SEMANTIC MEMORY ORGANIZATION FOR VERB CONCEPTS: PROACTIVE INTERFERENCE AS A FUNCTION OF CONTENT AND STRUCTURE

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Abstract

Semantic Memory Organization for Verb Concepts: Proactive Interference as a Function of Structure and Content

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The featural and the categorical proposals of semantic memory organization were investigated through the use of a variant of the release from proactive interference (PI) paradigm. Six categories of verb concepts were employed: verbs similar in semantic and argument structure (lexical causatives; e.g., *kill*); verbs similar in argument, semantic and morphological structure (morphological causatives; e.g., *darken*); verbs similar in semantic content (movement verbs; e.g., *walk*, and perception verbs; e.g., *hear)*; verbs similar in argument and morphological structure and semantic content (morphologically complex perception transitives; e.g., *re-watch*); and verbs similar in argument structure (intransitives; e.g., *sleep*). As controls, three categories of nouns (e.g., fruits) were employed. Three main hypotheses were examined in three PI experiments conducted on healthy young adults: (1) If verb concepts were represented on the basis of semantic structure, then verb concepts sharing semantic structure were expected to generate the most substantial amount of build-up effect; (2) If concepts were represented on the basis of shared semantic content, then words sharing semantic content were expected to generate the most substantial amount of build-up effect; (3) Assuming that noun and verb concepts were encoded differentially, a significant magnitude of PI release was expected as a function of a shift from pre-shift trials to the shift trials. Additionally, the role of morphological similarity as a plausible encoding dimension was explored. The results of the experiments indicated that both semantic feature and semantic content are reflected in the structure of semantic memory. Further, the findings suggested that morphological similarity is also a dimension along which concepts are encoded in semantic memory. Finally, significant magnitudes of PI release as a function of a class shift from verbs to nouns suggested that verbs and nouns are encoded differentially in semantic memory. The present findings have clear implications for an investigation of semantic deficits, namely category-specific verb deficits in neurological patients.

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The classification of memory into episodic and semantic subtypes was initially expounded by Tulving in 1972. Semantic memory is "a mental thesaurus, organized knowledge a person possesses about words, and other verbal symbols, their meaning and referents" (p: 34). More specifically, semantic memory is "our whole-world knowledge, including what we know about robins, what to do in a restaurant, and the history of civil war" (Kintsch, 1980). The structure of semantic memory has been brought under scrutiny through studies of category specific semantic deficits, or selective impairments confined to specific categories of semantic knowledge (Warrington & Shallice, 1984). There have been reports of patients with selective deficits for a variety of semantic categories such as fruits, vegetables and animals (Basso, Capitani, & Laiacona, 1988), abstract versus concrete words (Warrington, 1975), and nouns versus verbs (Caramazza & Hillis, 1991). The structure of semantic memory has also been investigated through memory research on normal populations (e.g., Marques, 2000). Memory research on both normal and impaired populations has led to two main proposals regarding the organization of semantic memory- the categorical and the featural proposals. According to the former, semantic memory is organized in terms of semantic categories (e.g., the category of fruits or vegetables), and according to the latter semantic memory is organized in terms of semantic features (e.g., fruits supposedly share the semantic feature CONSUMABLE) resulting in behavior apparently determined by category constraints. Whether or not these hypotheses are essentially the same or disparate has not as yet been well established (Marques, 2000). One reason for this uncertainty might be that the majority of studies of category specific deficits consider either dissociations within noun categories (e.g., a memory deficit for living things but not for nonliving things and vice versa), or dissociations between noun and verb categories (e.g., a memory deficit for nouns but not for verbs and vice versa). Verbs also label concepts in semantic memory; however, to this date, there have been no reported cases of category specific verb deficits cutting across different semantic categories of verb concepts (e.g., lexical causatives). Similarly, memory research on normal population has generally focused on the nature of the representation of noun concepts in semantic memory (e.g., Wickens et al., 1976; Marques, 2000).

The present study intended to investigate semantic memory organization for verb concepts in normal individuals. The idea was to use data from normal population to shed light on the nature of category-specific semantic deficits and how such deficits may be studied in the cases of verb-specific impairments.

This study is organized as follows: First, I briefly discuss the nature of category-specific semantic deficits followed by a review on the nature of verb-specific disruptions. I, then, turn to a discussion on the two main proposals for the representation of concepts in semantic memory-categorical and featural. This discussion sets the stage for the specific nature of the present study in which a variant on the release from proactive interference paradigm (Wickens, 1970; Marques, 2000) is implemented to explore the nature of verb concepts in semantic memory.

Category Specific Semantic Deficits

Cognitive neuropsychological research has revealed that brain injury or pathology can specifically deteriorate semantic memory while leaving intact domains of language such as phonology, orthography, syntax, and morphology. For example, Schwartz, Martin, and Saffran (1979) described the case of a neurological patient who could read aloud very well, albeit without comprehension, despite being profoundly impaired at many semantic memory tasks (e.g., a word-picture matching task, an oral naming or confrontation naming task). Other aspects of memory can also be preserved in the presence of semantic memory impairment. For example, De Renzi, Liotti, and Nichelli (1987) described a patient with preserved procedural, episodic and autobiographical memory who was severely impaired on all tasks tapping semantic memory.

Most patients with semantic memory impairment have a general impairment affecting all aspects of semantic memory. Some, however, have a selective impairment of particular categories of their semantic memory, or category-specific semantic deficits. Such impairments are characterized by an inability to recall items of a specific semantic category (Warrington & Shallice, 1984). Warrington (1975) was the first to investigate patients who appeared to have category specific semantic deficits. She described a patient with a progressive cerebral atrophy, later verified as Pick's disease, whose difficulties in word comprehension were far worse for concrete words than for abstract words. For example, he could correctly define *arbiter*, *supplication*, and *satirical*, but not *needle*, *acorn* or *poster*.

Since 1975 there has been abundant literature documenting various patterns of selective semantic impairment. The most frequently documented pattern, however, is the impaired knowledge of living things (e.g., animals) in the face of relatively preserved knowledge of nonliving things (e.g., human-made objects or artifacts). This pattern has been frequently documented in brain-damaged patients of various etiologies such as Herpes Simplex Encephalitis (HSE) (Gainotti & Silveri, 1996), cerebral infarction (Hart, Berndt & Caramazza, 1985), progressive atrophy of the temporal lobes (Basso, Capitani, & Laiacona, 1988), severe head injury (Farah, Hammond, Metha, & Ratcliff, 1989), and much less frequently in the dementia of Alzheimer type, DAT (Silveri, Daniele, Giostolisi, & Gainotti , 1991).

Gainotti and Silveri (1996) reported the case of a patient with HSE who demonstrated a selective inability to process information about animate objects (e.g., animals), and a spared ability to process information about inanimate objects (e.g., artifacts). The greater impairment in processing animate objects was consistent across tasks exploring the basic or a subordinate level of semantic knowledge using visual or verbal stimuli as input and various kinds of response modality (e.g., naming, matching to sample, yes/no response) as output. However, the pattern of impaired and spared semantic categories in LA was similar to that observed by other researchers (e.g., Warrington & Shallice, 1984) in that the living/nonliving dichotomy suffered from important, and systematic exceptions. For example, within the nonliving categories, food and musical instruments were selectively impaired, and within the living categories, body parts were selectively spared.

Farah, Hammond, Mehta, and Ratcliff (1989) also reported the case of a prosopagnosic patient, LH, who presented with a living/nonliving dissociation. Prosopagnosia is a type of associative visual agnosia in which the patient is affected with a greater impairment in the visual recognition of living things when compared to nonliving things. Thus, in addition to impairment in the visual recognition of objects, typical of associative visual agnosia, patients with prosopagnosia also demonstrate a category specific deficit in that visual agnosia is most severe for faces, animals, foods and plants compared to inanimate categories. LH was tested on questions about living and non-living things that were both visual and non-visual. For example, a living-visual question was *Do ducks have long ears?* whereas, a living-nonvisual question was *Are roses given on Valentine's day?*. The main purpose of the study was to determine whether the structure of semantic memory is fundamentally categorical (e.g., living things vs nonliving things) or modality specific (e.g. visual vs nonvisual). The findings revealed that LH had a selective semantic deficit for visual information about living things only. Thus, the observed semantic deficit appeared to be both modality specific and category specific. Farah et al. (1989) concluded that this finding suggests that the organization of semantic memory is perhaps both category-specific and modality-specific.

Further evidence for the dissociation between knowledge of living and nonliving things is gleaned from the study of patients in the early stages of the dementia of Alzheimer type (DAT). In a group of mild to moderate DAT patients, Silveri, Daniele, Giostolisi, & Gainotti (1991) documented a pattern of semantic dissociation similar to that reported in HSE patients: DAT patients exhibited more difficulty naming and recognizing living things in contrast to nonliving things. However, in this study only two tasks were used: a confrontation naming task where the patients named the presented pictures of living and nonliving things, and a verbal associate recognition task where the patients provided associate words for each item in the previous task. In addition, both tasks involved verbal processing only. Thus, the findings need to be interpreted with caution. Moreover, these findings could not be replicated by Gonnerman, Anderson, Devlin, Kempler, and Seidenberg (1997).

Gonnerman et al. (1997) examined a group of mild to moderate DAT patients using three tasks: oral naming or confrontation naming, superordinate comprehension, and word-picture matching tasks. In the oral naming task, patients were to name line drawings representing members of living (e.g., fruits) and nonliving (e.g., vehicles) categories. In the superordinate comprehension task, patients were presented with sets of pictures including one item (e.g., apple, chair) belonging to living and nonliving categories (e.g., fruit, furniture). The task was to select the item that belonged to the category named by the examiner (e.g., *point to the furniture*). In the word-picture matching task, the patients were presented with members of the same semantic category (e.g., fruit) and were asked to point to each member when it was named by the examiner (e.g., *point to the apple*). The findings revealed that the DAT patients did not have a selective impairment in naming and identifying members of living category in contrast to nonliving category. Thus, Gonnerman et al.'s (1997) findings did not replicate those of Silveri et al. (1991).

Overall, interpreting the results of DAT studies is impeded by the fact that there is a high degree of between-patients variability with regard to disease progression as well as neuropsychological profiles. It has, thus, been suggested that among DAT patients, a systematic, and detailed investigation of the pattern of deficits and the preservation of the functions of the individual patients may be more conducive to the development of models of normal semantic processing (Chertkow & Bub, 1990).

In an in-depth case study of a DAT patient, Mauri, Daum, and Sartori (1994) explored the hypothesis that category-specific impairments may occur in the early stages of DAT. A range of semantic tests involving verbal and visual processing (e.g. picture naming, part-whole matching, etc) as well as input and output modalities was administered to a patient, Helga, with mild dementia to assess whether category-specific deficit was restricted to certain materials or modalities. Her performance was compared to that of an HSE patient, Michelangelo, who presented with a well-documented semantic impairment specifically confined to the category of living things.

Similar to Michelangelo's performance, Helga demonstrated a prominent discrepancy in her ability to name, define, recognize or draw members of different semantic categories. More specifically, nonliving things were processed with higher accuracy than living things. Further, although Helga had a pronounced loss of knowledge of perceptual/visual features of living things (knowledge of the structural description), her general encyclopedic knowledge of non-perceptual attributes such as habitat, ferocity, or edibility was preserved. From Warrington and

Shallice's (1984) perspective, a loss of knowledge of visual or perceptual attributes appear to impair identification of living things to a greater extent than the identification of nonliving things.

Deficits of categories labeled by nouns do not represent the only kind of semantic deficits observed among neurological patients. In a number of studies, verb deficits have also been reported (e.g., Saffran, Berndt, & Schwartz, 1989). However, as alluded to previously, unlike category-specific noun deficits, category-specific verb deficits have not, as yet, been documented.

Verb Deficits

In the area of verb deficits, research on agrammatic aphasic patients abounds. Agrammatic aphasic patients are, mainly, patients with Broca's aphasia. Patients with Broca's aphasia have endured a frontal lesion as a result of which their speech is slow, halting and telegraphic with frequent emissions of function words (e.g. determiners, pronouns, prepositions) making their speech unintelligible. More specifically, they exhibit relative sparing of major content words (e.g. nouns, verbs, adjectives) and selective impairment of function words and grammatical markers. Aside from having difficulty producing function words, agrammatic patients have also been shown to have particular problems producing main verbs in their spontaneous speech (Myerson & Goodglass, 1972; Saffran, Schwartz, & Martin, 1980). Myerson and Goodglass (1972), for example, examined the spontaneous speech of three patients with Broca's aphasia who had different degrees of agrammatic impairment. In the speech of the most debilitated patient, there were approximately seven times as many nouns as verbs, and in the speech of the other two patients, there were twice as many nouns as verbs. This observation has been further corroborated through quantitative evidence reported by Zingester and Berndt (1990) and Miceli, Silveri, Villa, and Caramazza (1984). Miceli et al. (1984) argued that most agrammatic patients exhibit a double deficit at the level of lexical processing such that grammatical markers and main verbs may be differentially affected.

Difficulty producing main verbs, however, does not appear to be confined to agrammatic aphasics. Caramazza and Hillis (1991) reported two neurological patients, HW and SJD, who had suffered injury to their parietal and frontotemporal regions respectively. Their pattern of performance suggested modality-specific impairments mainly restricted to the class of verbs. In contrast to HW who demonstrated impaired verb processing in oral reading, SJD exhibited a verb processing deficit in written production. In Caramazza and Hillis' view, this dissociation indicates that the grammatical class of words represents a dimension of lexical organization, and that the grammatical-class knowledge might be represented redundantly in the phonological and orthographic lexicons and not in the semantic system.

Caramazza and Hillis' (1991) postulation was refuted by Danielle, Silveri, Giustolisis, and Gainotti (1993) and Daniele, Giustolisi, Silveri, Colosimo, and Gainotti (1994). Danielle et al. (1993, 1994) reported the cases of two neurological patients, GG and RA, whose verb-processing deficits appeared to alter conspicuously over time. More explicitly, initially the verb deficits of GG and RA were confined to overall production and production through one output modality respectively. However, in the course of time, as their disease progressed, the deficits began to appear in comprehension (GG) and other output modalities (RA). As Daniele et al. (1994) suggest, a semantic deficit may initially emerge in stringent tasks such as production and later on in other levels and through various lexical modalities. A semantic basis to verb-processing deficits has also been acknowledged by researchers studying semantic deficits in DAT patients (e.g., Robinson, Grossman, White-Devine, & D'Esposito, 1996).

Only a few studies on DAT patients have explored verb processing deficits. Among these is a study conducted by Robinson et al. (1996). Robinson et al. (1996) compared noun and verb picture naming in patients with DAT. In particular, the patients were required to name line drawings depicting actions and objects in a visual confrontation task. The findings revealed that patients had visual confrontation naming deficits not only for nouns but also for verbs. They were, however, significantly more impaired at naming verbs than nouns suggesting a noun-verb naming dissociation.

To further explore noun-verb or object-action naming dissociation in DAT, Cappa, Binetti, Pezzini, Padovani, Rozzini, and Trabucchi (1998) examined the naming performance of mild-moderate DAT and frontotemporal dementia (FTD) patients. Unlike Robinson et al. (1996), Cappa et al. (1998) examined confrontation naming employing realistic pictures of objects and actions. Their findings revealed a more severely impaired action naming than noun naming among both DAT and FTD patients. A clear-cut dissociation, however, was noted among the FTD patients only.

Unlike Robinson et al. (1996) and Cappa et al. (1998), Fung, Chertkow, Whatmough, Murtha, Peloquin, and Whitehead (2001) investigated action and object naming in DAT patients using computer animations resembling human action sequences. Line drawings were also used. Their study was innovative in that unlike most studies in which stagnant line drawings are used to investigate action naming, Fung et al. (2001) used dynamic pictures of actions. They cogently argued that to portray action being essentially "the process of doing" (p:327), dynamic stimuli are more ecologically sound than static stimuli. Logically, the findings of an action-naming study will not be valid unless the methodology used fits its purpose.

Fung et al. (2001) also investigated the reported living/nonliving dissociation in mild to moderate DAT patients (e.g., Silveri et al., 1991). Static pictures of living and nonliving things as well as animated pictures were employed. Similar to previous research on DAT and other brain-damaged patients, Fung et al. (2001) were able to delineate a significantly disproportionate naming deficit for living things relative to nonliving things. However, unlike previous research, Fung et al.'s (2001) findings did not demonstrate a disproportionate deficit in naming actions relative to objects. In other words, although the living/nonliving dissociation could be documented, the verb/noun naming dissociation could not be found regardless of the type of the stimulus set used, animated or static pictures of actions. Thus, Fung et al.'s (2001) study could not replicate Robinson et al.'s (1996) and Cappa et al.'s (1998) findings.

Verb-processing deficit was further explored by Breedin, Saffran, Myrna and Schwartz (1998) in a study with eight aphasic patients. Breedin et al. (1998) posited that verb complexity may play a role in the verb recall of these patients. Heavy and light verb production were examined in a verb story completion task (e.g., a story with verbs deleted from the second sentence). According to some analyses of verb-semantic representation (the decompositional, featural view; e.g., Rappaport-Hovav & Levin, 1997), verbs such as *go*, *have*, or *do* can occur as primitive features of other verbs, and are thus referred to as light verbs. For instance, the verb, *to go*, can supposedly occur as a feature of the verb, *to run*. In contrast, verbs such as *grab* or *sell* are assumed to be semantically complex containing primitive features in addition to other semantic components. These verbs are, thus, referred to as heavy verbs. The findings revealed that the semantic complexity of verbs had a significant effect on patients' verb retrieval such that patients were more adept at retrieving semantically more complex verbs (heavy verbs) than semantically less complex ones (light verbs). In Breedin et al.'s (1998) view, this finding is consonant with a decompositional or a featural view of concept representation. According to this view, which will be elaborated on in the following section, concepts are decomposable into primitive semantic features (e.g., the meaning of the verb *to run* can be decomposed into the semantic feature *to go* in addition to other primitive components). Additional semantic features in complex verbs, Breedin et al. (1998) argue, may suggest more connections among them, and more connections among semantic features, in turn, may suggest a stronger memory trace. Thus, in Breedin et al.'s view, the addition of semantic features may facilitate verb retrieval.

An opponent of the featural view could, however, contend that, quite contrary to Breedin et al's argument, the findings are against the featural view on the basis of the assumption that the number of semantic features should predict processing rate (Kintsch, 1974; Fodor, Garrett, Walker, & Parkes, 1980). More explicitly, semantically complex verbs presumably containing more semantic features should be retrieved more slowly than semantically less complex ones. Evidently, this is not what occurs in Breedin et al's (1998) study.

Put together, the above-mentioned studies on semantic deficits among others contribute significantly to our understanding of the nature of semantic memory and, as such, can help us build models of how semantic memory is organized. Selective impairments, in particular, have been instrumental in helping cognitive neuropsychologists determine the elements upon which concepts and categories are organized. Although the interest in category-specific semantic deficits has resulted in an enormous amount of empirical research documenting various patterns of selective semantic impairment, there has not been any consensus regarding what these patterns of impairment might impart regarding the nature of the stored semantic knowledge. As alluded to previously, verbs also label concepts in semantic memory, and one reason for the disagreement about models of semantic memory organization might be the fact that the nature of the representation of verb concepts has not been yet thoroughly investigated. Broadly speaking, however, semantic deficits have been construed as evidence for two kinds of semantic memory organization, the categorical and the featural organizations (Marques, 2000).

The Nature of the Representation of Concepts in Semantic Memory: The Categorical and the Featural proposals of semantic memory organization

From the perspective of the categorical proposal, category specific semantic deficits denote a direct organization of word meanings or concepts in terms of semantic categories (e.g. living vs nonliving categories). Within these categories are, presumably, concepts that are similar in terms of their semantic content. For instance, the concepts expressed by the words dog and cat being semantically similar are posited to be subsumed within the category of animals. From the perspective of the categorical proposal, then, the organization of knowledge in semantic memory is, fundamentally, categorical. In other words, semantic category is the organizing factor subsuming concepts that are similar in semantic content. The categorical representation of concepts is assumed to be reflected in brain structure, such that different semantic categories are either stored or processed in different brain regions. More specifically, it has been hypothesized that as the consequence of evolution, there are specific neural mechanisms in the brain essential for distinguishing evolutionary significant categories such as animals or body parts (Caramazza & Shelton, 1998). This hypothesis has been supported by several case studies where category appears to be the determining factor for the observed deficits affecting functional and perceptual features equally (Caramazza & Shelton, 1998; Hart, Berndt and Caramazza, 1985).

Hart, Berndt and Caramazza (1985) reported the case of a brain-injured patient, MD, who had significant difficulty naming members of fruit and vegetable categories but not food products outside the categories of fruits and vegetables.

