The influence of semantic and morphological complexity of verbs on sentence recall: Implications for the nature of conceptual representation and category-specific deficits☆

Forouzan Mobayyen, Roberto G. de Almeida*

Department of Psychology, Concordia University, 7141 Sherbrooke Street West, Montreal, Que., Canada H4B 1RG

Accepted 12 August 2004

Abstract

One hundred and forty normal undergraduate students participated in a Proactive Interference (PI) experiment with sentences containing verbs from four different semantic and morphological classes (lexical causatives, morphological causatives, and morphologically complex and simplex perception verbs). Past research has shown significant PI build-up effects for semantically and morphologically complex verbs in isolation (de Almeida & Mobayyen, 2004). The results of the present study show that, when embedded into sentence contexts, semantically and morphologically complex verbs do not produce significant PI build-up effects. Different verb classes, however, yield different recall patterns: sentences with semantically complex verbs (e.g., causatives) were recalled significantly better than sentences with semantically simplex verbs (e.g., perception verbs). The implications for the nature of both verb-conceptual representations and category-specific semantic deficits are discussed.
© 2004 Published by Elsevier Inc.

1. Introduction

The study of the nature of semantic memory deficits has benefited enormously from research using normal, unimpaired participants. Marques (2000), for instance, examined how concepts—the units of semantic memory—and categories may be affected selectively, using a variant of the Proactive Interference (PI) paradigm. Marques' investigation centered on the dispute between two main proposals regarding the nature of semantic memory organization, which have been the focus of much debate in the cognitive neuropsychological literature. These proposals have been referred to as categorical and featural. From the perspective of the categorical proposal, semantic memory organization relies on major taxonomic categories such as *fruits*, *furniture*, etc., with the living/non-living distinction representing the topmost superordinate branching of conceptual knowledge. Semantic deficits, according to this view, arise due to functional lesions affecting major branches of knowledge. From the perspective of the featural proposal, concepts are represented by sets of features (e.g., perceptual and conceptual attributes such as *round* and *serves for sitting*). Category-specific deficits, according to this view, arise from functional lesions affecting sets of features that are shared by clusters of concepts. Whether these proposals are essentially disparate or complementary has not yet been established (see, e.g., Marques, 2000; for a review). If, for instance, feature bundles underlie categorical organization, then the two views share the same theoretical underpinnings in that concepts are in effect represented by feature sets.

Very few studies on semantic deficits have investigated the patterns of disruption of concepts labeled by verbs (e.g., Breedin, Saffran, & Schwartz, 1998;

Kemmerer, Tranel, & Barrash, 2001). What is more, none of these studies has provided direct support for either view of semantic memory organization—categorical or featural—which casts doubt on the generalizibility of such proposals for the nature of semantic memory units and their organization. What these studies have suggested, instead, is that semantic memory deficits cut across clusters of concepts and affect verbs according to their semantic complexity, not necessarily the semantic categories to which they belong. In the Breedin et al. and Kemmerer et al. studies, verb concepts seem to be disrupted according to their semantic attributes or the use of those attributes in different linguistic and metalinguistic tasks. For instance, Breedin et al. found that aphasic patients had more difficulty producing light (e.g., *go*) rather than heavy (e.g., *run*) verbs, suggesting that verb concepts may deteriorate according to the complexity of their semantic templates: the less complex a verb is, the greater its likelihood of being affected. This result is counterintuitive, for light verbs are often taken to be constituents of heavy verbs (i.e., *go* is taken to be a constituent of the semantic template of *run*). Thus, if their constituents (or features) are disrupted, heavy verbs should also be affected. In Kemmerer et al.'s study, however, patients who had difficulty with verb-analytic tasks (i.e., those that require inferential or decompositional processing; e.g., comparing items or judging their proprieties) often had no difficulty using those items referentially (e.g., naming actions), suggesting a dissociation between referential and analytic properties of verb concepts.

