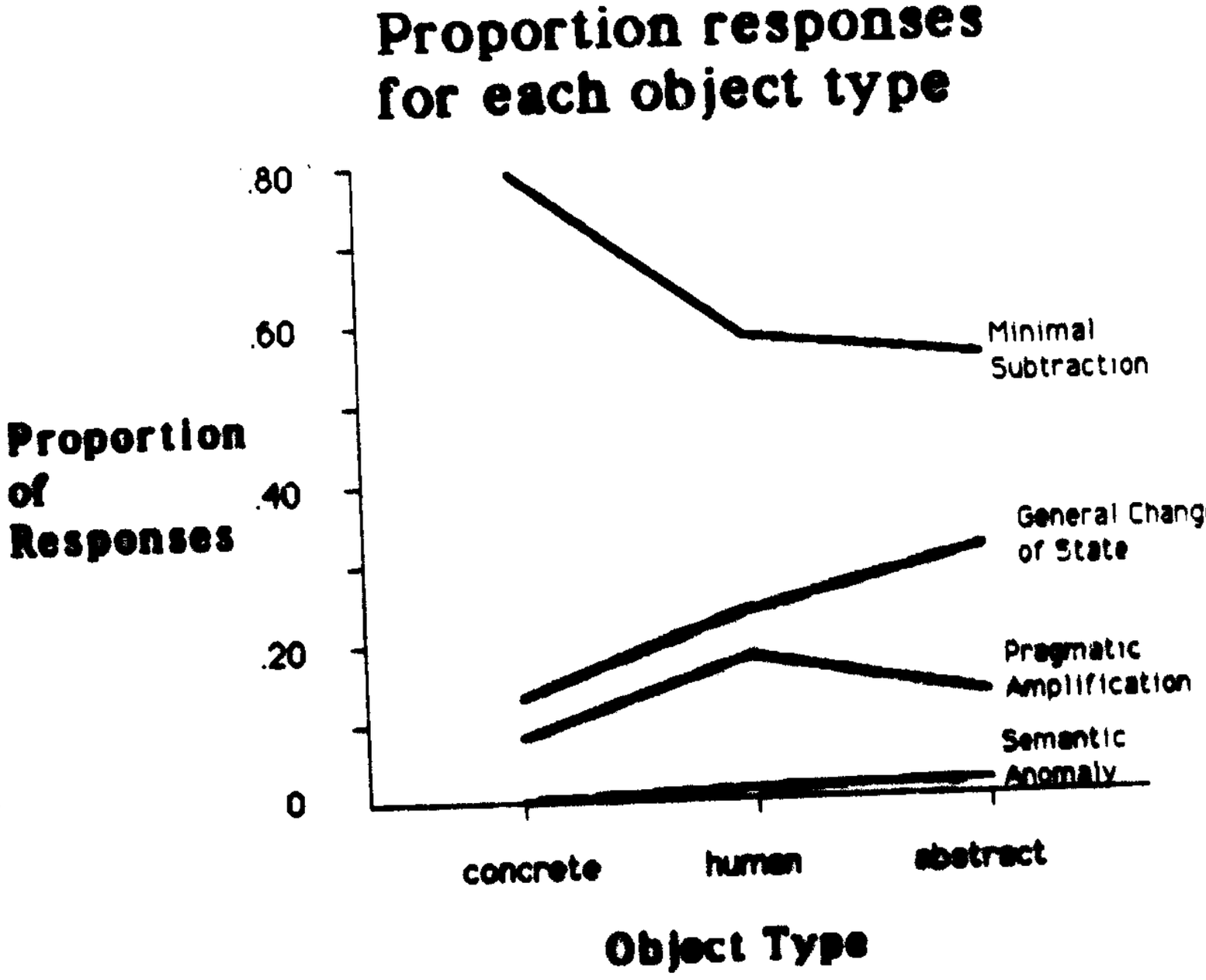

Proportion responses of each type
.80
.60
.40
.20
0
Proportion of Responses
Minimal Subtraction
General Change of State
Pragmatic Amplification
Semantic Anomaly
Object Type

Figure 8


Proportion responses for each object type
.80
.60
.40
.20
0
Proportion of Responses
Minimal Subtraction
General Change of State
Pragmatic Amplification
Semantic Anomaly
concrete
human
abstract
Object Type

## Appendix A

### Instructions used in Experiment 1

For each sentence which you will see, we would like you to write a paraphrase of that setence. What we mean by this, is that you should write what you think the sentence means in your own words. Try to avoid using the words that appear in the original sentence.

The way that we would like you to approach this task is to imagine that you are walking through the cafeteria and you overheard the sentence. Write down what you think the speaker might mean by the sentence. Try to do this naturally, as though you were really hearing such a sentence in real life, and thinking about what it might mean.

Here is an example of a sentence that you might see:

Janet is a dynamo.

You might want to write a paraphrase similar to this one:

Janet is a very energetic person.

Notice that you should keep the person's name unchanged. Do not try to paraphrase the names. Of course you need not paraphrase words such as "a," and "the." None of the other words that appear in the original sentences should be included in your paraphrase. Try to keep responses to one sentence. It should take you about one minute or less

to write each one. If you find yourself spending more time, you are probably thinking too hard.

Remember, please assume that the speaker intended something meaningful by each sentence, and make your interpretations as natural as possible.

## Appendix B

### Instructions used in Experiment 2

This experiment is about how people understand sentences. On each page you will see sentence followed by a set of possible meanings. Your job is to choose the best interpretation.

Please try to respond as naturally as possible. Imagine that you overheard the sentence while walking through a cafeteria. What would you think the speaker might have meant? Circle the response that seems what the speaker might have meant by the sentence. Please assume that the speaker intended something meaningful by each setence, and choose the interpretation that most accurately captures that intended meaning.

Here is an example of a setence that you might see:

Janet is a dynamo.

You might choose a response similar to this one:

Janet is a very energetic person.

Be choose an answer for every sentence. If you feel that none of the choices capture the meaning of the sentence, please pick the one that you feel is closest to the intended meaning. Try not to spend too much time on each sentence. Pick the choice that seems most natural to you.