Initially, MD was required to name a large array of items (line drawings, color photographs and actual objects) taken from the semantic classes of fruits, vegetables, and food products among others (e.g., animals, vehicles, tools, body parts, school, bathroom, kitchen, and personal items, clothing, colors, shapes, and trees). MD's difficulty appeared to be confined to naming individual members of the categories of vegetables and fruits. To examine his knowledge of the semantic categories of these items, MD was later provided with pictures of items from the categories of fruits, vegetables, animals, vehicles, and food products. He was asked to sort the pictures into piles based on their semantic classification and label the piles upon their production. His errors mainly consisted of confusions involving the categories of fruits and vegetables. For example, he categorized 3 out of 24 fruits as vegetables, and 6 out of 23 vegetables as fruits. Hart et al. (1985) further examined MD's knowledge of the members of the semantic categories by asking him to produce as many names as possible from 17 semantic categories. The mean number of fruit and vegetable names produced was significantly less than the mean number of names produced for other semantic categories. Hart et al. (1985) thus concluded that MD's ability to name and to categorize items of fruit and vegetable categories is compromised in contrast to his ability to name and categorize items of other semantic categories. To assess the possibility that MD's deficit may be restricted to stimuli processed through the visual modality, Hart et al. (1985) designed a further set of tasks: A set of 20 verbal definitions was developed for 10 fruit/vegetable items and 10 other items (e.g., animals, food products). MD named two out of 10 fruits and vegetables and all of the other items from their definitions. Next, MD was asked to name a set of items that he could not see but could feel with either the right or the left hand. MD named 6 out of 13 fruits, 11 out of 21 vegetables, and 11 out of 12 other items. A series of tasks was also developed to probe MD's comprehension of the names that he had difficulty producing. For instance, a 45-item word/picture matching task was developed in which MD was required to point to one of two pictures in response to an aurally presented word. MD was able to point to the pictures of fruits and vegetables accurately when the target word (fruit or vegetable) was presented aurally (word-picture matching task). He also did not demonstrate any difficulty categorizing the written names of fruits and vegetables under their respective semantic categories. From Hart et al.'s (1985) viewpoint, MD's pattern of responding in the above-mentioned tasks suggests that his deficit is not modality-specific, but semantic, for he was able to categorize items correctly when he was provided with their names, in a written or an aural form. His difficulty in categorizing pictures of fruits and vegetables could have been related to his inability to name them. In brief, in Hart et al.'s (1985) view, MD's selective naming deficit with two superordinate categories namely fruit and vegetable suggests that "the organization of the semantic system in some sense honors those categorical distinctions" (p: 440). In other words, MD's pattern of naming deficit may suggest that "the lexical-semantic system is organized categorically" (p: 440).

More support for the categorical proposal comes from other case studies reported by Hart and Gordon (1992), Kay and Hanley (1999) and Shelton, Fouch and Caramazza (1998). Beyond these, however, there is not much support for the categorical hypothesis of semantic organization. Warrington and Shallice (1984), for instance, documented the cases of two patients, JBR and YOT whose deficits did not conform to the living/nonliving categorization of semantic knowledge. JBR showed a deficit of living things, but he also had problems identifying some categories within the nonliving domain such as musical instruments and gemstones. YOT had a deficit of nonliving things (e.g., artifacts), but he also exhibited difficulties identifying body parts. To account for these findings, Warrington and Shallice (1984) posited that musical instruments and gemstones are similar to living things in that they are primarily distinguishable in terms of their perceptual attributes or features. Artifact and body parts, however, are categories of knowledge for which the feature, function, is most conspicuous. Thus, they contended that if brain damage selectively impairs visual semantic knowledge, this would have a more debilitating effect on living things than artifacts, with the exception of the categories of musical instruments, giving rise to the typical category specific patterns. The organization of semantic memory in terms of perceptual and functional features of objects has been coined as the sensory-functional theory of semantic memory organization (the SFT). However, the recasting of the living/nonliving categories in terms of sensory/functional features, as stipulated in the SFT, has not been supported by a number of studies. There are documented cases of patients who have living-thing deficits without the accompanying selective deficits for the perceptual properties as well as cases of patients with poor knowledge of visual information in the absence of an accompanying disproportionate deficit for living over nonliving things (Laiacona, Capitani & Barbarotto, 1997; Lambon Ralph, Howard, Nightingale, & Ellis, 1998).

These reports, however, do not alter the fundamental claim that category-specific deficits are associated with damage to distinct stores of knowledge whether they have living/nonliving or perceptual/functional structural organization as the SFT speculates.

The SFT is a variant of the featural proposal of semantic memory organization which is essentially a decompositional theory of concept representation. From the perspective of decompositional theories, concepts, being internalized mental representations, can be "exhaustively" (p: 112) decomposed into "a set of mental primitives" (p: 23) or basic features out of which concepts are constructed. (Jackendoff, 1990, p: 112). For example, the concept expressed by the word dog is assumed to be encoded in semantic memory by a finite list of mental features such as ANIMAL, MAMMAL, DOMESTIC, FOUR LEGS, BARKS etc (de Almeida, 1999a). From the perspective of decompositional theories, it is farfetched to assume that the concept DOG can be encoded as a list of dogs one has previously encountered. It is even more farfetched to assume that the concept DOG can be encoded as the list of dogs there ever have been and will be, or of all possible dogs because the brain is finite. Rather, we are "forced" to posit that the concept must be encoded as "a finite schema" (Jackendoff, 1995, p:24). Consequently, when encountering an immeasurably large array of objects, one familiar with the concept DOG will be able to judge whether the objects are dogs or not through comparing the composite representation of the concept DOG with the composite representation of arbitrary new objects and generating a judgment of conformance or nonconformance. In brief, decompositional theories contend that "most if not all lexical concepts are composites, that is they can be decomposed in terms of primitives" (Jackendoff, 1995, p: 25) (lexical concepts are concepts expressed by monomorphemic words from different categories such as nouns and verbs. Examples include concepts expressed by words such as *kill, dog,* or *elephant*).

Monomorphemic verbs (e.g., *kill*), being lexical concepts, are also believed to have composite representations in semantic memory. In particular, the extraction of primitive features such as causation in the case of lexical causative has led to substantial insight as well as controversy. Causative verbs are a class of verbs that are assumed to express causation through two sub-event templates such as [x CAUSE [E]] in which x is taken to represent the agent of causation and E is a resultative event or object of the supposedly primitive feature CAUSE. However, whether or not causative verbs are compositional is the subject of an ardent dispute and controversy (e.g., Fodor, 1970; Jackendoff, 1990; de Almeida, 1999b).

The verb *kill* in the sentence *John killed Mary* is assumed to be represented as follows: [CAUSE John [BECOME NOT ALIVE Mary]]. CAUSE, BECOME, and NOT ALIVE are presumably the likely primitives. However, as Jackendoff (1990) points out, there are "descriptive inadequacies oozing around the edges of decomposition" (p: 113). For example, "a rock *being not alive* does not qualify it as dead" (p: 113). Moreover, one can die slowly, but it is not logically possible to talk about someone becoming dead slowly. Fodor (1970) further contends that, whereas one can cause someone to die on Tuesday by shooting him on Monday, one cannot kill someone on Tuesday by shooting him on Monday. Unlike *cause to die, kill* points to only one event.

Despite arguments against the decomposition of lexical causatives, in particular, and decompositional theories in general (e.g., Fodor, 1970), most proposals of semantic memory organization are contingent upon the notion of decomposition. For example, according to the featural proposal, category specific semantic deficits can be perceived as secondary to selective damage to different types of semantic features resulting in behavior apparently confined to categories (Marques, 2000). In other words, differences in feature composition and organization between taxonomical categories are viewed as responsible for the observed category deficits. There are numerous studies that appear to lend support to the featural proposal of semantic memory organization. These studies include neuropsychological case studies of patients with brain injury (e.g., Warrington & Shallice, 1984), studies on normal populations employing a paradigm popular in memory research called "release from proactive inhibition" (Wickens, 1970), or studies that present data based on connectionist models of semantic memory (e.g., Farah & McClelland, 1991).

Connectionist modeling has been instrumental in research on semantic impairments, and ultimately semantic memory, because it promotes the understanding of semantic impairments in terms of damage to the normal semantic system. Connectionist modeling entails implementing semantic networks using the units, weights, learning algorithms, and other components of the connectionist approach (Rumelhart & McClelland, 1986). Semantic impairments, then, can be simulated by introducing anomalies in the model. Such simulations can provide important clues regarding the organization of semantic memory and the bases of semantic impairments. Such an approach was taken by Farah and McClelland in 1991.

On the basis of the SFT theory, Farah and McClelland (1991) speculated that perceptual features in semantic memory might be represented in a much lower ratio for artifacts than for living things. They incorporated this estimation in a connectionist model that took a representation of either a picture or a word as input and generated its semantic representation as output. The trained model was, then, damaged in differing degrees by eliminating either visual or functional semantic features. Damage to visual features yielded a selective impairment for living things; whereas, removing functional features resulted in a deficit specific to artifacts. In both cases, the severity of the deficit was associated with an increase in semantic damage. Thus, the model generated category-specific deficits even though its semantic representation was not organized by category. In other words, category specificity was seen as an emergent property of the semantic system arising from the underlying distribution of perceptual and functional features.

More support for the featural proposal can be gleaned from studies employing the Brown-Peterson (BP) (Brown, 1958; Peterson & Peterson, 1959) or the release from proactive interference (PI) paradigm (Wickens, 1970; Marques, 2000). The PI paradigm is based on the interference theory of short term memory (STM) (Peterson, 1967). According to this theory, forgetting occurs due to proactive interference (PI) defined as an impaired ability to recall an item due to its similarity to other items stored earlier in memory. For interference theory, then, PI is a retrieval phenomenon.

Wickens (1970, 1972) made use of the functional relationship between retention and similarity as a means of investigating the way materials are encoded in memory. The experimental paradigm used is the release from PI, and the tasks employed in these experiments are usually semantic in nature (e.g., word recall). In this paradigm, the experimental group is usually presented with three trials, each containing three items (a word triad) drawn from the same semantic category (e.g. nouns labeling fruits). However, on the fourth trial, the release trial, new items drawn from a different category are introduced (e.g., verbs). For the control group, all trials contain items drawn from the same semantic category, and the items on the fourth trial are identical to those presented to the experimental group on the release trial. If the retention of items on the release trial exceeds that of the control group on the corresponding trial, then, one may conclude that the release from PI may have occurred as a consequence of a decrement in interference. In other words, the release from PI occurs because of a shift on the fourth trial to a different semantic category. It is then argued that if PI release is obtained, the two semantic categories (the one whose items are presented on the first three trials and the one whose items are presented on the release trial) are encoded differently. By the same token, if PI is obtained on the first three trials, then the items of the semantic category presented on these trials are encoded similarly. These items could have been encoded either on the basis of their similar semantic features or similar semantic content, or perhaps both.

The inferred encoding characteristics, investigated through the use of the release from PI, are generally assumed to reflect both short-term and long-term memory processes. In fact, Waugh and Norman (1965) suggested that even immediate retention is mediated by both long term and short term processes. Hopkins, Edwards, and Cook (1972) reasoned that if the accrued PI is exclusively due to short-term processes, then it should dissipate rapidly. However, if long-term processes are implicated, then the recovery from PI should not be complete until after a 2-minute rest period. They set out to examine their assumption in a PI-release experiment.

In Hopkin et al.'s (1972) study, each participant in the experiment received four successive trials. Half of the participants, the control group, received a shift in the taxonomic category of the words on the fourth trial (e.g., from animal names to tree names), and the other half, the experimental group, received no taxonomic shift. Since a taxonomic shift produces a marked release from PI (Wickens, 1970), it was assumed that the control group would provide an index of the maximum amount of PI dissipation that might be expected in the experimental group. The groups were formed by the combination of two levels of word category shift (shift and no shift) and five different lengths of rest interval (0, 15, 30, 60, and 120 sec) interpolated between the third and fourth trials.

The findings revealed that there was virtually no difference in performance among the groups on the first three trials. They uniformly exhibited a decrement in recall or proactive interference. Performance on the fourth trial tended to improve as the rest interval increased indicating the dissipation of PI. However, the performance on the experimental group (no shift group) remained significantly below that for the control group (shift groups) connoting that substantial PI remained after a 2-minute rest. The dissipation of PI (PI-release) was further assessed through examining the rate of dissipation in PI with interpolated rest compared to the decrement in performance (PI) from trial 1 to trial 3. The mean PI from trial 1 to trial 3 was 1.63, and for the no-shift conditions, the mean improvement in performance was .81 from 0 to 120 sec of rest. This is clearly only 50% of trial 1 to trial 3 decrement.

In another experiment, Hopkins et al. (1972) introduced a rest interval of five minutes as the only rest interval. The results revealed that the trial 4 performance of the shift group was again significantly superior to that of the no-shift group suggesting that even after a five-minute interval, PI dissipation was not maximally achieved in the no-shift group. Further, whereas the amount of recall decrement or PI on the first three trials was the same as the previous experiment, the percentage of PI dissipation for the no-shift groups was approximately 69%. This observation further suggested that PI dissipation was only partially complete. On the basis of the observation that a considerable amount of PI remains following a rest interval from 2 to 5 minutes, Hopkins et al. (1972) concluded "it appears that performance in the release from PI paradigm is mediated by a combination of long-term and short-term memory processes " (p: 67). This conclusion was corroborated by Kincaid & Wickens (1970) in a similar experiment.

If in PI-release experiments long-term processes are implicated, then, memory performance in such experiments could be used to infer how words are encoded in semantic memory. This, in fact, constituted the fundamental premise in a series of experiments conducted by Wickens (1970), Wickens, Dalezman & Eggemeier (1976), and Marques (2000).

In two PI-release experiments, Wickens et al. (1976) investigated whether different amounts of PI release would occur for sets of words belonging to different semantic categories (e.g., fruits, vegetables). The semantic categories used were those of fruits (e.g., apple), vegetables (e.g., asparagus), professions (e.g., banker), flowers (e.g., lily), meats (e.g., mutton), consumable, alcoholic (e.g., brandy) and non-alcoholic (e.g., lemonade) liquids, and non-consumable liquids (e.g., gasoline). The words belonging to these categories differed with regard to the number of semantic features they shared (e.g., two, one and zero). For example, vegetables, Wickens et al. (1976) argued, share two features with fruits: they are both edible and are ground-based. Like fruits, meats are edible, but they do not grow from the ground, thus they share only one feature with fruits. Flowers, like fruits, grow from the ground, but they are not edible, hence sharing only one feature with fruits. Finally, professions are neither edible nor ground-based, thus sharing no feature with fruits. If the category of fruits constituted the control group, Wickens et al. (1976) argued that the category of professions, having no feature overlap with fruits, would show the most amount of PI release. Vegetables, however, having the most amount of feature overlap with fruits, would produce the least amount of PI release.

In the first PI-experiment, the category of fruits, vegetables, meats and professions were used as stimuli. On the fourth trial, all five groups of participants, control and experimental, received word triads drawn from the category of fruits.

However, on the first three trials, the groups differed with respect to the category of words employed. These categories included the names of vegetables, meats, flowers, professions, and fruits. The control group received word triads from the category of fruits on all four trials.

The findings were compatible with the featural proposal of concept representation in that the degree of PI release was inversely associated with the number of common features among words. For example, as expected, the vegetable group, sharing two features with the fruit group, showed the least amount of release; whereas, the profession group, sharing no features with the fruit category, showed the most amount of release. The meat and the flower group, both sharing one feature with the fruit category, showed similar amounts of release.

In the second PI-experiment, a different set of categories, the category of liquids, was used. On the fourth trial, all groups of participants, control and experimental, received a word triad from the category of consumable non-alcoholic liquids. On the first three trials, however, the groups differed with respect to the semantic category employed. These categories included the category of meats, alcoholic beverages, non-consumable liquids, professions, and non-alcoholic liquids. The control group received word-triads from the category of consumable non-alcoholic liquids on all four trials. The category of non-alcoholic liquids (the target trial group) shared two features with the category of alcoholic liquids (consumability and liquidity); one feature with the category of meats (consumability) and non-consumable liquids (liquidity), and no feature with the category of professions. Thus, it was expected that the category of professions and alcoholic beverages would generate the most and the least amount of PI release respectively.

As expected, the category of professions, sharing no common feature with the target trial group, showed the most amount of release. Unexpectedly, however, the category of alcoholic beverage exhibited more release than the category of meats and non-consumable liquids each of which sharing only one feature with the target trial group. Wickens et al. (1976) explained this paradoxical finding contending that for the alcohol group, an evaluative dimension, good-bad, might have been operating. In other words, participants might have construed the alcoholic beverages as being "bad", and this evaluative feature might have been involved in the participants' encoding of the first three word triads. On the fourth trial, they experienced a word triad they might have conceived as positive. Thus, for many participants in the group of alcoholic beverages, the shift on the fourth trial may have involved a shift in two features, namely the feature of alcohol as a chemical, and the evaluative feature of alcohol as being bad. This shift in two features, Wickens et al. (1976) argue, might have led to a greater amount of release than was expected in the category of alcoholic beverages.

Despite this unexpected finding, Wickens et al.'s (1976) study in its entirety lends support to the featural proposal of concept representation: concepts sharing common features (e.g., liquids) produce PI because they are encoded on the basis of similar features. In other words, when one attempts to retrieve these concepts, the same features or the same loci become activated leading to PI. When shifting to a different semantic category (e.g., fruits), one experiences a release from PI due to an alteration in the loci of features becoming activated. From the perspective of the featural proposal, thus, a release from PI suggests that the concepts on the shift trial are encoded on the basis of features different from those of the concepts presented on the pre-shift trials.

Additionally, Wickens et al.'s (1976) experiment suggests that the two proposals of semantic memory organization, namely categorical and featural, may not be fundamentally disparate. The study was intended to explore the effect of category membership on PI-buildup and release. The findings, however, essentially showed that the degree of release from PI as a function of category membership is inversely related to the feature overlap between different semantic categories (e.g., more release from fruits to occupations than from fruits to vegetables). This finding supports the assumption that the observed categorical effects might be overshadowed by feature composition and interrelation. This assumption is further supported in a recent PI experiment conducted by Marques (2000).

In a study on normal population, Marques (2000) compared the two proposals of semantic organization (category and feature) using a variant of the release from PI which incorporated cue presentation, a form of semantic priming. There were two conditions, the standard release condition and the cue condition. In the standard release condition, on all four trials, the control group received word triads drawn from the category of living things (e.g., animal). The experimental group, however, differed from the control group in that on the first three trials, word triads from the category of artifacts (e.g., vehicles) were presented. The fourth trial (the shift trial, non-living to living) contained word triads identical to those presented on the fourth trial of the control group (e.g., animals). This condition was contrasted to a cue condition prior to which participants were told that the words employed could or could not refer to means of transportation. This cuing served to reverse the control and the experimental group on the basis of a functional feature (e.g., means of transportation). The control group received only means of transportation: the first three trials contained names of vehicles and the fourth trial contained the names of animals that were also means of transportation (e.g., horse). The experimental group changed from the names of animals that were not means of transportation (e.g., dog) to names of animals that were on the fourth trial. In this condition, the featural and categorical information run opposite to one another allowing for an examination of their importance in terms of semantic organization. In the standard release condition, a continuing PI build up for the control group and PI release for the experimental group on the shift trial was expected. In the cue condition, if category was the organizing factor in semantic memory, and if functional features were not pertinent to the differentiation of living things, a repetition of results from the standard condition was expected (PI release on a categorical basis). Alternatively, however, if the role of functional features, or features in general, was pivotal to the organization of semantic memory, PI-release as a function of the presented cue was expected.

The findings from the standard release condition showed significant PI-build up and release on the basis of a shift from the non-living to the living category. The findings from the cue condition, however, showed PI-release on the basis of featural information. In other words, functional cuing produced PI-release against categorical information. These findings were further evaluated in another PI-experiment where a perceptual feature (e.g., size) was opposed to categorical information.

Similar to the previous experiment, a standard release condition was compared to a cue condition. In the standard release condition, the control group received only the names of living things (e.g., animals). The experimental group, however, changed from the names of furniture on the first three trials to the names of animals on the shift trial. Before participants were tested on the cue condition, they were told that the items they were required to recall would be larger or smaller than a human being. This cuing served to reverse the experimental and control groups based on a perceptual feature (e.g., size). The control group then received the names of things that were all larger than a human being: furniture on the first three trials and animals on the fourth trial (e.g., gorilla). The experimental group changed from animals that were smaller than a human being (e.g., dog) to animals that were larger on the fourth trial (e.g., gorilla). Similar to the previous experiment, for the standard condition, if category was more fundamental to semantic organization than feature, then PI- build up and release on the basis of a categorical shift was expected. In the cue condition, if the role of category was more prominent than that of feature, a repetition of results from the standard condition was expected. However, if the role of feature in semantic organization was more salient than that of category, PI build up and release as a function of perceptual cuing was expected in the cue condition.