Although these studies have aimed at helping us to understand the manner in which verb concepts are affected by patterns of semantic dissociations, it is far from clear how verbs are represented in semantic memory, and the roles played by factors such as morphological and semantic complexity in the dissolution of knowledge pertaining to verb concepts.

The present experiment is part of an investigation of the patterns of memory disruption of verb concepts relying on data from normal participants. It follows from a series of experiments (de Almeida & Mobayyen, 2004) in which we employed a variant of the PI paradigm (Marques, 2000) to investigate how different verb classes may be affected as a function of the interference (PI build-up) generated by the computation of shared semantic and morphological codes. We assumed that recall of verb items across successive trials should be determined by the degree of shared semantic attributes of these items (features or categorical content) and, following Marques, we assumed that recall patterns would reveal information about the nature of semantic memory organization.

In our experiments, we employed verbs sharing semantic-structure features (lexical causatives such as *burn*, *bend*, and *melt*, which are taken to share the feature cause in their similar semantic templates), and verbs sharing semantic content but not semantic structure (perception verbs; e.g., *hear*, *watch*; and movement verbs such as *run* and *jump*). In addition, we examined the role of morphological complexity in the patterns of PI build-up by employing verbs that are morphologically complex but which differ in their semantic complexity (morphological causatives—such as *deepen* and *lighten*—and morphologically complex reiterative perception verbs such as *rewatch* and *rehear*). Our results showed that verbs sharing semantic features (causatives) engendered significant amounts of PI build-up, but so did verbs that belong to similar semantic categories but differ in their argument- and semantic-structure properties (perception and movement verbs). We also found that morphologically complex verbs—both those sharing semantic structure and semantic content—produced the greatest amount of PI build-up. These results suggest that both semantic features and semantic content may be reflected in the organization of semantic memory. Specifically, the results indicated that the categorical and featural proposals of semantic memory organization are not fundamentally distinct; rather they may complement each other in the organization of semantic memory.

The present experiment investigates the degree of interference generated by the verb classes used in our previous study, when these items are placed in sentence contexts. Studies on sentence recall have shown that recall is a function of propositional complexity: when numbers of words are controlled, the more propositions a sentence has, the less it is recalled in full (Kintsch, 1974). We relied on this finding from sentence memory research to manipulate semantic and morphological complexity of verbs that may or may not engender propositional complexity. We reasoned that if causatives are represented by semantic templates such as (1a), then both (1b) and (1c) denote two events, one in which the agent (*the gardener*) acts to cause a given event, and another in which the surface direct object of the verb (*the plants*) undergoes a change of state (*Y*, the resultative event; see, e.g., Rappaport Hovav & Levin, 1998). Thus, such verbs add propositional complexity to their sentences beyond their surface forms. Notice, however, that while the semantic complexity of the morphological causative *fertilize* in (1c) is morphologically transparent (it is marked by the morpheme *–ize*), the semantic complexity of the lexical causative *grow* in (1b) is morphologically opaque.

(1) a. [*x* ACT [CAUSE [*Y*]]
    b. The gardener grew the plants
    c. The gardener fertilized the plants

A similar parallel can be drawn between morphologically simple and complex perception verbs in (2).

However, contrary to causatives, perception verbs are not taken to be semantically complex—they simply denote a relation between agent and patient of the main verb as represented in (2a) and (2b). In the case of the morphologically complex perception verb, the reiterative morpheme (*re-*) does not add propositional complexity but modifies the temporal (i.e., reiterative) properties of the perception event, as shown in (2c) and (2d).