As expected, the findings from the standard condition revealed significant PI-release as a function of a shift from the category of non-living things (e.g., furniture) to living things (e.g., animals). In the cue condition, although PI-build up and release were obtained as a function of the priming of a perceptual feature, they did not reach significance. However, the fact that a repetition of findings from the standard condition did not occur (e.g., release on the basis of category only) suggested that perceptual features may play a major role in semantic organization.

Overall, in Marques' (2000) study, the findings from the standard conditions of both experiments support a categorical as well as a featural organization of semantic memory. The categorical proposal is supported because significant PI-build up and release were obtained as a function of a shift in semantic categories (e.g., nonliving to living). The featural proposal is also supported because, as Marques (2000) suggests, there is a possibility that "a featural basis subsumes the observed categorical effect: the majority and/or the more salient features would be concurrent with the living/nonliving distinction, whereas others, including those that were cued, could oppose that distinction" (p: 701). This interpretation is also consonant with Wickens et al.'s (1976) findings.

The findings from the cue conditions, however, tend to support a featural organization of semantic memory. In the first experiment, functional priming produced significant PI-build up and release in spite of the categorical information, and in the second experiment, PI-build up and release were obtained as a function of perceptual priming, albeit not significantly. Overall, however, a featural interpretation of semantic organization cannot be made because first the features investigated were not large enough to allow a general interpretation of semantic organization. Second, functional priming appeared to play a more important role than perceptual priming. Further, a categorical interpretation of semantic organization cannot be entirely dismissed because although there was a condition in which a feature cue was opposed to a naturally occurring categorical shift, there was no condition where a category cue was opposed to a naturally occurring featural shift.

The present Study

As we have seen, researchers investigating semantic memory either through cases of semantic deficits or studies on normal population have not, as yet, reached a consensus regarding the nature of semantic memory organization. Some espouse the view that concepts are represented on the basis of primitive features (e.g., Farah & McClelland, 1991), others adhere to a categorical representation of concepts (e.g., Caramazza & Shelton, 1998), and still some others believe that the two proposals may not be really apart (Marques, 2000). One reason for this disagreement might be the fact that the majority of studies of semantic deficits have investigated either dissociations within noun categories (living versus nonliving) or dissociations between noun and verb categories. However, the nature of the psychological representation of verb concepts has not, as yet, been well explored. This shortcoming in memory research might be partly responsible for the hitherto equivocal knowledge regarding semantic memory organization. If we assume, following many researchers in the field, that category-specific semantic deficits result from selective damage to specific features of noun concepts, then we are automatically adhering to the view that concepts in semantic memory are decompositional. If so, then we must, logically, expect documented cases of category-specific verb deficits resulting from selective damage to specific features of verb concepts (e.g., *cause, go*). However, thus far, no such cases have been documented. This, in turn, casts doubt on the decompositional view of concept representation and on the nature of the dichotomy between the featural and the categorical proposals.

Aside from semantic deficit research, memory research on normal populations also has not been very helpful in clarifying semantic memory organization. Although there is a preponderance of research on the nature of the representation of different classes of nouns (e.g., *fruits, artifacts*), there are scant studies on the nature of the representation of different classes of verbs (e.g., lexical causatives). As alluded to previously, PI-studies on the nature of the encoding of nouns have mostly concluded that concepts are represented on the basis of primitive features. This conclusion, however, has been reached in the absence of empirical studies on the nature of the representation of different classes of verbs.

The present study was intended to correct for this shortcoming by conducting a series of PI-experiments on normal population. The purpose of these experiments was to explore the nature of the representation of verb concepts in semantic memory and thus shed light on the controversy on the nature of semantic memory organization. This controversy arises from studies with normal and impaired populations that thus far have concentrated mostly on category specificity of noun concepts.

Moreover, this study was motivated largely by the claim made in linguistics that the behavior of a verb is assumed to be in part determined by its meaning or semantics (Levin, 1993; Jackendoff, 1990). From this perspective, verb classes are defined on the basis of features that compose verb meanings, thus making them appropriate for an investigation of the nature of semantic memory organization. A brief discussion of the nature of the verbs employed in this study will follow.

Lexical Causatives

Lexical causatives are presumably a semantically coherent class of verbs and as such they are expected to exhibit similar behavior (Levin, 1994). More explicitly, the class of lexical causatives supposedly have the semantic feature CAUSE inherent in their meanings, and thus as a class they are considered to be semantically coherent. However, despite sharing semantic feature or structure, in general, lexical causatives denote events that do not share semantic content. For instance, the verbs *bounce* and *stop* denote different events such that *John bounced the ball* and *John stopped the ball* denote different activities that John performed with the ball. In both cases, however, the verbs denote that John is an agent of causation of the event of which the ball is the object that underwent a change of state or position in space. In general, these statements can be interpreted as meaning *John CAUSE the ball to bounce* and *John CAUSE the ball to stop*. In brief, lexical causatives are assumed to share semantic feature or structure but not semantic content.

Additionally, causative verbs display a set of properties that presumably reflect the meaning components of this class (Levin, 1993). For example, in terms of their argument-taking properties, they assume two arguments expressed as the subject and the object (e.g., *Mary killed John*).

Morphological Causatives

A morpheme is the smallest unit of a language that carries definable meaning or grammatical function. Morphological causatives (e.g., *lighten*) are multimorphemic verbs; that is they contain more than a single morpheme (e.g., a free morpheme, *light*, and a bound or suffix morpheme, *en*, in *lighten*). The suffix morpheme is attached to all morphological causatives, and thus verbs belonging to this class are considered similar in terms of their morphological structure. In other words, they are considered complex at the lexical level.

The suffix morpheme in morphological causatives is the one that explicitly marks the verb for denoting causation. Contrary to lexical causatives, where causation is assumed to be a morphologically unmarked semantic feature, morphological causatives do explicitly denote causation. However, as the proponents of decompositional theories attest to, not only the suffix morpheme, but the semantic feature CAUSE in the conceptual structure of morphological causatives is responsible for the expression of causation among such verbs. In other words, they are viewed as concepts that could be semantically represented as templates headed by the semantic feature CAUSE. If so, morphological causatives are complex not only at the lexical level (e.g., with a bound morpheme such as *en, ify*) but also at the semantic level (with the feature CAUSE). Additionally, morphological causatives are two-argument verbs in that they all assume a subject and an object (e.g., *Mary darkened the room*).

Intransitive Verbs

Intransitives (e.g., *sleep, pray*) take only one argument expressed as subject. These verbs may not be semantically similar, but in term of their argument-taking properties, they all resemble each other in that they only allow for one argument (the agent of the action denoted by the verb; e.g., *I sneeze, she prays*). Since they do not share semantic feature, but only syntactic (argument-structure) properties, they are not expected to produce any degree of PI build-up in a PI release task.

Movement Verbs

Verbs of motion are all verbs that denote bodily movement through space (e.g., *walk, jump*). Assuming a decompositional view of semantic representation, the meaning of movement verbs presumably includes the semantic feature GO. However, although all these verbs share, by assumption, the feature GO, none of them share the manner of movement. In other words, they differ in their semantic representation with respect to how the movement is carried out (Levin, 1993). Thus, as a class, movement verbs are presumably less coherent than lexical or morphological causatives. Additionally, motion or movement is a component of many verb meanings (e.g., contact verbs such as *touch* and *pound*). As Jackendoff (1990) proposes, even a verb such as *sell* or *buy* may have the feature GO in their semantic structures in the sense that to sell or to buy something involves the movement of an object from A to B.

In any event, sharing the feature GO does not suggest sharing similar events or similar content-as discussed in the case of lexical causatives. The meanings of movement verbs seem to be represented more on the basis of the semantic content

of motion than on the primitive feature GO. In other words, movement verbs seem to share semantic content beyond the sharing of the semantic feature GO. For instance, the verbs *walk* and *run* in *John walked home* and *John ran home* denote similar events that John performed
in the sense that they both involve bodily motion, and as such they share semantic content.

Perception Verbs

According to Levin's (1993) classification of verbs, the perception verbs used in this study fall under the categories of sight (e.g., *watch*) and see (e.g., *feel*) verbs. Both *sight* and *see* verbs usually take two arguments (e.g., *I saw the Mona Lisa*; *the crew observed the island*). Simply, they take the perceiver as the subject and what is perceived as the direct object. They can, however, be used as both transitives and intransitives.

As the label *perception* suggests, these verbs are tied to the actual perception of an entity, and in this sense they might be semantically coherent. However, unlike lexical causatives, in the case of these verbs, it is not very clear whether or not there is a primitive feature shared by all class members. One can, however, postulate that these verbs may all share the feature + PERCEPT (Segalowitz & de Almeida, 2002). But, similar to the case of movement verbs and the feature GO, in this case also the feature + PERCEPT could be the component of some other verbs belonging to a different verb class (Psychological verbs; e.g., *fear*). Thus, it is safe to assume that perception verbs may be semantically similar in that they all share the semantic content of perception. More explicitly, similar to movement verbs, perception verbs denote similar events and thus share semantic content beyond the sharing of the semantic feature +PERCEPT.

Complex Transitives

Complex Transitives (e.g., *rewatch*) are multimorphemic verbs containing a free morpheme (e.g., *watch*) and a prefix morpheme (e.g., re). The group of complex transitives used were all perception verbs belonging to the subset of sight verbs (Levin, 1993). Other than sharing the semantic content of perception, they were also similar in terms of their argument-taking properties: they all assumed two arguments expressed in terms of a subject and an object (e.g., *I rescan the disk*).

In addition to above-mentioned verbs, nouns were also used. Nouns were used both as controls and as a means of investigating whether or not their representation in semantic memory may differ from that of verbs.

Hypotheses

As discussed at length previously, the major premise of this study is that "memory performance is a reflection of how the materials were encoded in the first place" (Wickens et al., 1976, p: 307). As Marques (2000) points out, although a recall task used in the present study may not explicitly underscore semantic properties or organization, "these dimensions are present in recall and their contribution to both semantic memory organization and retrieval can be evaluated on proactive interference build-up and release effects" (P: 688).

Following the featural proposal, it was expected that verbs supposedly belonging to the semantically more coherent classes of lexical and morphological causative would produce the most substantial amount of PI build-up. In other words, despite their differences in morphological structure, if both lexical and morphological causatives are represented or encoded by the semantic feature CAUSE, they are expected to produce the most substantial amount of build-up effect. In contrast, verbs presumably belonging to semantically less coherent classes such as movement were expected to produce less PI build-up relative to lexical and morphological causatives. Conceivably, these findings would corroborate the decompositional, or the featural view of concept representation

Following the categorical proposal, for verbs sharing semantic content (e.g., movement verbs), the most substantial amount of PI build-up was expected. This finding would suggest that these concepts may be organized on the basis of their shared semantic content. In other words, the most substantial build-up effect for the category of movement verbs would have the implication that the exemplars of this semantic category may be organized within the semantic category of movement verbs on the basis of their shared semantic content. Additionally, significant magnitudes of PI build-up were expected for the noun categories (e.g., fruits) also sharing semantic content.

If, as Marques (2000) postulates, the featural and the categorical proposals are not really different, then similar magnitudes of build-up effects were expected for concepts presumably sharing semantic feature (e.g., lexical and morphological causatives) and concepts presumably sharing semantic content (e.g., fruits, liquids). Further, assuming that noun and verb concepts are differentially encoded (neither on the basis of shared content nor feature), a class shift from verb concepts on the pre-shift trials to noun concepts on the shift trials was expected to generate significant magnitudes of PI-release. In as much as the nouns used on the shift trials shared neither semantic content nor feature with the verb concepts used on the pre-shift trials, significant PI release on the shift trials would equally support the categorical and the featural proposal of semantic memory organization. Finally, since the intransitive verbs employed were not semantically similar, for these verbs, no significant PI build-up was expected

Experiment 1

The goal of this experiment was to investigate the possible PI build-up and release between classes of verbs differing along structural and semantic relations. As discussed earlier, it has been hypothesized that verbs such as lexical causatives share a semantic feature such as CAUSE, even though, in general, they denote events that do not share semantic content. For instance, the verbs *bounce* and *stop* denote different events such that *John bounced the ball* and *John stopped the ball* denote different activities that John performed with the ball. As discussed previously, lexical causatives are not morphologically marked and if any relation exists between these concepts, that is, if any PI build-up is obtained between them, then it can only be ascribed to their shared semantic representation. By contrast, morphological causatives share not only the semantic feature CAUSE, but morphological structure in the sense that they also express causation by attaching a causative morpheme (e.g., *-en* or *–ify*) to an adjective (e.g, *thicken*). Thus, not only do they share semantic feature (e.g., CAUSE), but they also have similar morphological structures. Movement verbs, as discussed, denote similar events and as such share semantic content but not feature and morphological structure. In addition to the above-mentioned classes of verbs, the present experiment also employed intransitive verbs-which as discussed share only argument structure.

On the basis of the featural proposal, it was expected that lexical and morphological causatives, supposedly sharing the conceptual feature CAUSE, would produce the most substantial build-up effect relative to other words. On the basis of the categorical proposal, words sharing semantic content (e.g., movement verbs) were expected to produce the most substantial build-up effect relative to others. Intransitive verbs, being semantically dissimilar, were not expected to produce any significant build-up effect. Moreover, a class shift from verb concepts on the pre-shift trials to noun concepts on the shift trials was expected to produce significant magnitudes of PI release.

Method

Participants

Participants consisted of 39 Concordia University students who were native speakers of English.

Apparatus

Stimuli were presented in white letters over black background on a 17" Macintosh monitor. Stimulus presentation was controlled by a Macintosh G3 computer running PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993). For data collection, each participant was provided with a twenty-four paged booklet prior to the experiment (Appendix A).

Stimuli

The stimuli consisted of 60 words, arranged in 20 triads, belonging to both noun and verb categories. The categories of nouns included fruits, flowers, meats, vegetables, and professions; and the categories of verbs included movement, intransitive, morphological causative, and lexical causative verbs.

Nouns

The noun triads included the following items: *banana, peach, apple; pear, grape, cherry; lemon, plum, apricot; kiwi, lime, melon* (Fruits); *iris, rose, lily* (Flowers); *pork, pastrami, ham* (Meats); *lettuce, mushroom, cucumber* (Vegetables); *banker, librarian, politician* (Professions). With the exception of kiwi, all fruit names were taken from Wickens et al.'s (1976) study. The mean frequency for each of the three triads of the fruit category were: 6.33, 45.33, 6.66, and 5, respectively.

The other noun triads were chosen on the basis of Francis and Kucera's (1982) norms. The mean frequencies for the triads of flowers, meats, vegetables, and professions were 29.3, 10, 1.33 and 7.66, respectively.

Verbs

The verb triads included the following items: *crash, heat, fly; rip, crush, freeze; drain, melt, grow* (Lexical Causatives); *shorten, soften, tighten; solidify, straighten, modify; sterilize, flatten, thicken* (Morphological Causatives); *walk, jump, climb; arrive, enter, approach; cross, descend, follow* (Movement verbs); *pray, walk, sneeze; sleep, think, die; sweet, bloom, arrive* (Intransitive Verbs). The mean frequencies of the verb triads were the following: morphological causatives- (3.66, 3, 7.66); lexical causatives- (45, 3.66, 28.33); intransitives- (37.66, 190.33, 19.66); movement verbs- (45.33, 75, 52)

Procedure

The participants were tested individually in the Psycholinguistics and Cognition lab of Concordia University. They were seated in front of the computer at a viewing distance of approximately 57 cm. Prior to the experiment, each participant was asked to report his or her consent by reading and signing a consent form (Appendix B).

A variant on the Wickens' (1970) proactive interference (PI) paradigm was developed. There were five blocks of words each of which consisted of four trials, and each trial consisted of a word triad. One block consisted of control trials only, and the other four blocks consisted of experimental trials. In each experimental block, the first three trials contained verb triads which changed to a noun triad on the shift trial (the fourth trial). The control block contained noun triads (fruit names) on all four trials. Within each trial, the order of the presentation of words was randomized by the computer so that each participant received a different order of word triads.

On each trial, a 2 s warning asterisk was followed by a word triad, one word at a time, each word appearing for 1 s. The participant was required to read the words and try to keep them in mind for later recall. The word triad was, then followed by a distracter task in which a three-digit number was presented on the screen. The participant was required to count aloud backwards by threes for 18 s. After the distracter task, a question mark presented on the screen accompanied by a beep signaled the participant to recall the word triad by writing it down in a booklet. The question mark remained on the screen for 8 seconds. Two beeps signaled the end of the recall period and the beginning of the next trial. At the end of each block, the participant was required to take a 2 min break.

Results

Across all the 20 trials, for each word correctly recalled, the participant received one point. The score for each participant on each trial was converted into percentages. The raw data, thus comprised the participants' percentage correct recall. The statistical methods employed included within-subject analyses of variance and subsequent Tukey tests at the alpha level of 0.05.

To determine whether participants' overall recall significantly changed as a function of word type and trial, a 5 (word type: fruit, movement, intransitive, lexical causative, morphological causative) by 4 (trial: 1, 2, 3, 4) within-subjects ANOVA was conducted on the participants' percentage correct recall (Appendix C, Table 1). The analysis revealed a significant main effect of word type, $F(4, 38)=9.35$, $p<.05$ and a significant main effect of trial, $F(3, 38)=24.97$, $p<.05$ (Appendix D). There was also a significant interaction between word type and trial, $F(12, 38)=3.38$, $p<.05$ (Figure 1).

Post hoc Tukey tests for movement verbs revealed significant mean differences between trial one ($M=92.35$, $SD=16.12$) and trial three ($M=80.33$, $SD=31.29$), $F(1, 38)=6.02$, $p<.05$, and trial two ($M=94.03$, $SD=12.94$) and trial three, $F(1, 38)=7.85$, $p<.05$. For Lexical causatives, post hoc Tukey tests revealed significant mean differences between trial one ($M=90.61$, $SD=22.86$) and trial two ($M=73.52$, $SD=35.20$), $F(1, 38)=12.23$, $p<.05$, and trial one and trial three ($M=72.67$, $SD=28.50$), $F(1, 38)=13.47$, $p<.05$. Finally for Morphological causatives, post hoc Tukey tests showed significant mean differences between trial two ($M=80.37$, $SD=25.04$) and trial three ($M=57.31$, $SD=34.17$), $F(1, 38)=22.23$, $p<.05$, and trial

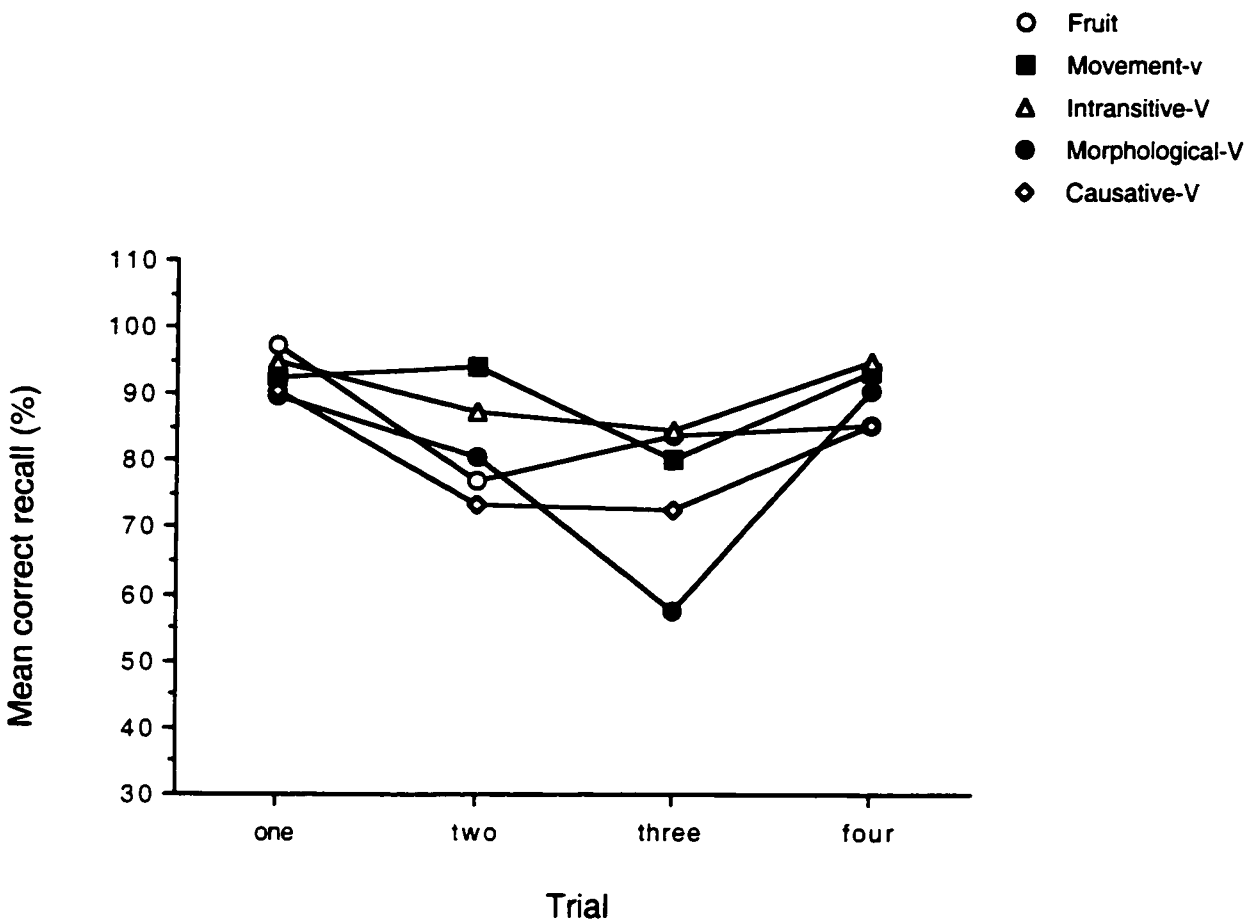

Figure1. The percentage correct recall as a function of word type and trial

one (M=89.76, SD=20.45) and trial three, $F(1,38)=44.03$, $p<.05$. SD=25.04) and trial three (M=57.31, SD=34.17), $F(1, 38)=22.23$, $p<.05$, and trial one (M=89.76, SD=20.45) and trial three, $F(1, 38)=44.03$, $p<.05$.

To determine whether or not PI release on the shift trials was significant when compared to PI build-up on the pre-shift trials, and to determine whether or not participants' verb recall significantly decreased over the pre-shift trials, 4 one-way within-subjects ANOVAs were conducted (Appendix C, Table 2, 3, 4, 5). The analyses revealed a significant main effect of trial for movement verbs, $F(3, 38)=5.15$, $p<.05$ (Figure 2), lexical causatives, $F(3,38)=5.36$, $p<.05$ (Figure3), and morphological causatives, $F(3, 38)=19.01$, $p<.05$ (Figure 4). The analysis for intransitives approached significance at $F(3, 38)=2.45$, $p=.06$. A post hoc Tukey test revealed a significant mean difference between the first three trials and the shift trial of morphological causatives only, $F(1, 38)=12.99$, $p<.05$. The post hoc Tukey test for movement verbs approached significance at $F(1, 38)=2.99$, $p=.08$. For the build-up trials only, the significant mean differences were the same as those reported previously. For movement verbs, there was an unexpected increment in recall from trial one to trial two; however, the magnitude of recall increment was not significant. For lexical causatives, there was no significant build-up effect from trial two to trial three. For morphological causatives, as reported previously, significant build-up effects were found from trial one through trial three. Finally, as expected, intransitives did not reveal any significant build-up effect (Figure 5).

To compare the amount of build-up effect between verb concepts differing in terms of semantic feature and content, a 3 (verb type: morphological causatives,

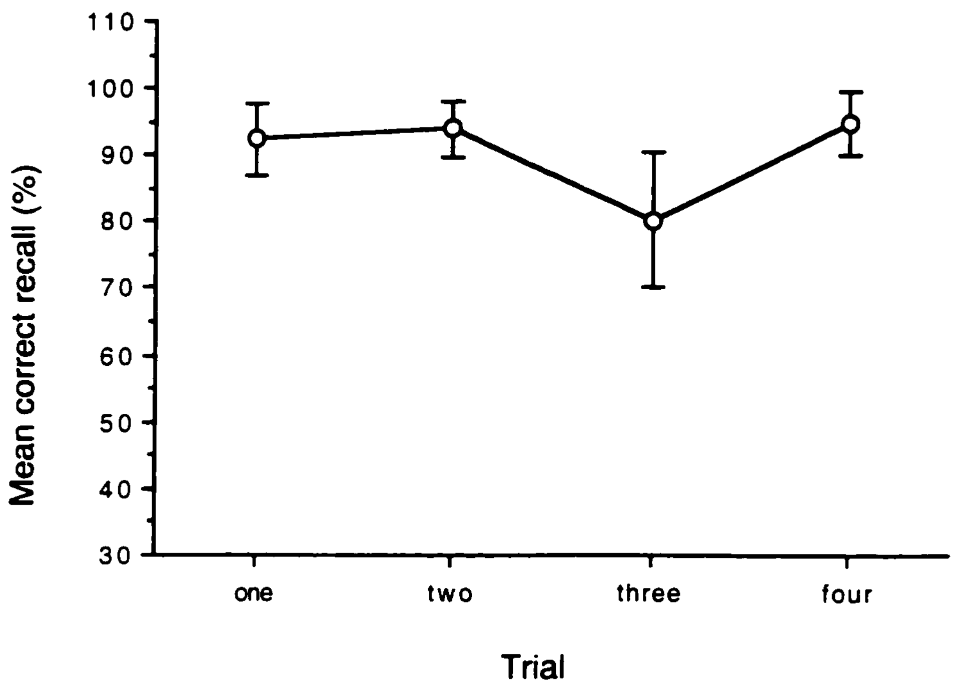

Figure 2. The percentage correct recall for movement verbs as a function of trial in Experiment 1

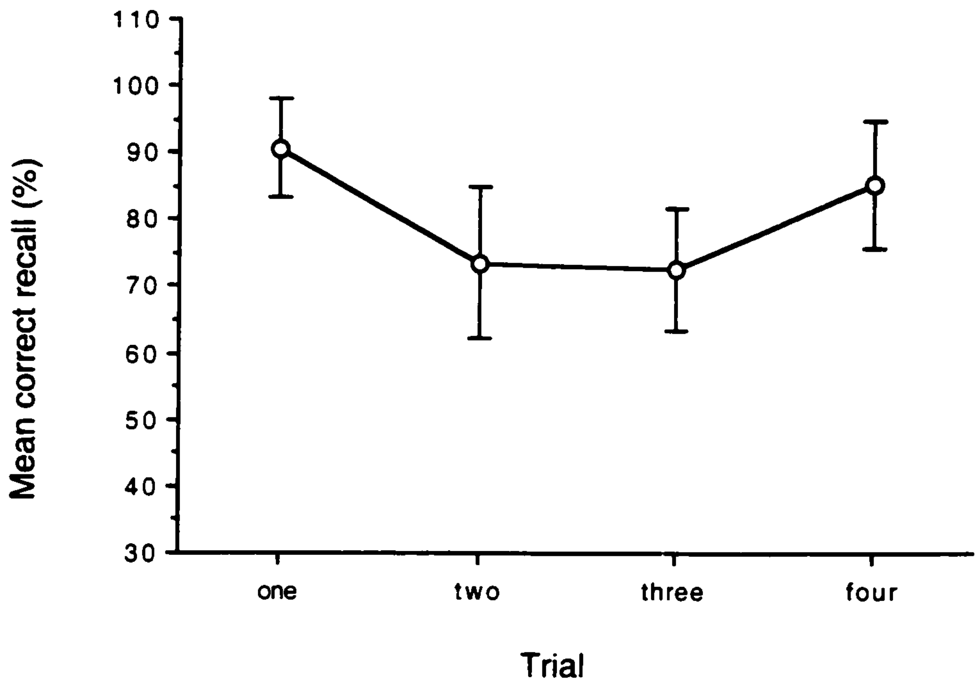

Figure 3. The percentage correct recall for lexical causatives as a function of trial in Experiment 1

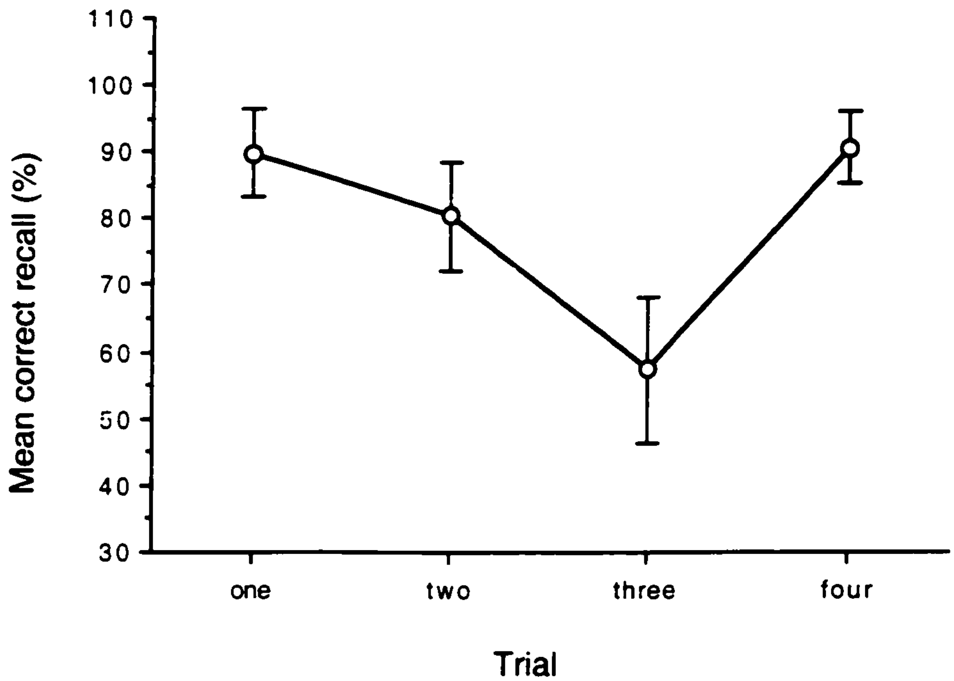

Figure 4. The percentage correct recall for morphological causatives as a function of trial in Experiment 1

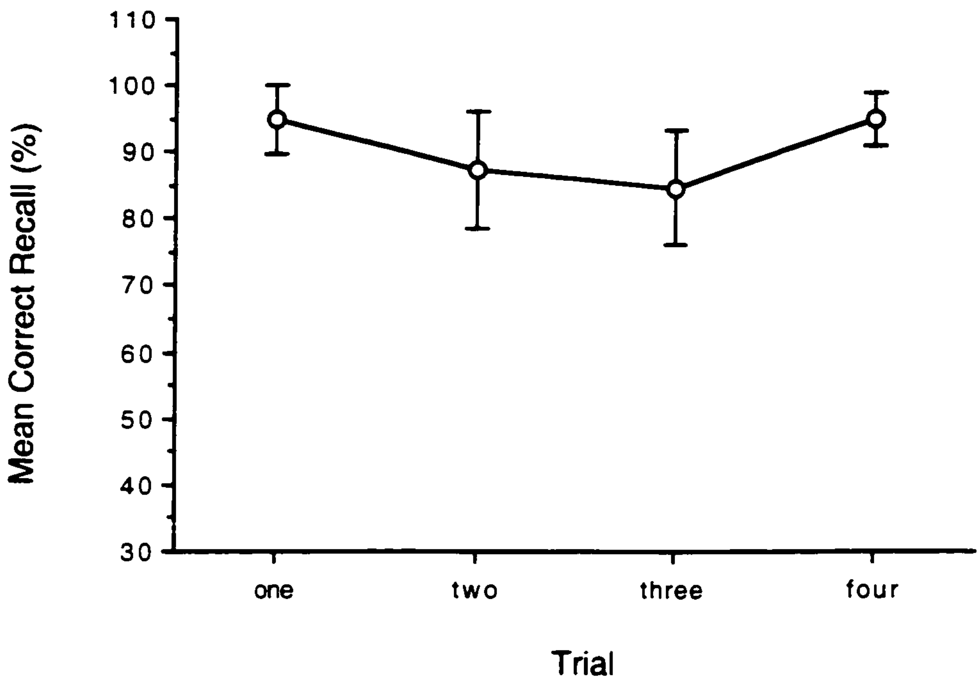

Figure 5. The percentage correct recall for intransitives as a function of trial in Experiment 1

lexical causatives, movement verbs) by 3 (trial: 1, 2, 3) within-subjects ANOVA was conducted (Appendix C, Table 6). The analysis revealed a significant main effect of verb type, $F(2, 38)=10.54$, $p<.05$, and a significant main effect of trial, $F(2, 38)=24.18$, $p<.05$ (Appendix E). There was also a significant interaction between verb type and trial, $F(4, 38)=4.05$, $F(2, 38)=24.18$, $p<.05$ (Appendix E). There was also a significant interaction between verb type and trial, $F(4, 38)=4.05$, $p<.05$ (Figure 6).

Subsequent post hoc Tukey tests revealed a significant mean difference between trial three ($M=57.31$, $SD=34.17$) of morphological causatives and trial three ($M=72.66$, $SD=28.50$) of lexical causatives, $F(1, 38)=8.84$, $p<.05$. A significant mean difference between trial two ($M=73.51$, $SD=35.20$) of lexical causatives and trial two ($M=94.02$, $SD=12.93$) of movement verbs was also found, $F(1, 38)=15.78$, $p<.05$. The mean difference between trial three ($M=80.32$, $SD=31.29$) of movement verbs and trial three ($M=72.66$, $SD=28.50$) of lexical causatives approached significance at $F(1, 38)=2.20$, $p=.07$. In addition, a significant mean difference between trial two ($M=80.36$, $SD=25.03$) of morphological causatives and trial two of movement verbs was found, $F(1, 38)=6.99$, $p<.05$. Finally, the mean difference between trial three of morphological causatives and trial three of movement verbs was significant at $F(1, 38)=19.86$, $p<.05$.

With regard to the control group (e.g., fruits), to determine whether or not participants' recall significantly decreased over the trials, a one way within-subjects analysis of variance and subsequent post hoc Tukey tests were conducted

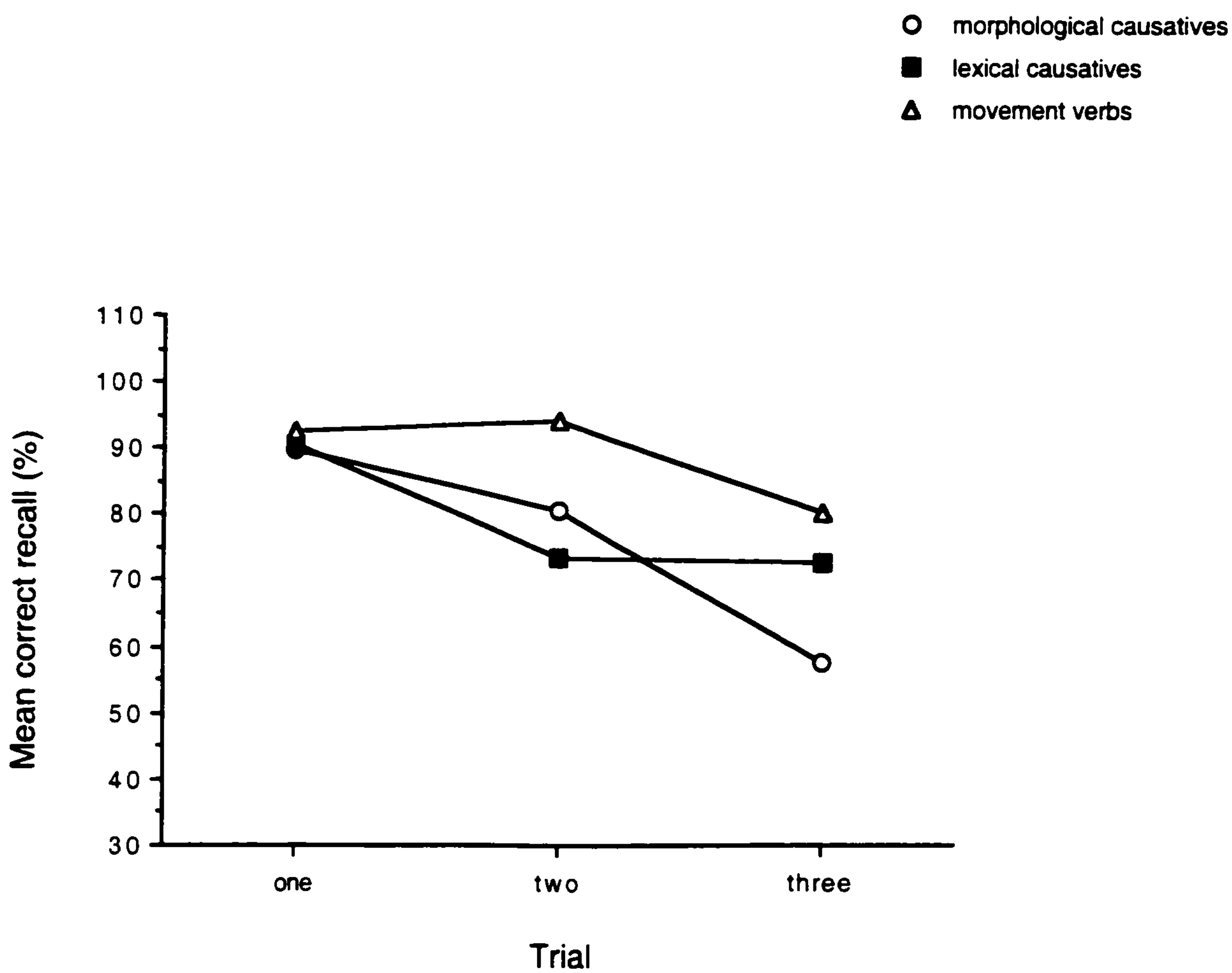

Figure 6. The percentage correct recall for morphological and lexical causatives and movement verbs as a function of trial in Experiment 1

(Appendix C, Table 7). The analysis revealed a significant main effect of trial, $F(1, 38)=6.05$, $p<.05$ (Figure 7). Subsequent post hoc Tukey tests revealed a significant mean difference between trial one ($M=97.44$, $SD=8.96$) and trial two ($M=76.92$, $SD=32.58$), $F(1, 38)=18.81$, $p<.05$, trial one and trial three ($M=83.80$, $SD=21.42$), $F(1, 38)=8.31$, and trail one and trial four ($M=85.48$, $SD=21.34$), $F(1, 38)=6.38$, $p<.05$. The mean differences between trial two and trial three and trial three and trial four were not significant.

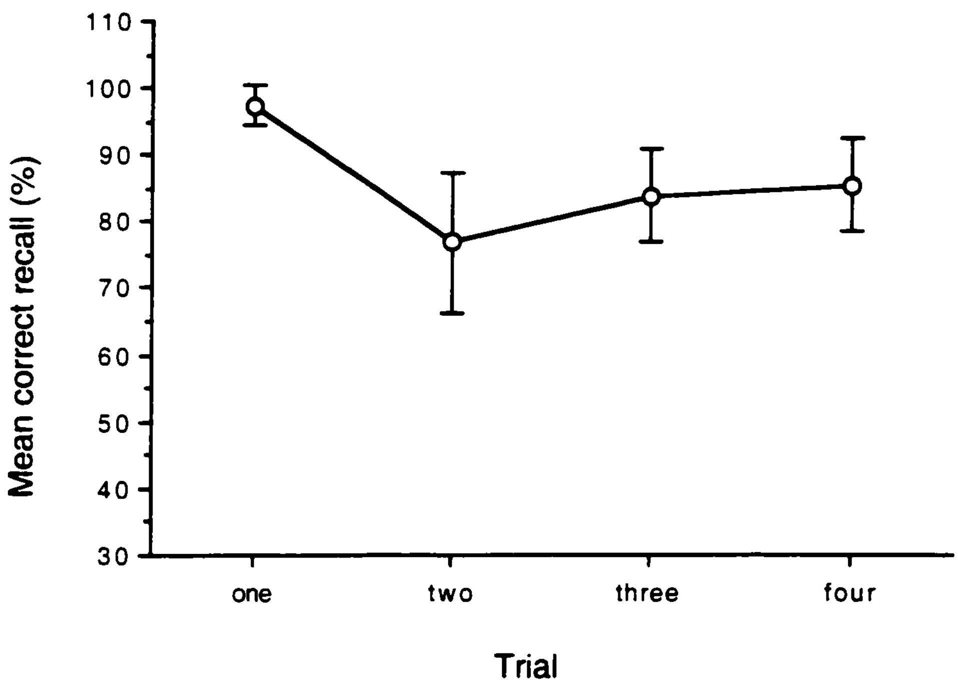

Figure 7. The percentage correct recall for fruits as a function of trial in Experiment 1

Discussion

The results of the present study substantiate the featural proposal by showing that verb concepts belonging to presumably semantically coherent verb classes (e.g., lexical causatives, morphological causatives) produce significantly more PI build-up effects than movement verbs. On both the second and the third pre-shift trials, morphological and lexical causatives produced significantly larger magnitudes of build-up effect than movement verbs supposedly sharing semantic content. This finding suggests that causative verbs (e.g., lexical and morphological) might be semantically encoded on the basis of the feature, CAUSE. The present findings also support the categorical proposal by showing that words sharing semantic content (e.g., movement verbs) also produce significant magnitudes of build-up effect. Fruits, sharing semantic content, did not generate a significantly coherent magnitude of build-up effect throughout the four trials. However, a significant decrement in recall between the first and the fourth trials was obtained, equally supporting the categorical proposal. Moreover, as expected, intransitives did not produce any significant build-up effect indicating that they are not encoded as a category in semantic memory.