(2) a. The gardener smelled the plants
    b. The gardener re-smelled the plants
    c. [*x* PERCEIVE *y*]
    d. [AGAIN [*x* PERCEIVE *y*]]

In the present experiment, it was expected that sentence recall would be a function of the morphological and semantic complexity of the sentence's main verbs. More specifically, if causatives in fact engender sentence-propositional complexity, it was expected that they would produce the least amount of PI build-up and would be recalled less often in full than sentences with perception verbs. Moreover, it was expected that morphologically complex verb classes would produce greater amounts of PI build-up and worse recall overall than their simplex counterparts. Better recall—and less PI—of semantically complex items would indicate that, as obtained by Breedin et al. (1998), more complex verbs generate stronger memory codes and thus are easier to remember than semantically simplex items. Our predictions extended to the nature of semantic memory organization and the dispute between featural and categorical proposals. While lexical causatives share semantic features but no semantic content (e.g., *bend* and *grow* label different events), perception verbs share content (i.e., label similar events) but no semantic features. We reasoned that greater PI build-up of causatives could be taken as further support for the featural view, while greater PI build-up of perception verbs could be taken to support the categorical view.

2. Method

2.1. Participants

One hundred and forty English-speaking Concordia undergraduate students participated in the study.

2.2. Materials and design

Four classes of verbs were used, as discussed above: two semantically complex (lexical and morphological causatives; e.g., *grow* and *fertilize*), and two semantically simplex classes (morphologically simplex and complex perception verbs, e.g., *smell* and *re-smell*). There were nine verbs of each type, with all verbs forming nine quartets, with each verb quartet inserted into one sentence type (e.g., *The gardener grew/fertilized/smelled/re-smelled the plants*), thus forming 36 unique sentences.

Each verb class comprised one block of trials and each participant was presented with only one block. Each block consisted of four trials, with three sentences in each trial. The first three trials in each block consisted of sentences that contained verbs belonging to the same verb category (the PI-build-up trials), and the fourth trial (the PI-release or the control trial) consisted of sentences that contained verbs belonging to a different verb category. For this trial, three new sentences with verbs belonging to the morphologically simplex perception category were created. These sentences were used in all release trials.

2.3. Procedure

Participants were randomly assigned to one of the four blocks. Each block started with a 2-s warning asterisk, which was followed by the presentation of three sentences through headphones. The sentences were presented one at a time with a 2-s interstimulus interval. The sentence triad was followed by a distractor task in which a three-digit number was presented on the computer screen. The participant was required to count aloud from that number backwards by 3's for 9 s. After the distractor task, a question mark was presented on the screen accompanied by a beep, which signaled the participant to recall the sentence triad and write it down in a booklet. The question mark remained on the screen for 16 s. Two beeps signaled the end of the recall period and the beginning of the next trial. The experiment lasted approximately 7 min.

3. Results and discussion

For each sentence correctly recalled, participants received 1 point. The score for each participant on each trial was then converted into percentages. The raw data were thus comprised of the participants' percentage correct recall for each one of the four triads that each participant received. The present analyses took into account only full sentence recall. Fig. 1 depicts the mean percentage sentence recall for all verb classes. A 2 (semantic complexity: complex vs. simplex) by 2 (morphological complexity: complex vs. simplex) by 4 (trial) ANOVA revealed no effect of trial. This indicates that the classic PI build-up and PI release components of the paradigm are not obtained when sentences are employed. For the remaining analyses, only data from the three build-up trials were taken into account. Fig. 1 depicts the data corresponding to the two main linguistic variables—morphological and semantic complexity—collapsed across the three build-up trials. The results revealed a
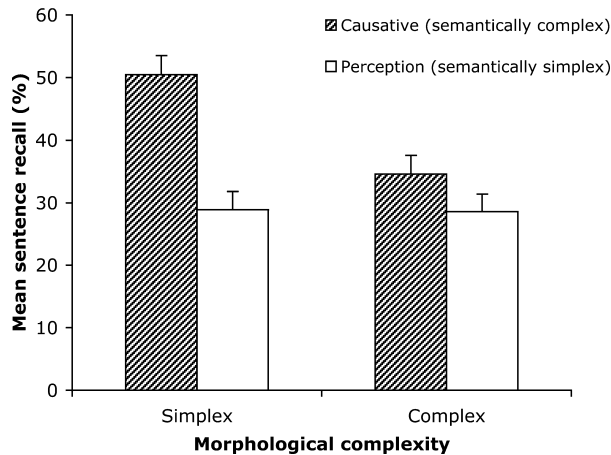
Fig. 1. Mean sentence recall as a function of the semantic and morphological complexities of the main verb.