There are some reasons to contend that the present findings may favor the featural proposal to a larger extent than the categorical one: First, as discussed earlier, morphological and lexical causatives accrued a significantly larger amount of build-up effect than movement verbs. Second, unlike the Wickens et al's (1976) study, the category of fruits, sharing semantic content, did not produce significantly coherent build-up effects throughout the four trials. This unexpected finding, however, could not be entirely interpreted in terms of the superiority of the featural over the categorical proposal. The order of the presentation of the blocks was not randomized, and as a result, all participants consistently received the block of fruit trials at the beginning of the experiment. It is very plausible that at the beginning of the experiment, participants were more motivated to perform optimally. Thus, the lack of coherent PI build-up effect for fruits may partially reflect the operation of such uncontrolled factors. In Experiment 2, an effort was made to eliminate this potential confound.

In addition, unlike Wickens et al's (1976) study where each participant received an extra point for recalling the sequence in which the words were presented, the experimenter in this study did not award any point to the correct sequence recalled. In fact, in the present study, Wickens et al's (1976) scoring method was made irrelevant through a randomization of the order of the presentation of words within each trial. One could, thus, speculate that the different scoring method employed in this study might have contributed not only to the unexpected pattern of recall obtained for the category of fruits, but also to the pattern of recall obtained for the other word categories. This possibility was explored in Experiment 2 where Wickens et al's (1976) scoring method was employed.

Experiment 2

Essentially, Experiment 2 constituted a replication of Experiment 1. The same semantic classes of verbs and the same procedure was adopted. However, an effort was made to employ a more stringent methodology. One of the main changes consisted of a randomization of the presentation of the blocks. Moreover, as controls, two groups of words were employed, namely Wickens et al's (1976) categories of fruits and liquids. Like the exemplars of the fruit category, the exemplars of the liquid category were similar in semantic content (e.g., lemonade). Also, the order of the presentation of the words within each trial was not randomized, so that Wickens et al's (1976) scoring method- with one point attributed to the correct order of words recalled- could be adopted.

Method

Paticipants

Participants consisted of 30 Concordia University students who were native speakers of English. None of the participants had already participated in Experiment 1.

Apparatus and Stimuli

The apparatus was the same as the one adopted in Experiment 1. The stimuli were the same 60 words for the noun and verb categories employed in Experiment 1, with the addition of a Liquid category with 12 items arranged in the following triads: *lemonade, shake, cocoa; cider, pop, juice; soda, orangeade, cream; kool-aid, Pepsi, tea*. The mean frequency of the triads in this category was 21.5, 10, 15.7, and 8.7, respectively.

Procedure

The procedure was the same as the one adopted in Experiment 1, except for the following changes: unlike Experiment1, in this experiment, there were two blocks of control trials containing word triads from the fruit and liquid categories. Within each trial, the order of the presentation of words was kept constant. The order of the presentation of the blocks was randomized, so that each participant received a different order of the blocks.

Results

Across all the 24 trials, for each word correctly recalled, the participant received one point. An extra point was also awarded if the participant correctly recalled the order of the presentation of the words. The score for each participant on each trial was converted into percentages. The raw data, thus comprised the participant's percentage correct recall. The statistical methods employed included within-subject analyses of variance and subsequent Tukey tests at the alpha level of 0.05.

To determine whether participants' overall recall significantly changed as a function of word type and trial, a 6 (word type: fruit, liquid, movement, intransitive, lexical causative, and morphological causative) by 4 (trial: 1, 2, 3, 4) within-subjects ANOVA was conducted on the participants' percentage correct recall (Appendix F, Table 8). The analysis revealed a significant main effect of word type, $\underline{F}$ (5, 29)=17.28, $\underline{p}$<.05 and a significant main effect of trial, $\underline{F}$(3, 29)=55.94, $\underline{p}$<.05 (Appendix G). There was also a significant interaction between word type and trial, $\underline{F}$ (15, 29)=15.34, $\underline{p}$<.05 (Figure 8).

Post hoc Tukey tests for movement verbs revealed significant mean differences between trial one ($\underline{M}$=94.44, $\underline{SD}$=21.59) and trial three ($\underline{M}$=59.99, $\underline{SD}$=37.56), $\underline{F}$(1, 29) =26.53, $\underline{p}$<.05, trial two ($\underline{M}$=96.67, $\underline{SD}$=20.21) and trial three, $\underline{F}$(1, 29)= 30.06, $\underline{p}$<.05, and trial three and trial four ($\underline{M}$= 98.87, $\underline{SD}$=16.31), $\underline{F}$(1, 29)=33.80, $\underline{p}$<.05. For Lexical causatives, post hoc Tukey tests revealed significant mean differences between trial one ($\underline{M}$=91.13, $\underline{SD}$=17.34) and trial two ($\underline{M}$=74.44,

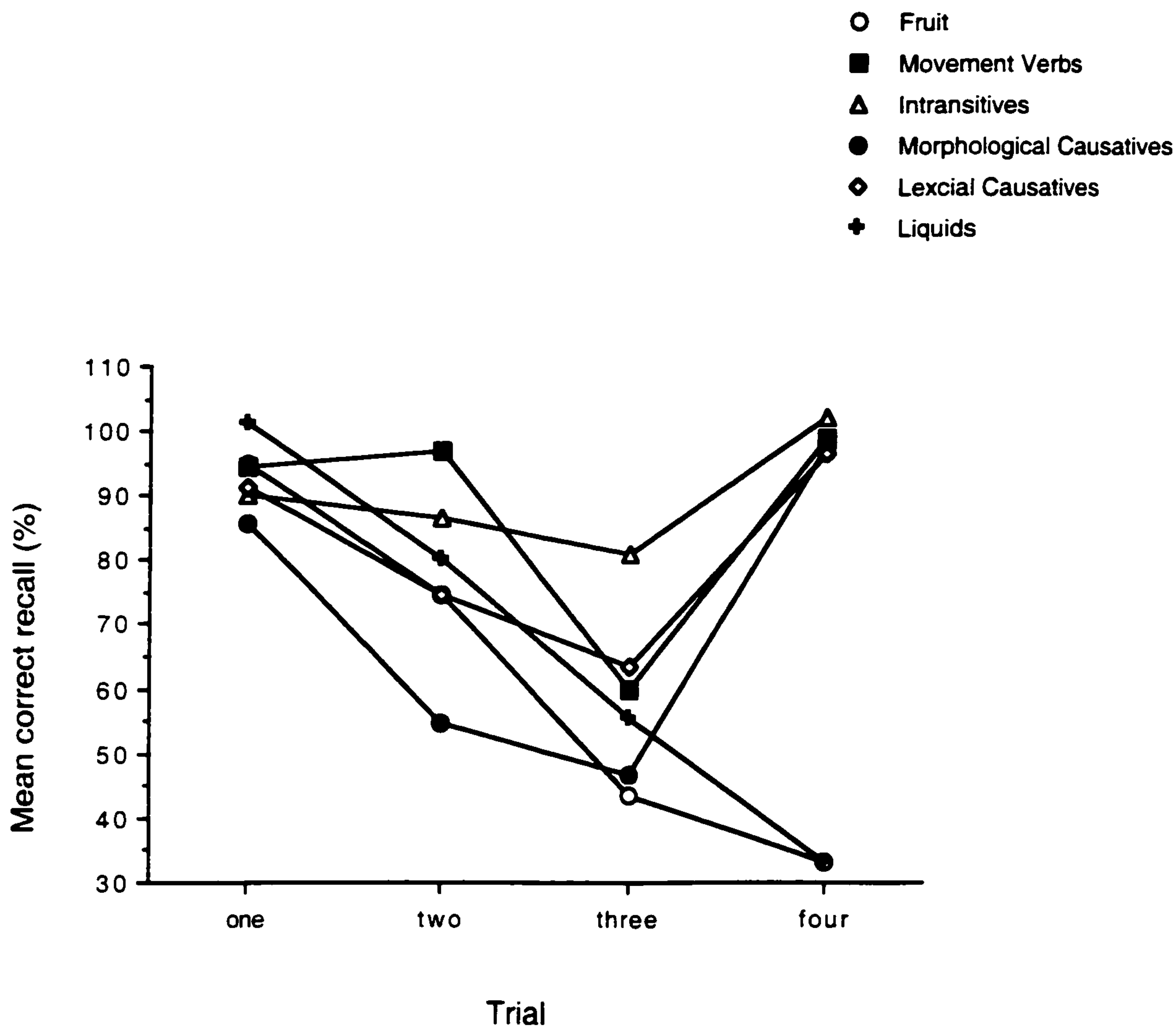

Figure 8. The percentage correct recall as a function

of word type and trial in Experiment 2

SD=34.62), $F(1, 29)=6.22$, $p<.05$, trial one and trial three (M=63.34, SD=35.39), $F(1, 29)=17.26$, $P<.05$, trial two and trial four (M=96.66, SD=18.21), and trial three and trial four, $F(1, 29)=11.04$, $p<.05$. Finally for Morphological causatives, post hoc Tukey tests showed significant mean differences between trial one (M=85.56, SD=20.86) and trial two (M=54.67, SD=37.32), $F(1, 29)=21.34$, $p<.05$, trial one and trial three (M=46.65, SD=41.60), $F(1, 29)=33.85$, $p<.05$, trial two and trial four (M=97.76, SD=28.93), $F(1, 29)=41.51$, $p<.05$, and trial three and trial four, $F(1, 29)=58.40$, $p<.05$.

To determine whether or not PI release on the shift trials was significant when compared to PI build-up on the pre-shift trials, and to evaluate whether or not participants' verb recall significantly decreased over the pre-shift trials, four one-way within-subjects ANOVAs and subsequent post hoc Tukey tests were conducted (Appendix F, Table 9, 10, 11, 12). The analyses revealed a significant main effect of trial for movement verbs, $F(3, 29)=19.50$, $p<.05$ (Figure 9), lexical causatives, $F(3, 29)=9.36$, $p<.05$ (Figure 10), morphological causatives, $F(3, 29)=18.42$, $p<.05$ (Figure 11), and intransitives, $F(3, 29)=3.29$, $p<.05$ (Figure 12). Subsequent post hoc Tukey tests revealed significant mean differences between the first three trials and the shift trial of movement verbs, $F(1, 29)=7.58$, $p<.05$, lexical causatives, $F(1, 29)=10.07$, $p<.05$, morphological causatives, $F(1, 29)=29.16$, $p<.05$, and intransitives, $F(1, 29)= 8.19$, $p<.05$. For build-up trials only, the significant post hoc Tukey tests were the same as those reported previously. As in Experiment 1, no significant PI build-up effect was found for intransitive verbs.

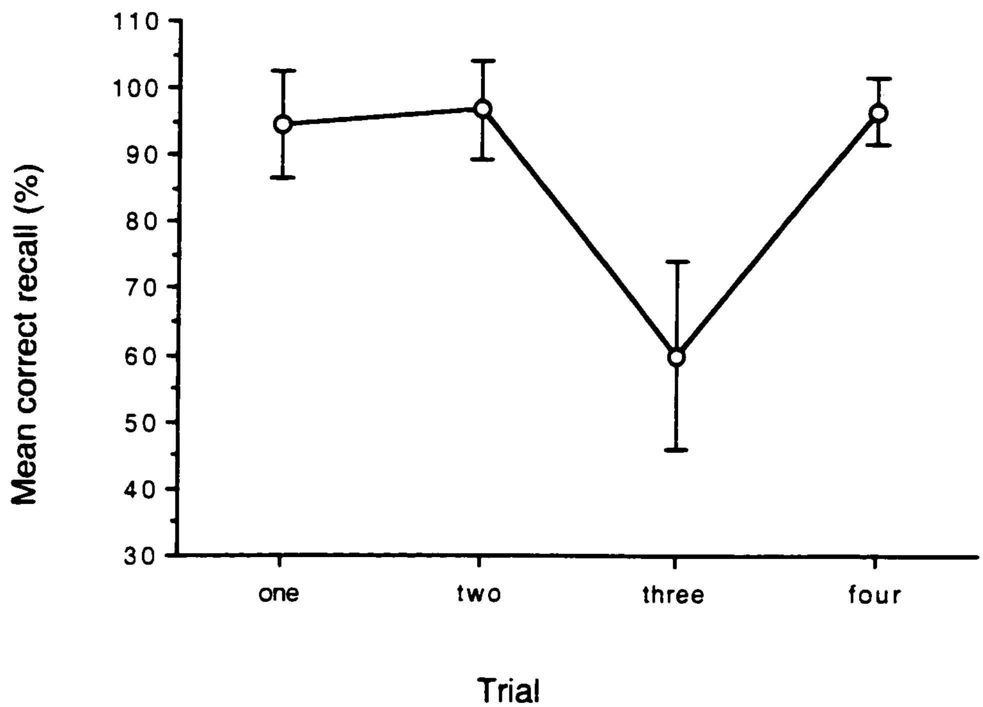

Figure 9. The percentage correct recall for movement verbs as a function of trial in Experiment 2

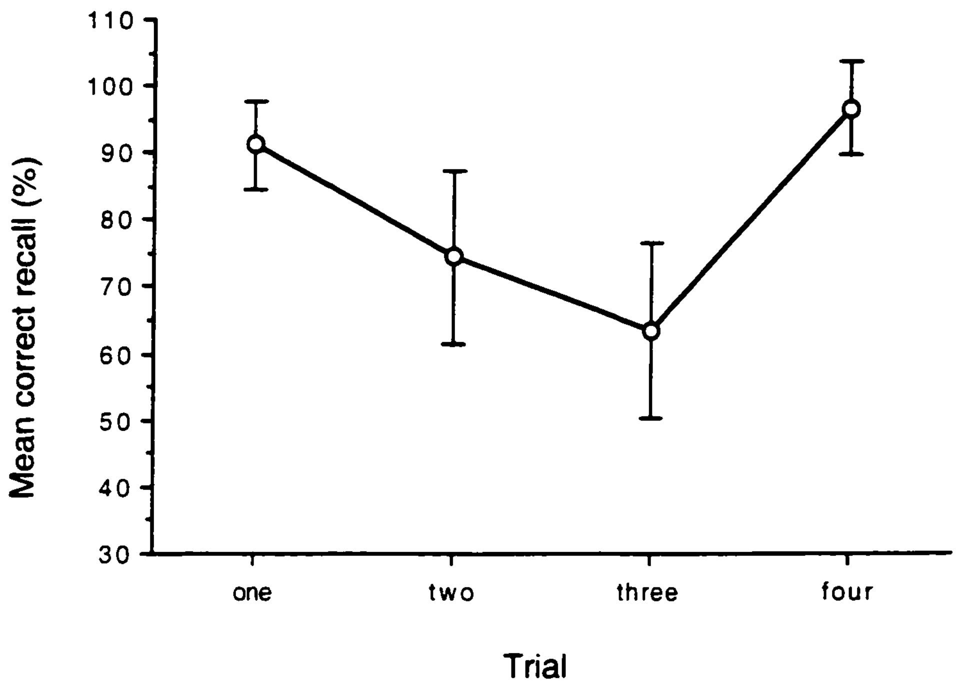

Figure 10. The percentage correct recall for lexical causatives as a function of trial in Experiment 2

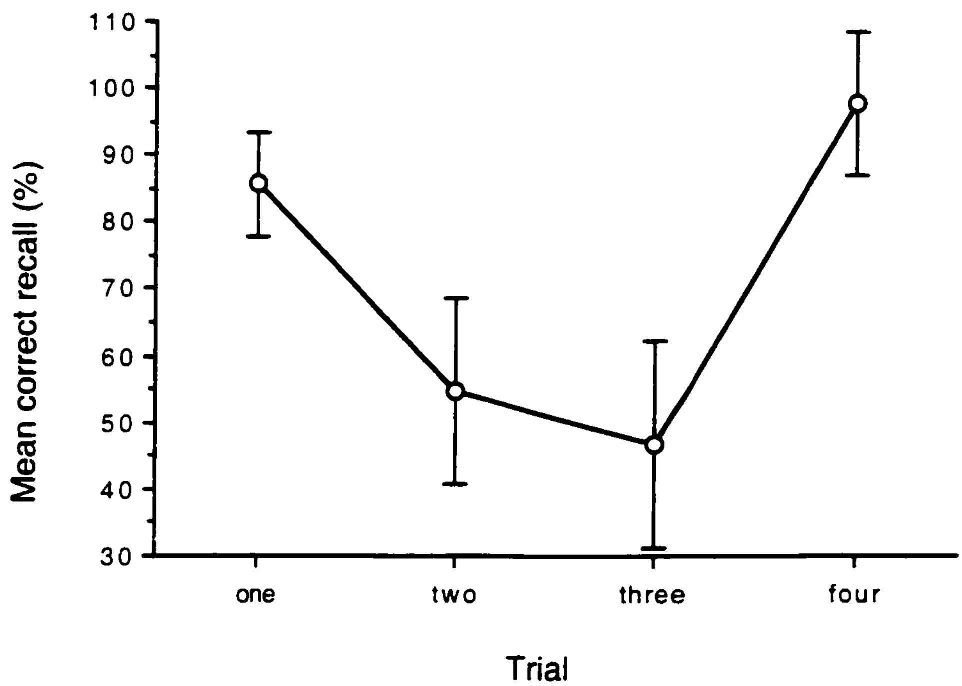

Figure 11. The percentage correct recall for morphological causatives as a function of trial in Experiment 2

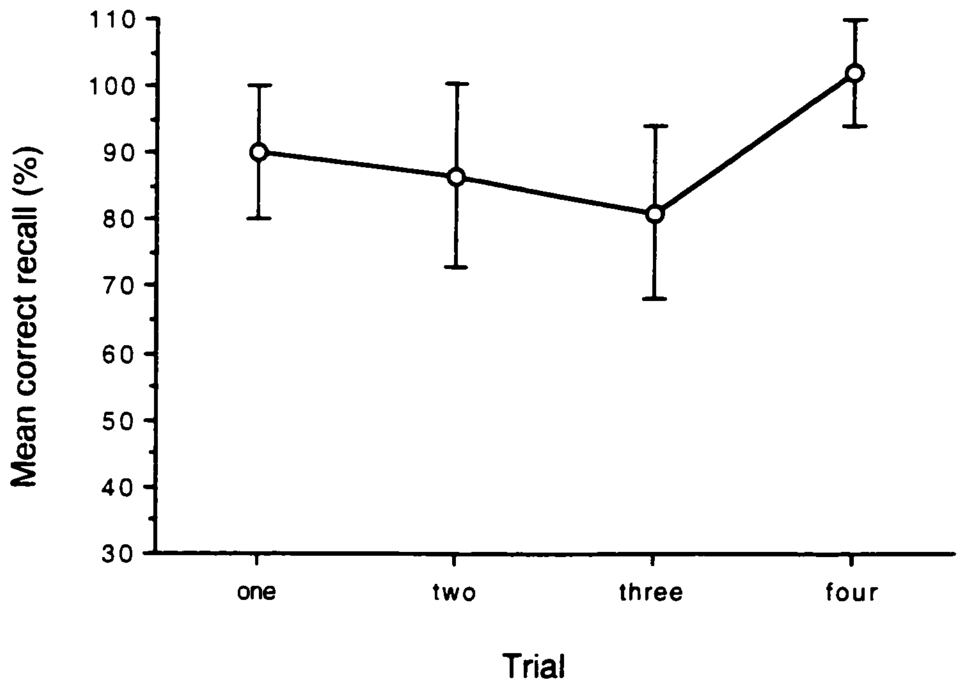

Figure 12. The percentage correct recall for intransitives as a function of trial in Experiment 2

Also, simiiar to Experiment 1, for movement verbs, there was an unexpected increment in recall from trial one to trial two; even though, the difference proved nonsignificant. Additionally, as in Experiment 1, for lexical causatives, there was no significant PI build-up from trial two to trial three. Unlike Experiment 1, however, for morphological causatives, the PI build up from trial two to trial three was not significant.

To compare the magnitude of build-up effect between verb concepts differing in terms of semantic feature and semantic content, a 3 (verb type: morphological causatives, lexical causatives, movement verbs) by 3 (trial: 1, 2, 3) within-subjects ANOVA was conducted (Appendix F, Table 13). The analysis revealed a significant main effect of verb type, $F(2, 29)=21.58$, $p<.05$, and a significant main effect of trial, $F(2, 29)=31.53$, $p<.05$ (Appendix H). There was also a significant interaction between verb type and trial, $F(4, 29)=3.66$, $p<.05$ (Figure 13).

Subsequent post hoc Tukey tests revealed a significant mean difference between trial two ($M=54.67$, $SD=37.32$) of morphological causatives and trial two ($M=91.12$, $SD=17.34$) of lexical causatives, $F(1, 29)=25.44$, $p<.05$. The mean difference between trial two of lexical causatives and trial two ($M=91.12$, $SD=17.34$) of movement verbs was not significant. As in Experiment 1, a significant mean difference between trial three ($M=74.44$, $SD=34.62$) of lexical causatives and trial three ($M=46.65$, $SD=41.60$) of morphological causatives was found, $F(1, 29)=14.78$, $p<.05$. The mean difference between trial three ($M=59.99$, $SD=37.56$) of movement verbs and trial three of lexical causatives approached significance at $F(1, 29)=3.99$, $p=.047$. The mean difference between trial three of

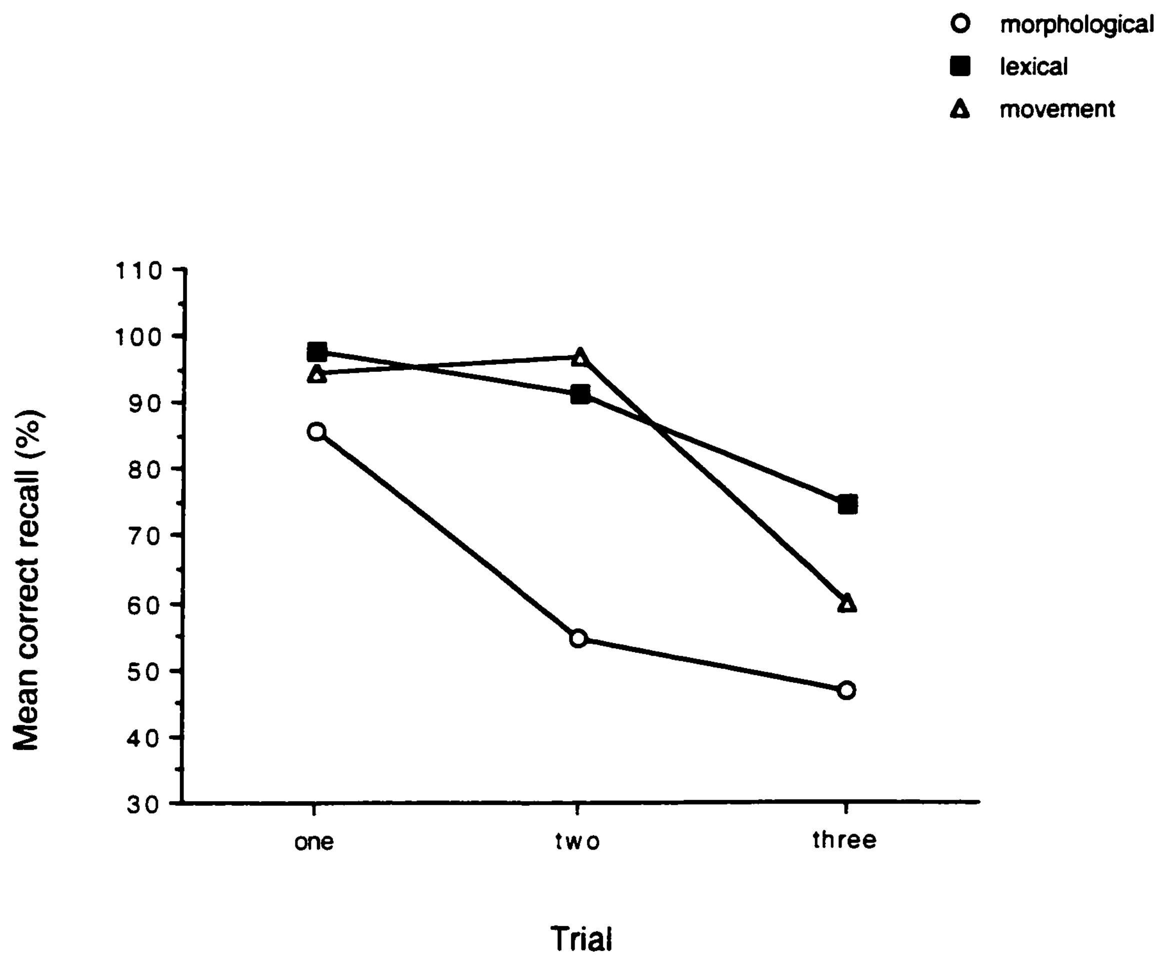

Figure 13. The percentage correct recall for morphological and lexical causatives and movement verbs as a function of trial in Experiment 2

movement verbs and trial three of morphological causatives also approached significance at $F(1, 29)=3.40$, $p=.067$.

With regard to control groups (fruits and liquids), to examine whether or not participants' recall significantly decreased over the trials, two one-way within-subjects analyses of variance, and subsequent post-hoc Tukey tests were conducted (Appendix F, Table, 14, 15). The analyses revealed a significant main effect of trial for fruits, $F(3, 29)=44.19$, $p<.05$ (Figure 14), and for liquids $F(3, 29)=44.19$, $p<.05$ (Figure 15).

Subsequent post hoc Tukey tests for fruits showed a significant mean difference between trial one ($M=94.77$, $SD=21.93$) and trial two ($M=74.45$, $SD=22.63$), $F(1, 29)=11.43$, $p<.05$, trial one and trial three ($M=43.35$, $SD=31.76$), $F(1, 29)=73.13$, $p<.05$, trial one and trial four ($M=33.35$, $SD=37.16$), $F(1, 29)=104.35$, $p<.05$, trial two and trial three, $F(1, 29)=26.75$, $p<.05$, and trial two and trial four, $F(1, 29)=46.73$, $p<.05$. There was no significant mean difference between trial three and trial four.

Post hoc tests for liquids showed significant mean differences between trial one ($M=101$, $SD=10.63$), and trial two ($M=80$, $SD=25.64$), $F(1, 29)=14.29$, $p<.05$, trial one and trial three ($M=55.53$, $SD=34.23$), $F(1, 29)=66.66$, $pP<.05$, trial one and trial four ($M=33.35$, $SD=23.19$), $F(1, 29)=147.34$, $p<.05$, trial two and trial three, $F(1, 29)=19.23$, $P<.05$, trial two and trial four, $F(1, 29)=69.86$, and trial three and trial four, $F(1, 29)=15.79$, $p<.05$.

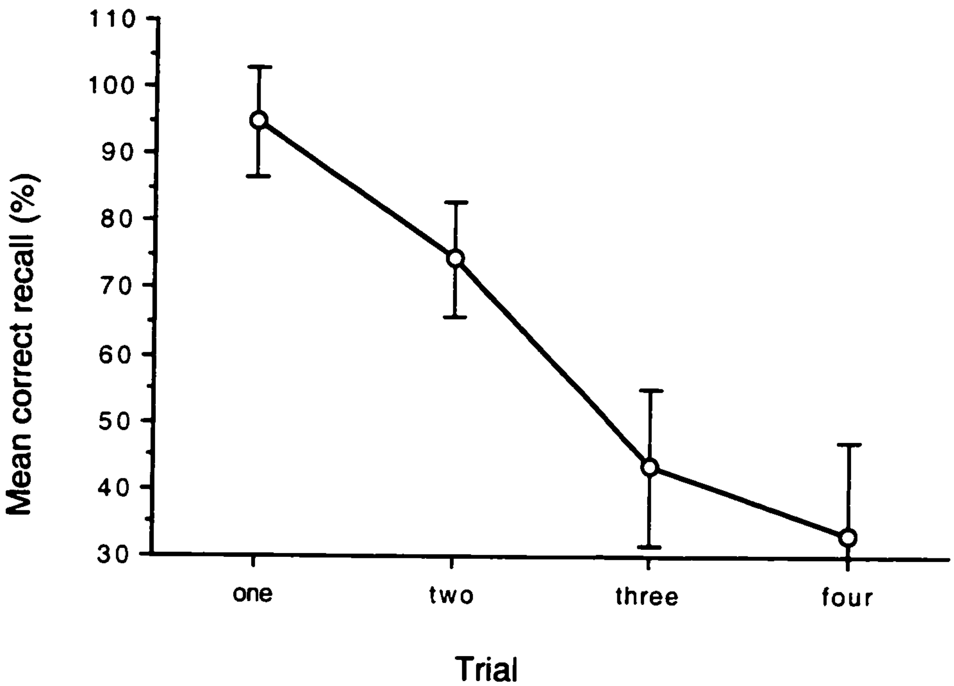

Figure 14. The percentage correct recall for fruits as a function of trial in Experiment 2

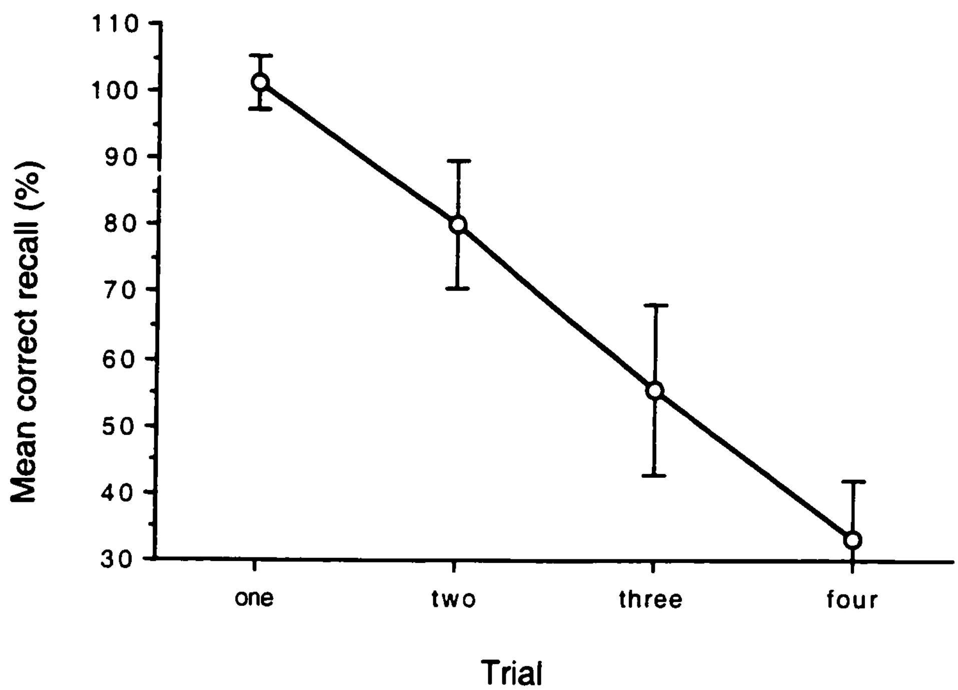

Figure 14. The percentage correct recall for liquids as a function of trial

Discussion

Overall, the results of Experiment 2 substantiate *both the featural and the categorical proposals* indicating that verbs sharing semantic content (e.g., movement verbs), and semantic feature (e.g., lexical causatives) produce significant and similar magnitudes of PI build-up effect. Similar to Experiment 1, on the third pre-shift trials, morphological causatives produced a larger magnitude of build up effect than lexical causatives. In as much as morphological causatives presumably share the semantic feature CAUSE, this finding supports the featural proposal of semantic memory organization. Movement verbs and lexical causatives, however, showed similar magnitudes of PI build-up on the second trials, and on the third trials, their difference was not significant. Since movement verbs share semantic content, this finding appears to support the categorical proposal of semantic memory organization. Additionally, unlike Experiment 1, nouns sharing semantic content (e.g., fruits, liquids), produced significant magnitudes of build-up effect throughout the four trials. Further, similar to Experiment 1, intransitives did not generate any significant build-up effect suggesting that they are not encoded as a category in semantic memory. In other words, intransitives being a syntactic category do not generate any significant PI build-up effects. Finally, for all verb concepts used on the pre-shift trials, significant PI release on the shift trials were obtained suggesting that noun and verb concepts are differentially encoded in semantic memory. In as much as the noun and verb concepts employed shared neither semantic content nor semantic feature, this finding equally supports the categorical and the featural proposals of semantic memory organization.

Nouns sharing semantic content produced substantial amounts of build-up effect throughout the four build-up trials. This finding is not consonant with the pattern of build-up effect found for fruits in Experiment 1. However, as alluded to previously, in Experiment 1, the block of fruits was always presented first in the experiment. This methodological limitation was removed in Experiment 2. This observed inconsistency between the two experiments could have been the consequence of such methodological modification.

Interestingly, in both experiments, unlike morphological and lexical causatives, movement verbs did not produce a significant recall decrement from the first to the second pre-shift trials. In addition, in both experiments, lexical causatives did not generate a significant build-up effect from the second to the third pre-shift trials. These consistent findings might be a function of the particular items used, and this possibility remains to be explored in future studies.

Furthermore, the present experiment demonstrated that a class shift from verbs to nouns produces significant amounts of PI release suggesting that noun and verb concepts are encoded differentially in semantic memory. For all word categories used, there was no significant difference in recall for the words used on the first trial and those used on the shift trial indicating that the new category on the shift trial reinstated memory performance.

Moreover, in both Experiment 1 and 2, on the third pre-shift trials, morphological causatives consistently generated larger amounts of build-up effect than lexical causatives and movement verbs. Morphological causatives generating more PI build-up than movement verbs may support the featural proposal of semantic memory organization. However, since both morphological and lexical causatives presumably share the semantic feature CAUSE, one may postulate that, perhaps the difference between the two classes of verbs stems from morphological complexity among morphological causatives. In other words, one may ascribe the significant difference in PI build-up between morphological and lexical causatives to the complexity at the lexical level, beyond their semantic similarities. Thus, any more PI build-up observed in morphological causatives in contrast to lexical causatives may be attributed to morphological complexity, not to semantic complexity.

The possibility that morphological complexity produces more PI build-up, beyond semantic similarity was explored in Experiment 3 where the patterns of PI build-up in morphological causatives and lexical causatives was compared to those for complex transitives (e.g., *rewatch*) and perception verbs. Semantically, the complex transitives used were not as coherent a class as morphological causatives, but they were similar to morphological causatives in that they also contained a bound morpheme (e.g., *re*), and were thus complex at the lexical level.

Experiment 3

In Experiment 3, the predications made in Experiment 1 were further evaluated. Additionally, the effect of morphological complexity on PI build-up was evaluated through examining build-up effect among different classes of verbs, namely complex transitives, perception verbs, morphological causatives and lexical causatives. Given that memory performance indicates how materials were encoded in the first place (Wickens et al., 1976), the more pronounced effect of PI build-up among morphologically complex verbs in contrast to the other verbs would suggest that morphological complexity would contribute to the way concepts are encoded in semantic memory.

Moreover, unlike Experiment 1 and 2 where the causatives verbs employed could denote both external and internal events (e.g., *melt, grow*), in Experiment 3, the causative verbs employed denoted only externally caused events (e.g., *kill, rip*). According to Rappaport Hovav and Levin (1997), internal causatives denote an internally caused changes of state, whereas, external causatives denote an externally caused change of state. Externally-caused change-of-state verbs such as *break* and *kill* may contrast with internally-caused, change-of-state verbs such as *blossom* which name states that come about naturally in an entity. Levin and Rappaport Hovav (1997) note that internal causatives show a systematic ambiguity allowing both a "be-in-state" reading and a "change-of-state" reading. For example, the verb *blossom* in *The amaryllis blossomed for ten days* has a "be-in-a-state" reading. In *the tree blossomed in a day*, however, the verb *blossom* has a "change-of-state" reading. This ambiguity is consistently absent from externally caused, change-of-state verbs. For example, verbs such as *break* never have a "be-in-state" reading: a sentence like *The vase broke* can never mean that the vase was in a state of being broken.

In addition to the aforementioned refinement made to the exemplars of lexical causatives, and the introduction of complex transitives, in Experiment 3, Wickens et al.'s (1976) category of vegetables was employed as controls.

Method

Participants

Participants consisted of 28 Concordia University students who were native speakers of English. Neither of them had already participated in the previous experiments.

Apparatus and Stimuli

The apparatus was the same as the one adopted in Experiments 1 and 2. Similar to the previous experiments 60 words belonging to both noun and verb categories were employed as stimuli. The noun categories were the same as the previous ones, except for the liquid category and the second, third and the fourth triads of the fruit category which were not used. A vegetable category was introduced with 12 items arranged in the following triads: *onion, spinach, carrot; asparagus, potato, broccoli; celery, radish, bean; tomato, cabbage, pepper*. The first three triads in this category were taken from Wickens et al.'s (1976) study, and the last triad was taken from the Francis and Kucera's (1982) norms. The mean frequency of these triads included 13.7, 5.7, 4, 11, respectively. The verb categories were the same as the ones employed in Experiment 2 with the addition of complex transitives and perception verbs each of which contained 9 items arranged in the following triads: *taste, watch, feel; see, smell, notice; analyze, observe, hear* (Perception Verbs); *resmell, rewatch, reobserve; rehear, reexamine, retaste; recrave, rewitness, rescan* (Complex Transitives). The category of lexical causatives was also modified to include only externally caused verbs: *shatter, kill, drop; crush, spill, rip; drain, stop, cook*. The mean frequency of the verb triads in these categories were 188.66, 288.33, 51.66 for perception verbs; 1, 1, 1 for complex transitives ; and 40.66, 3.66, and 47 for lexical causatives.

<u>Procedure</u>

The procedure was the same as the one adopted in Experiment 2.

Results

Across all the 20 trials, for each word correctly recalled, the participant received one point. An extra point was also awarded if the participant correctly recalled the order of the presentation of the words. The score for each participant on each trial was converted into percentages. The raw data, thus comprised the participant's percentage correct recall. The statistical methods employed included within-subject analyses of variance and subsequent Tukey tests at the alpha level of 0.05.

To determine whether in overall participants' recall significantly changed as a function of word type and trial, a 5 (word type: vegetable, perception, complex transitive, lexical causative, and morphological causatives) by 4 (trial: 1, 2, 3, 4) within-subjects ANOVA was conducted on participants' percentage correct recall (Appendix I, Table 16). The analysis revealed a significant main effect of word type, F (4, 27)=4.36, p<.05 and a significant main effect of trial, F(3, 27)=33.45, p<.05 (Appendix J). There was also a significant interaction between word type and trial, F (12, 27)=4.09, p<.05 (Figure 16).