significant effect of semantic complexity, $F(1, 34) = 15.795$, $p = .0004$, and a marginally significant effect of morphological complexity, $F(1, 34) = 4.05$, $p = .052$; and consistent with our prediction, morphologically simplex constructions were recalled better than complex ones. Moreover, there was a significant interaction between semantic and morphological complexity, $F(1, 34) = 5.79$, $p = .022$.

As can be seen in Fig. 1, sentences containing semantically complex but morphologically simplex causative verbs were recalled better than those containing morphological causatives and perception verbs. The difference between lexical and morphological causatives was significant, $F(1, 34) = 28.22$, $p < .0001$. There was no significant difference between the two types of perception constructions. In the comparison across semantic types, sentences with lexical causatives were recalled better than those with morphologically simplex perception verbs, $F(1, 34) = 52.17$, $p < .0001$. In the comparison between morphologically complex constructions, causatives also engendered better recall than perception, $F(1, 34) = 4.07$, $p = .048$.

These results show that semantically complex sentences—as determined by the propositional complexity introduced by their main verbs—engender better recall than semantically simplex ones. This seems to be at odds with the hypothesis that propositional complexity affects sentence recall. The finding that causatives—which by hypothesis share semantic features—lead to better sentence recall than perception verbs may suggest that concepts in semantic memory are encoded on the basis of

their shared semantic features, thus supporting the featural view of semantic memory organization. The results seem to point in the same direction as those obtained by Breedin et al. (1998) and suggest that complex verb concepts create stronger memory codes and thus are easier to recall than semantically simplex verbs. The results could also be taken to support a decompositional view of lexical-conceptual representation. It is not clear, however, whether the semantic complexity effect we obtained is a function of the computation of semantic features, which are constituents of verb templates, or whether it is an effect of inferential, analytic processes. Under this last interpretation, then, causatives are not semantically more complex than other verbs, but trigger a more complex set of meaning postulates (de Almeida, 1999).

Regarding the nature of category-specific semantic deficits, the present results seem to indicate that verb semantic classes may be affected according to their shared semantic-template features (or similar analytic inferences), rather than their categorical relations. Although no such results have been reported in the cognitive neuropsychological literature, the refinement of experimental materials according to verbs' shared semantic features may lead to both a better diagnostis of verb-semantic breakdowns and a better understanding of semantic memory.

References

Breedin, S. D., Saffran, E. M., & Schwartz, M. F. (1998). Semantic factors in verb retrieval: An effect of complexity. *Brain and Language, 63*, 1–31.

de Almeida, R. G. (1999). What do category-specific semantic deficits tell us about the representation of lexical concepts?. *Brain and Language, 68*, 241–248.

de Almeida, R. G., & Mobayyen, F. (2004). Semantic memory organization for verbs: Proactive Interference as a function of lexical structure and content. Manuscript submitted for publication.

Kemmerer, D., Tranel, D., & Barrash, J. (2001). Patterns of dissociation in the processing of verb meanings in brain-damaged subjects. *Language and Cognitive Processes, 16*, 1–34.

Kintsch, W. (1974). *The representation of meaning in memory*. Hillsdale, NJ: Lawrence Erlbaum.

Marques, J. F. (2000). The "living things" impairment and the nature of semantic memory organization: an experimental study using PI-release and semantic cues. *Cognitive Neuropsychology, 17*, 683–707.

Rappaport Hovav, M., & Levin, B. (1998). Building verb meanings. In M. Butt & W. Geuder (Eds.), *The projection of arguments: lexical and computational factors* (pp. 97–134). Stanford, CA: CSLI Publications.