Post hoc Tukey tests for perception verbs revealed significant mean differences between trial one (M=97.48, SD=27.52) and trial two (M=76.56, SD=35.60), F(1, 27) =11.02, p<.05, and trial two and trial four (M=99.96, SD=22.58), F(1, 27)= 14.58, p<.05. For Lexical causatives, post hoc Tukey tests revealed significant mean differences between trial one (M=97.52, SD=15.81) and trial two (M=64.17, SD=42.29), F(1, 27)=20.19, p<.05, trial one and trial three (M=75.35, SD=31.48), F(1, 27)=12.16, p<.05, trial two and trial four (M=96.29, SD=24.91), F(1,

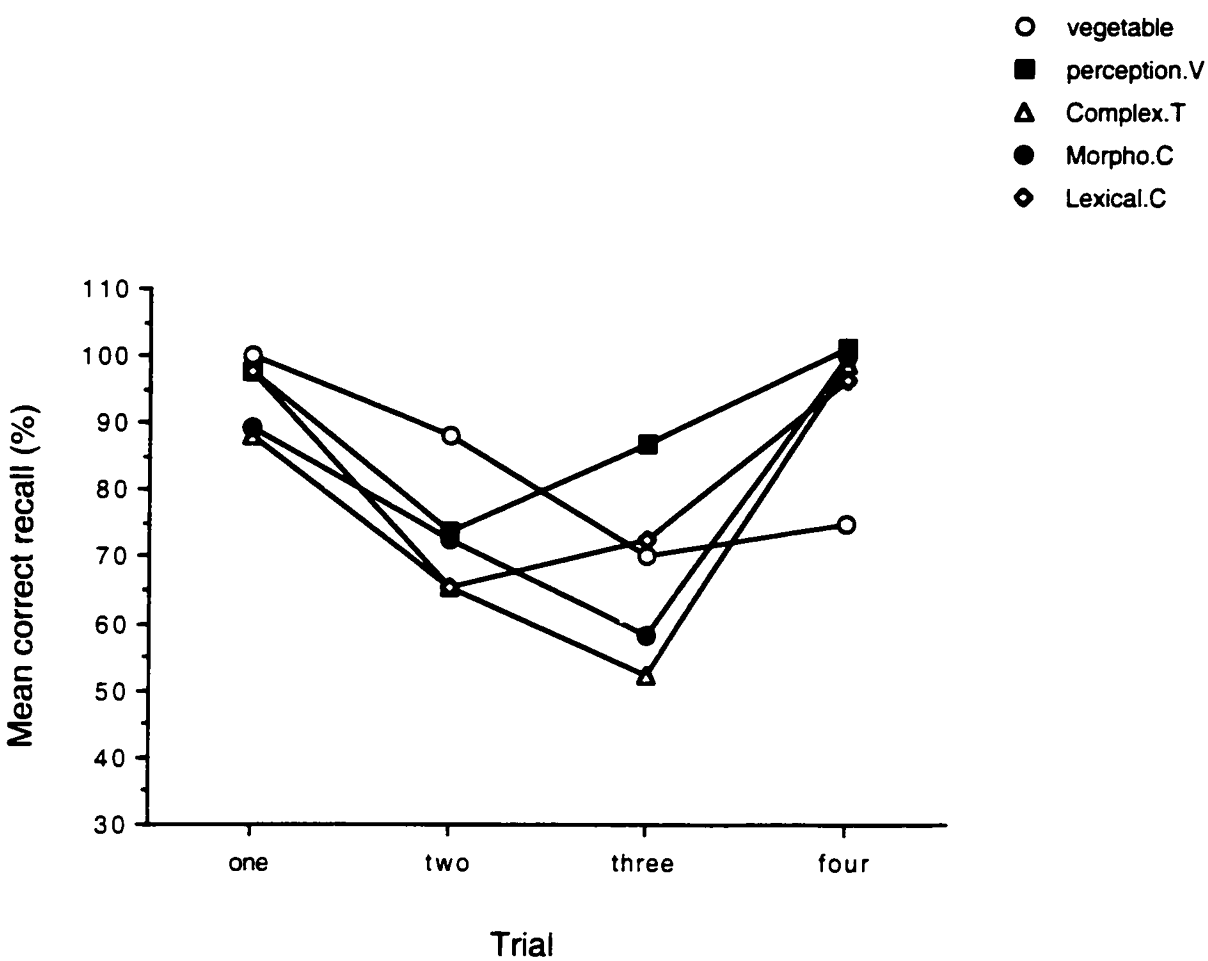

Figure 16. The percentage correct recall as a function of word type and trial in Experiment 3

27)=18.74, p<.05, and trial three and trial four, F(1, 27)=11.04, P<.05. For Morphological causatives, post hoc Tukey tests showed significant mean differences between trial one (M=90.18, SD=22.15) and trial two (M=71.66, SD=34.22), F(1, 27)=5.43, p<.05, trial one and trial three (M=59.25, SD=39.61), F(1, 27)=18.81, p<.05, trial two and trial three, F(1, 27)=4.03, p<.05, trail two and trail four (M=96.29, SD=24.91), F(1, 27)=14.50, p<.05, and trial three and trial four, F(1, 27)=33.82, p<.05. Finally, Tukey tests for complex transitives revealed significant mean differences between trial one (M=87.71, SD=24.57) and trial two (M=66.70, SD=30.67), F(1, 27)=10.02, p<.05, trial one and trial three (M=59.25, SD=39.61), F(1, 27)=25.06, p<.05, trial two and trial four (M=99.92, SD=33.23), F(1, 27)=21.68, p<.05, and trial three and trial four, F(1, 27)=40.20, p<.05.

To determine whether or not participants' verb recall significantly decreased over the pre-shift trials (PI build-up), and to determine whether or not PI release on shift trials was significant when compared to PI build-up on the pre-shift trials, four one-way within-subjects ANOVAs (Appendix I, Table 17, 18, 19, 20) and subsequent post hoc Tukey tests were conducted. The analyses revealed a significant main effect of trial for perception verbs, F(3, 27)=6.78, p<.05 (Figure 17), lexical causatives, F(3, 27)=9.43, p<.05 (Figure 18), morphological causatives, F(3, 27)=10.61, p<.05 (Figure 19), and complex transitives, F(3, 27)=22.55, p<.05 (Figure 20). Subsequent post hoc Tukey tests revealed significant mean differences between the first three trials and the shift trial of perception verbs, F(1, 27)=7.61, p<.05, complex transitives, F(1, 27)=34.47, p<.05, lexical causatives, F(1, 27)=8.36, p<.05, and morphological causatives, F(1, 27)=16.61, p<.05. The significant mean differences for the build-up trials were the same as those reported previously. For perception verbs, there was no significant PI build-up from trial two to trial three. As in

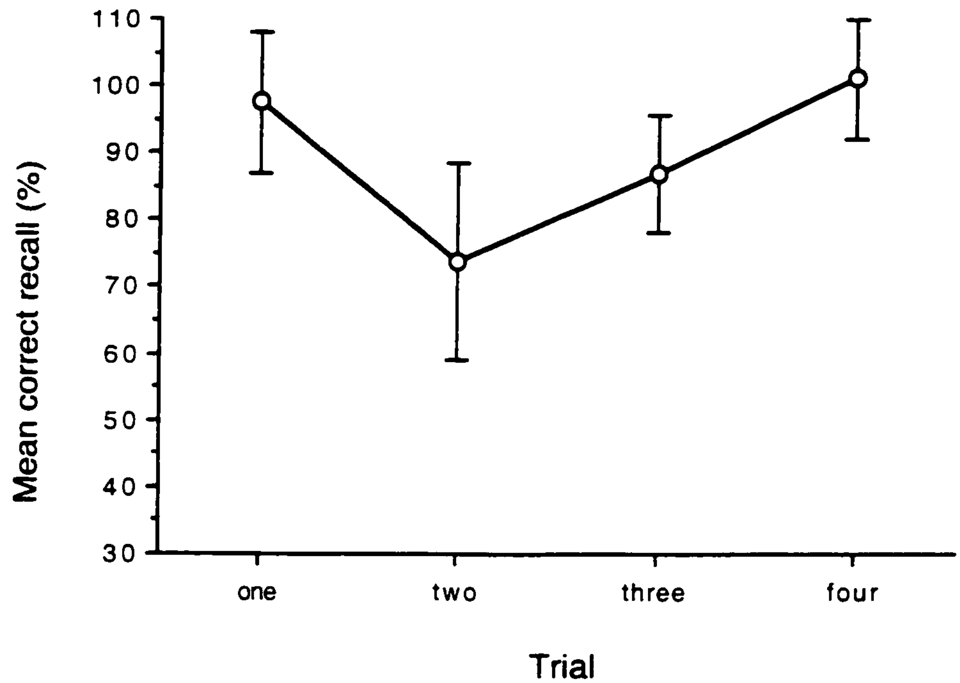

Figure 17. The percentage correct recall for perception verbs as a function of trial in Experiment 3

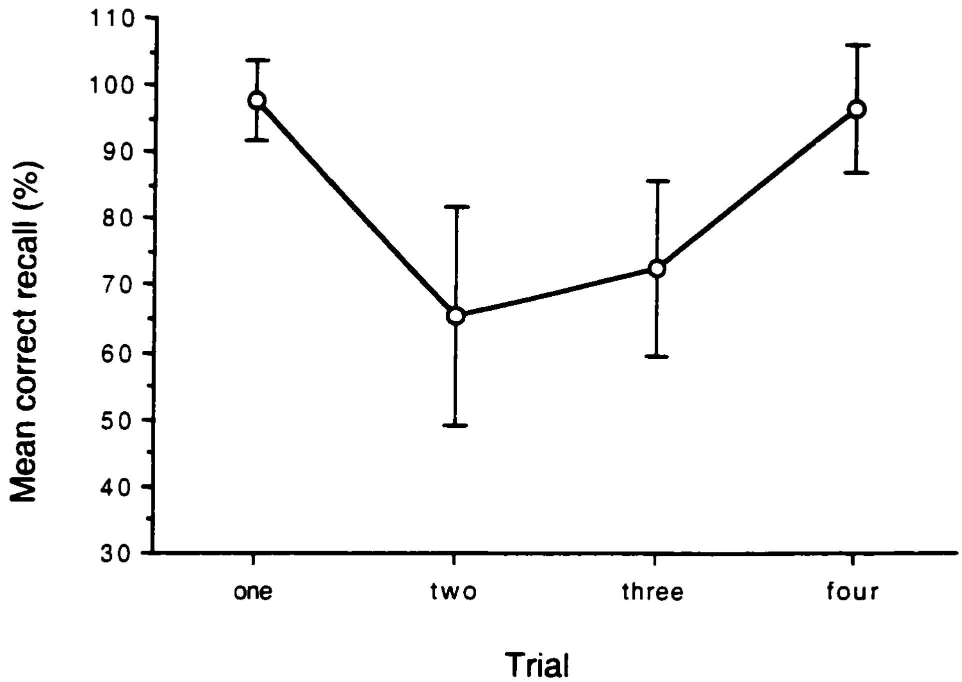

Figure 18. The percentage correct recall for lexical causatives as a function of trial in Experiment 3

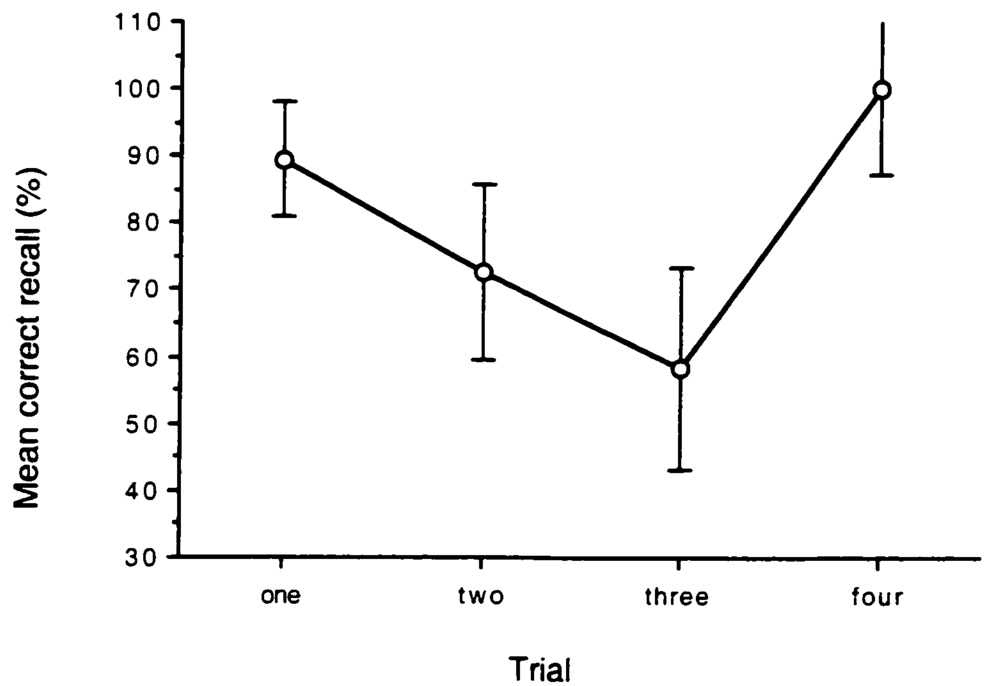

Figure 19. The percentage correct recall for morphological causatives as a function of trial in Experiment 3

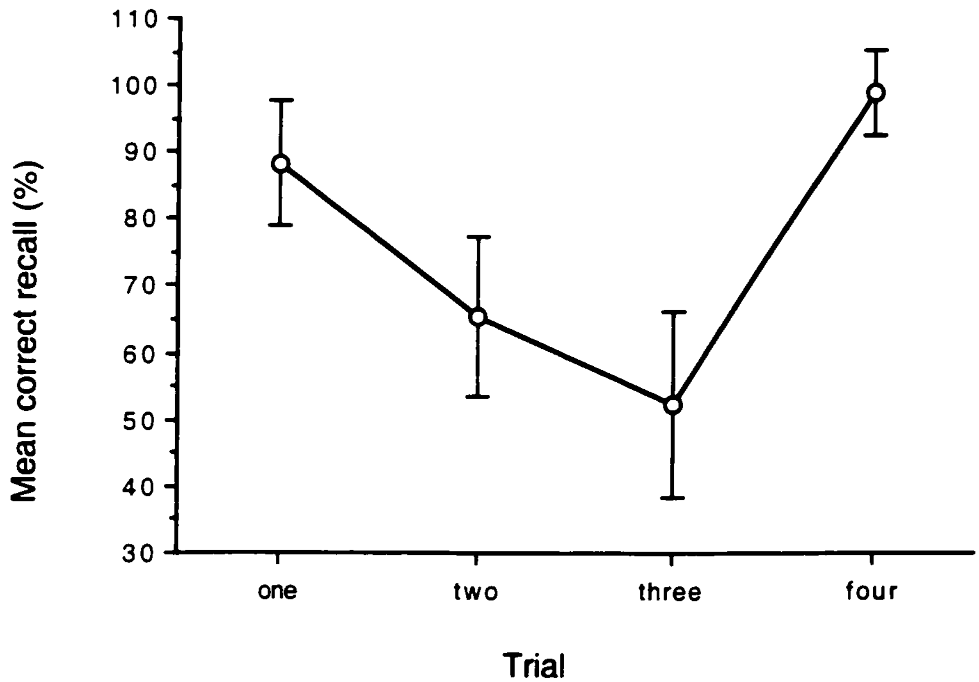

Figure 20. The percentage correct recall for complex transitives as a function of trial in Experiment 3

experiment 1 and 2, for lexical causatives, no significant PI build-up was found from trial two to trial three.

Regarding the control group (vegetables), to determine whether or not participants' recall significantly decreased over the trials, a one-way within-subjects analysis of variance, and subsequent post-hoc Tukey tests were conducted (Appendix I, Table 21). The analysis revealed a significant main effect of trial for vegetables, $F(3, 27)=6.24$, $p<.05$ (Figure 21). Subsequent post hoc Tukey tests showed a significant mean difference between trial one ($M=99.98$, $SD=20.10$) and trial three ($M=70.20$, $SD=36.70$), $F(1, 27)=15.30$, $p<.05$, trial one and trial four ($M=74.99$, $SD=33.51$), $F(1, 27)=10.78$, $p<.05$, and trial two and trial three, $F(1, 27)=5.56$, $p<.05$. There was no significant difference between trial three and trial four, $F(1, 27)=.39$, $p=.53$.

To compare the magnitude of PI build-up between verb concepts, a 4 (verb type: perception verbs, complex transitives, lexical and morphological causatives) by 3 (trial: 1, 2, 3) within subjects ANOVA and subsequent post hoc Tukey tests were conducted (Appendix I, Table 22). The analysis revealed a significant main effect of verb type, $F(3, 27)=6.35$, $p<.05$, and a significant main effect of trial, $F(2, 27)=31.36$, $p<.05$ (Appendix K). The interaction between verb type and trial approached significance at $F(6, 27)=2.11$, $p=.054$ (Figure 22). Subsequent post hoc Tukey tests revealed a significant mean difference between trial three ($M=52.32$, $SD=35.70$) of complex transitives and trial three ($M=72.65$, $SD=34.01$) of lexical causatives, $F(1, 27)=7.31$, $p<.05$. There was also a significant mean difference between trial three of complex transitives and trial three ($M=86.96$, $SD=22.76$) of

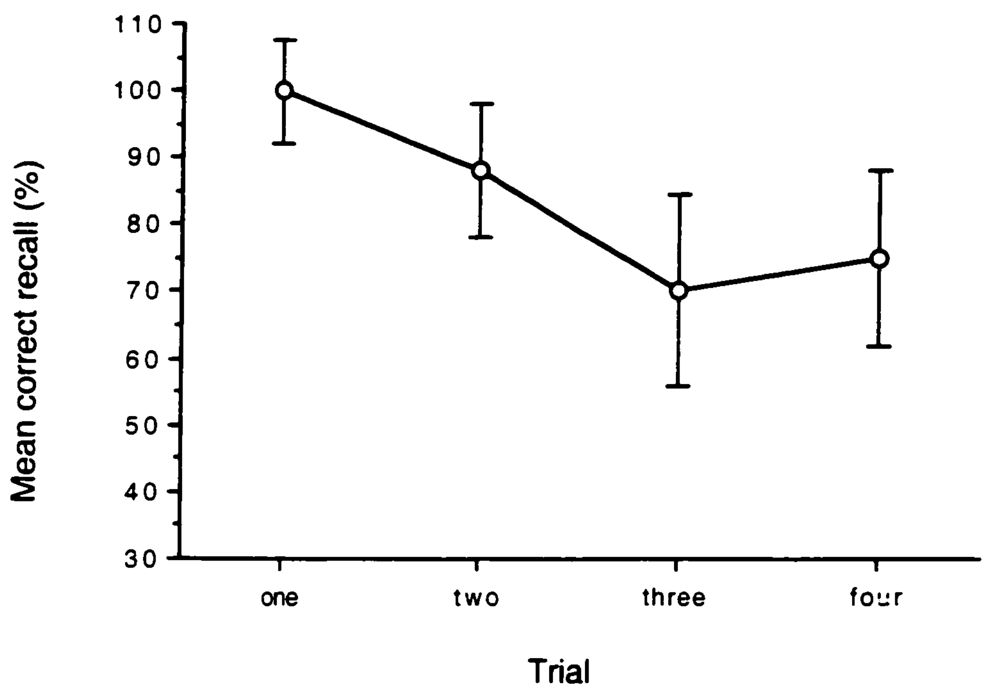

Figure 21. The percentage correct recall for vegetables as a function of trial in Experiment 3

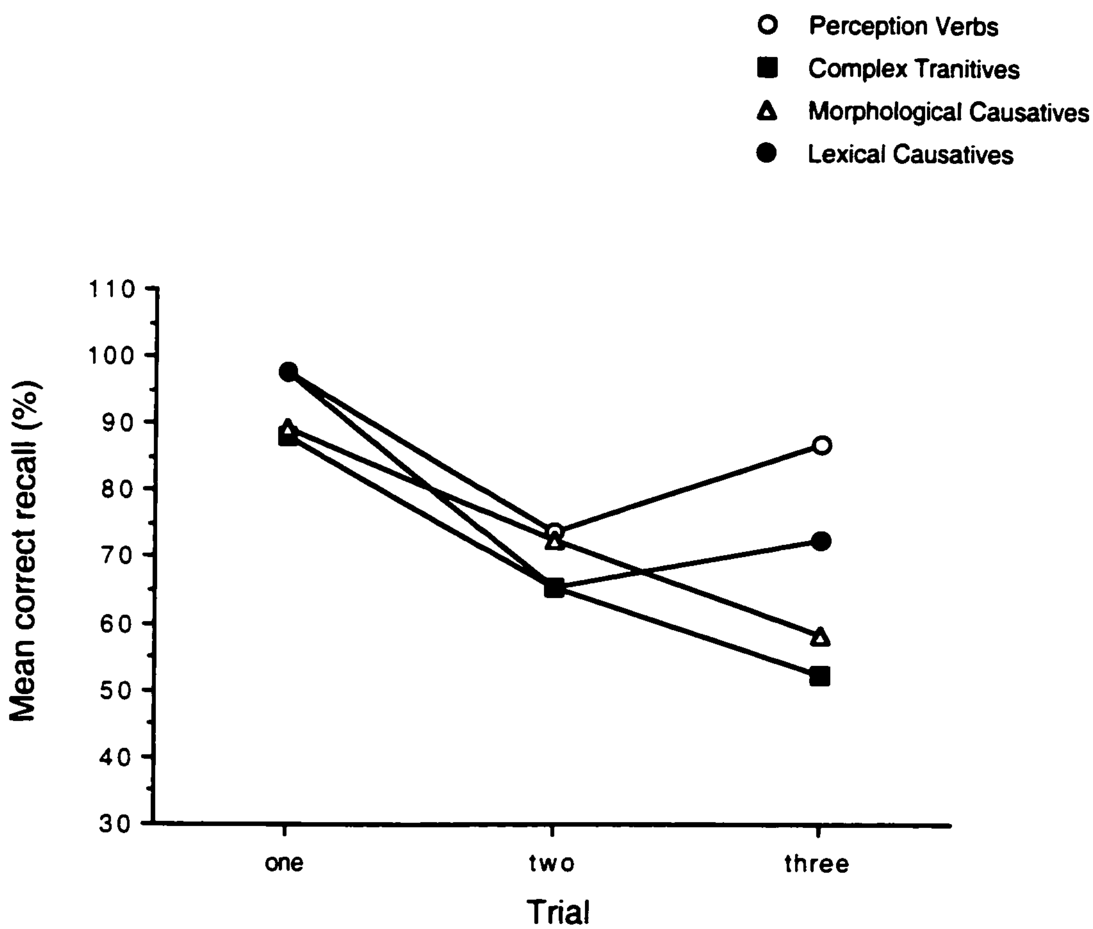

Figure 22. The percentage correct recall for lexical and morphological causatives, complex transitives and perception verbs as a function of trial in Experiment 3.

perception verbs, $F(1, 27)=21.24$, $p<.05$. There was no significant mean difference between trial three of complex transitives and trial three ($M=58.32$, $SD=39.19$) of morphological causatives. The mean difference between trial three of morphological causatives and trial three of lexical causatives ($M=72.65$, $SD=34.01$) approached significance at $F(1, 27)=3.64$, $p=.058$. There was a significant mean difference between trial three of morphological causatives and trial three of perception verbs, $F(1, 27)=14.53$, $p<.05$. The mean difference between trial three of lexical causatives and trial three of perception verbs approached significance at $F(1, 27)=3.62$, $p=.058$.

Discussion

As in Experiment 2, the results of Experiment 3 seem to substantiate *both the categorical and the featural proposals* of semantic memory organization. Verb concepts sharing semantic content (e.g., complex transitives), and semantic feature (e.g., morphological causatives) produced significant and similar magnitudes of PI build-up effect. Among verb concepts, complex transitives and morphological causatives produced the largest magnitude of build-up effect followed by lexical causatives and perception verbs. Similar to Experiment 1 and 2, morphological causatives produced a larger amount of build-up effect than lexical causatives. Nouns sharing semantic content (e.g., vegetables) generated significant amounts of PI build-up, particularly when considering their first and fourth trials. Also, similar to Experiment 2, for all verb categories used, a shift to the noun categories produced significant magnitudes of PI release. The principal finding of this study, however, was the observation that morphological similarity among words that label concepts is an important dimension in the representation of concepts in semantic memory.

Unlike Experiment 2, in Experiment 3, nouns sharing similar semantic content (e.g., vegetables) did not produce significant amounts of build-up effect from trial one through trial 4. In the previous experiment, fruits and liquids were used; whereas, in the present experiment, the members of the vegetable category were employed. Although the members of these categories all share semantic content, one can hardly expect the same amount of build-up effect among these concepts. Interestingly, however, in both experiments, words sharing semantic content produced significant magnitudes of build-up effect between their fourth and their first trials. Additionally, similar to both Experiment 1 and 2, the pattern of build-up effect for morphological causatives was more substantial than that for lexical causatives. In fact, the pattern of build-up effect obtained for morphological causatives was very similar to that for complex transitives.

The complex transitives used in this study were all perception verbs made morphologically complex by the addition of a prefix morpheme (re-watch). As discussed earlier, perception verbs through denoting similar events share semantic content. The results, however, showed that perception verbs, unlike complex transitives, did not produce any significant build-up effect from their second to their third trials. Most importantly, they did not produce any significant PI when considering the difference between their third and their first trials. Additionally, on their third trial, complex transitives produced a significantly larger amount of build-up effect than perception verbs did on their corresponding trial. One way to interpret these patterns is to suggest that morphological complexity, not shared content, has led to the significant build-up effect among complex transitives. This interpretation may be corroborated by the finding that morphological causatives generate a pattern of PI build-up very similar to that for complex transitives. Other than morphological similarity, the class of morphological causatives and complex transitives share no similarity. However, lexical causatives, apparently sharing the semantic feature CAUSE, also generated significant amounts of PI build-up effect. In all three experiments, lexical causatives consistently produced significant amounts of build-up effect when considering the difference between their third and first trials. The same pattern was also observed for noun concepts (e.g., fruits, liquids, vegetables) and movement verbs sharing semantic content. A conservative way to interpret these findings, thus, might be to suggest that perhaps, aside from the role of feature and content in semantic memory organization, morphological similarity among words is a dimension along which words are encoded in semantic memory. To shed more light on the contribution of morphological similarity to the representation of concepts, one could compare the pattern of PI build-up in two sets of words whose mere difference lies in the fact that one set is morphologically complex but the other is not. For example, in the present study, the experimenter could add the prefix morpheme to the same set of perception verbs and use them as complex transitives.

In brief, the present findings appear to corroborate both the featural and the categorical proposals of semantic memory organization. Morphological causatives share semantic feature (CAUSE) and are complex at the lexical level. Complex transitives share semantic content and are also complex at the lexical level. The exemplars of these apparently different classes of verbs generated significantly similar magnitudes of PI build-up effect. Not to mention the significant PI build-up effects obtained for other concepts, this finding per se may suggest that the categorical and the featural proposals may not be really apart, that feature and category subsume each other in the organization of semantic memory. Furthermore, in addition to semantic feature and content, morphological similarity is ostensibly a dimension along which words might be encoded in semantic memory.

General Discussion

The present study investigated the featural and the categorical proposals of semantic memory organization through the medium of the release from the proactive interference paradigm. Concepts labeled by verbs and nouns were employed. In the experiments that were carried out, significant PI build-up effect was observed for verb concepts supposedly sharing the semantic feature, CAUSE, namely the lexical and morphological causatives. This finding seems to corroborate the featural proposal of semantic memory organization in the sense that PI build-up can be accounted for by the supposed feature lexical and morphological causatives seem to share. Similarly, concepts, mainly sharing semantic content (e.g., movement verbs, fruits, liquids, vegetables) produced significant magnitudes of PI build-up effect similarly corroborating the categorical proposal of semantic memory organization. In addition to semantic feature and content, morphological similarity among words also appeared to be a dimension along which words are encoded in semantic memory. In brief, the results of the three experiments suggest that the organization of semantic memory may reflect both semantic feature and semantic content.

In Experiment 1, verb concepts sharing the semantic feature CAUSE produced a significantly larger amount of build-up effect than verb concepts sharing semantic content (e.g., movement verbs). More explicitly, morphological causatives produced the largest amount of build-up effect followed by lexical causatives and movement verbs. This finding appeared to support the featural proposal to a larger extent than the categorical proposal. Intransitives, sharing syntactic structure, did not produce any significant PI build-up effect indicating that syntactic categories, such as intransitives, are not encoded as a category in semantic memory. Unlike Wickens et al.'s (1976) study, the fruit category did not produce significant PI build-up effect throughout the four trials. Presumably, one reason leading to this finding was the fact that the presentation of the blocks was not randomized, and as a result the participants consistently received the fruit trials at the beginning of the experiment. In Experiment 2, this possible confound was removed.

Experiment 2, essentially constituted a replication of Experiment 1. The same classes of verb and noun concepts were employed, except for a category of liquids that was added. Among verb concepts, morphological causatives appeared to show the largest magnitude of PI build-up effect. Lexical causatives and movement verbs demonstrated similar magnitudes of PI build-up. In addition, unlike Experiment 1, in Experiment 2, noun concepts sharing semantic content (e.g., fruits, liquids) generated significant magnitudes of PI build-up throughout the four trials. These patterns seemed to support both the categorical and the featural proposals of semantic memory organization. Similar to Experiment 1, intransitives did not generate any significant PI build-up suggesting that they are not encoded as a category in semantic memory. Furthermore, a class shift from verb concepts used on the pre-shift trials to noun concepts used on the shift trials produced significant amounts of PI release indicating that noun and verb concepts may be differentially encoded in semantic memory. In as much as noun and verb concepts used on the shift and pre-shift trials shared neither semantic content nor feature, this finding equally corroborated the categorical and the featural proposal of semantic memory organization.

In Experiment 1 and 2, it was observed that the pattern of PI build-up effect for morphological causatives is consistently more substantial and coherent than those obtained for lexical causatives and movement verbs. As discussed earlier, in contrast to movement verbs, sharing semantic content, morphological causatives share semantic feature (e.g., CAUSE). In addition, unlike movement verbs, morphological causatives are complex at the lexical level. Thus, the larger amount of PI build-up among morphological causatives compared to movement verbs could be attributed to either semantic or lexical complexity among morphological causatives. Morphological and lexical causatives, however, are both semantically complex, and the difference between them lies in the fact that morphological causative are lexically complex; whereas, lexical causatives are not. Thus, any more PI build-up among morphological causatives in contrast to lexical causatives could be attributed to lexical complexity beyond semantic complexity. This postulation was put to test in Experiment 3 where the pattern of PI build-up among morphological causatives and lexical causatives was contrasted to that for complex transitives and perception verbs.

In Experiement 3, The complex transitives used were all perception verbs, which presumably share semantic content. One thus may postulate that the pattern of PI build-up among complex transitives cannot be entirely due to morphological similarity among them. Intriguingly, however, the set of perception verbs used did not produce any significant magnitudes of build-up effect; whereas, the complex transitives did produce a significantly pronounced pattern of PI build-up, very similar to that obtained for morphological causatives. One is, thus impelled to suggest that morphological similarity, not shared content, is responsible for the significantly coherent pattern of build-up effect among complex transitives. However, before arriving at such a conclusion, it is necessary to point out that although most of the perception verbs used were the same as those in the set of complex transitives, there were a few of them that were not (feel, see, notice, analyze). To underscore the contribution of morphological similarity with more clarity, one needs to use the exact set of perception verbs, made morphologically complex, as complex transitives.

For the present, it seems legitimate to assert that on account of the fact that unlike perception verbs, complex transitives produced a significant amount of PI build-up effect, morphological similarity may be reflected in the structure of semantic memory. This assertion is further supported by the finding that in contrast to lexical causatives, morphological causatives produced a more substantial magnitude of PI build-up effect. As in Experiment 1 and 2, lexical causatives, sharing the semantic feature CAUSE, showed a significant magnitude of PI build up when comparing their third trial to their first trial. Also, as in Experiment 2, noun concepts (e.g., vegetables), sharing semantic content, generated significant magnitudes of PI build-up effect. Overall, then as in Experiment 2, the findings of Experiment 3 seem to support both the categorical and the featural proposals of semantic memory organization. The findings also appear to indicate that morphological similarity, in addition to semantic feature and content, is a dimension in the representation of concepts.

As discussed earlier, not only similarities in semantic feature and morphemes, but similarities in semantic content also proved to be reflected in the structure of semantic memory. Concepts mainly sharing semantic content such as fruits, liquids, and vegetables consistently generated significant magnitudes of build-up effect supporting the categorical proposal of semantic memory organization. The proponents of the featural proposal (e.g., Jackendoff, 1990), however, may contend that these findings, in fact, corroborate the featural proposal, for it could be argued that the exemplars of the fruit or other categories (e.g., vegetables) all share the semantic feature CONSUMABLE. Thus, significant build-up effects obtained for the exemplars of such categories may suggest that they are encoded along a similar semantic feature, namely CONSUMABLE. If so, then, if the feature

CONSUMABLE is damaged, one should expect a recall deficit for members of all edible categories alike (e.g., liquids, food, vegetables, fruit). However, this is, evidently, not always the case. As reported previously, Hart et al. (1985) have documented the case of a patient who has a semantic deficit merely for the categories of fruits and vegetables, and not for other edible categories. There are also other similar documented cases of semantic deficits that could be explained on the basis of the categorical and not the featural proposal (e.g., Hart & Gordon, 1992; Kay & Hanley, 1999). Although the assumption that the structure of semantic memory may subsume both content and feature might be "unparsimonious" (Marques, 2000, P: 687), some reported cases of semantic deficits, along with present findings, connote that , at least for the present, we need to rely on both proposals.

Aside from the consistent pattern of build-up effect obtained for lexical and morphological causatives, another consistent finding is the observation that a class shift from verbs (pre-shift trials) to nouns (shift trials) produce significant magnitudes of PI release. Wickens et al. (1976) stated that "there are certain sorts of class shifts which are relatively easy to identify, as are verbs to nouns, past to present tense, or singular to plural, but they produce essentially no release" (P: 307). This statement was, in fact, based on a series of PI experiments investigating several class shifts including the shift from verbs to nouns. Ever since, there has been, to my knowledge, no study attempting to further explore PI release when shifting from the class of verbs to nouns. The present study consistently demonstrated that a class shift from verbs to nouns do generate significant amounts of PI release. Since the noun and verbs concepts employed shared neither semantic content nor feature, this finding equally supports the categorical and the featural proposals of semantic memory organization.

The present findings clearly need confirmation and extension. One way to confirm these findings is to measure semantic encoding through employing other semantic tasks such as a lexical decision task, or a recognition test. Unlike the Wickens' (1970) paradigm that involves more active encoding processes, a lexical decision task or a word recognition task rely on more passive semantic activation. In other words, such tasks do not entail active organization or the use or discovery of semantic relationships. It would be worthwhile and illuminating to compare the present results to those obtained using a different semantic encoding paradigm. Furthermore, an extension of the present findings would be to use the present data to shed light on the nature of category-specific semantic deficits. As alluded to previously, thus far, there has been no reported cases of category-specific verb deficits. If, as the present findings attest to, lexical causatives are represented on the basis of the semantic feature CAUSE, then one, following the featural proposal, should expect a case of lexical causative-specific verb deficit in a patient with the damaged feature, CAUSE. The use of the present findings to investigate verb deficits represnets a productive avenue to explore the organization of semantic memory.

In conclusion, three experiments were conducted to investigate the featural and the categorical proposals of semantic memory organization. The findings suggested that the structure of concepts in semantic memory may reflect both a featural and categorical organization. Morphological similarity among words also appeared to be a dimension along which words are encoded in semantic memory. Furthermore, the experiments conducted consistently indicated that a class shift from verbs to nouns generate significant magnitudes of PI release supporting both the categorical and the featural proposals of semantic memory organization. Finally, in the first two experiments, it was consistently observed that intransitive verbs do not generate any significant PI build-up effects. This finding may suggest that intransitives, sharing syntactic structure, are not encoded as a category in semantic memory.

The present findings clearly have strong implications for studies of category-specific semantic deficits in neurologically patients. An insightful extension of the present study is an exploration of category-specific verb deficits in neurological patients employing different semantic encoding paradigms. The use of different paradigms or different populations may prove to be a productive avenue for an exploration of the representation of conceptual knowledge in human memory.

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Appendix A

The Booklet

Appendix B

The Consent Form

Consent Form to Participate in Research

This is to state that I agree to participate in a study being conducted by Forouzan Mobayyen in conjunction with her master's thesis under the supervision of Dr. Roberto. G. de Almeida of the psychology department of Concordia University.

A. Purpose
I have been informed that the purpose of the research is to study the way verbs are represented in memory

B. Procedure
I have been informed that the experiment involves the following procedure:

The Release from Proactive Interference Paradigm- You will be presented with triads of words on a computer screen. Your task will involve keeping the words in your memory and trying to recall them right after a question mark signals the request for recall.

I have been informed that the study does not measure my level of intelligence, or language proficiency. I have been informed that the there is no form of discomfort, surprise or deception in the experiment. I have also been informed that there my name will not be associated with my data collected in the experiment. I understand that my participation in this study is confidential and the information I provide will be kept strictly confidential.

C. Conditions of Participation

- I understand that I am free to decline to participate in the experiment without negative consequences
- I understand that I am free to withdraw my consent and discontinue my participation at anytime without negative consequences
- I understand that my participation in this study is confidential
- I understand that the data from this study may be published
- I understand the purpose of the study and I know that I have been made fully aware of the purpose

I Have Carefully Studied the above and Understand this Agreement. I Freely Consent and Agree to participate in this study.

Name (please print)-------------------------------------
Signature---
Date--

Appendix C

The ANOVA Summary Tables (Experiment 1)

Table 1

ANOVA Summary Table for Percentage Correct Recall as a Function of Trial.

Source	df	SS	MS	F
Word Type	4	16205.06	4051.26	9.34*
Trial	3	35183.65	11727.88	24.96*
Subjects	38	104586.11	2752.26	
Interaction	12	18902.66	1575.22	3.37*

P*<.05

Table 2

ANOVA Summary Table: Percentage Correct Recall for Movement Verbs as a Function of Trial.

Source	df	SS	MS	F
Subject	38	21370.65	562.38	
Trial	3	5404.06	1801.35	5.14*

$P^{*} < .05$

Table 3

ANOVA Summary Table: Percentage Correct Recall for Lexical Causatives as a Function of Trial.

Source	df	SS	MS	F
Subject	38	65205.01	1715.92	
Trial	3	9249.32	3083.10	5.36*

P*<.05

Table 4

ANOVA Summary Table: Percentage Correct Recall for Morphological Causatives as a Function of Trial

Source	df	SS	MS	F
Subject	38	38725.93	1019.10	
Trial	3	28165.59	9388.53	19.01*

P*<.05

Table 5

ANOVA Summary Table: Percentage Correct Recall for Intransitive Verbs as a Function of Trial

Source	df	SS	MS	F
Subject	38	19709.80	518.67	
Trial	3	3268.08	1089.36	2.46

P<.05

Table 6

ANOVA Summary Table: Percentage Correct Recall for Morphological and Lexical Causatives and Movement Verbs as a Function of Verb Type and Trial

Source	df	SS	MS	F
Verb Type	2	10918.94	5459.47	10.54*
Trial	2	25663.65	12831.82	24.18*
Subjects	38	76644.88	2016.97	
Interaction	4	8432.04	2108.01	4.05*

P*<.05

Table 7

ANOVA Summary Table: Percentage Correct Recall for Fruits as a Function of Trial

Source	df	SS	MS	F
Subject	38	28394.22	747.21	
Trial	3	8518.08	2839.36	6.50*

P*<.05

Appendix D

Means and Standard Deviations for Word Type and Trial (Experiment 1)

	Word Type					Trial			
	Fruit	Movement	Intra	MC	LC	One	Two	Three	Four
M	85.91	89.96	90.39	79.51	80.56	93	82.40	75.74	89.93
SD	23.64	20.88	21.75	28.19	30.04	17.63	28.37	30.14	20.17

Note. Move, Intra, MC, and LC stand for Movement verbs, Intransitive verbs, Morphological Causatives and Lexical Causatives, respectively.

Appendix E

Means and Standard Deviations for Verb Type and Trial (Experiment 1)

	Verb Type			Trial		
	LC	MC	Movement	One	Two	Three
M	78.93	75.81	88.89	90.90	82.63	70.10
SD	30.20	30.20	22.32	19.85	27.19	32.58

Note. LC, MC, and Movement stand for lexical causatives, morphological causatives, and movement verbs respectively.

Appendix F

ANOVA Summary Tables (Experiment 2)

Table 8

ANOVA Summary Table for Percentage Correct recall as a Function of Trial

Source	df	SS	MS	F
Word Type	5	79434.54	15886.90	17.27*
Trial	3	107842.99	35947.66	55.93*
Interaction	15	154327.83	10288.52	15.33*
Subject	29	87210.40	3007.25	

P*<.05

Table 9

ANOVA Summary Table: Percentage Correct Recall for Movement Verbs as a Function of Trial

Source	*df*	*SS*	*MS*	*F*
Subject	29	24204.05	834.62	
Trial	3	21065.96	7021.98	9.36*

*P**<.05

Table 10

ANOVA Summary Table: Percentage Correct Recall for Lexical Causatives as a Function of Trial

Source	df	SS	MS	F
Subject	29	24204.05	834.62	
Trial	3	21065.96	7021.98	9.36*

$P^* < .05$

Table 11

ANOVA Summary Table: Percentage Correct Recall for Morphological Causatives as a Function of Trial

Source	df	SS	MS	F
Subject	29	43037.97	1484.06	
Trial	3	53629.99	1787.66	18.41*

P*<.05

Table 12

ANOVA Summary Table: Percentage Correct Recall for Intransitive Verbs as a Function of Trial

Source	df	SS	MS	F
Subject	29	44067.57	1519.57	
Trial	3	7177.53	2392.51	3.28*

P*<.05

Table 13

ANOVA Summary Table: Percentage Correct Recall for Lexical and Morphological causatives and Movement verbs as a Function of Verb Type and Trial

Source	df	SS	MS	F
Verb Type	2	33715.99	16857.99	21.58*
Trial	2	47870.68	23935.34	31.53*
Subject	29	57052.47	1967.32	
Interaction	4	11485.56	2871.39	3.66*

P*<.05

Table 14

ANOVA Summary Table: Percentage Correct Recall for Fruits as a Function of Trial

Source	df	SS	MS	F
Subject	29	50899.22	1755.14	
Trial	3	71912.02	23970.67	44.19*

P*<.05

Table 15

ANOVA Summary Table: Percentage Correct Recall for Liquids as a Function of Trial

Source	df	SS	MS	F
Subject	29	31264.18	1078.07	
Trial	3	77839.30	25946.43	55.52*

P*<.05

Appendix G

Means and Standard Deviations for Word Type and Trial (Experiment 2)

	Word Type						Trial			
	Movement	Intra	LC	MC	Fruit	Liquid	One	Two	Three	Four
M	87.49	89.99	81.39	71.16	61.48	67.49	92.83	77.81	58.32	77.03
SD	29.63	31.02	30.47	39.01	37.79	35.47	20.67	32.57	37.59	39.73

Note: Movement, Intra, LC, and MC stand for movement verbs, intransitive verbs, lexical causatives, and morphological causatives, respectively.

Appendix H

Means and Standard Deviations for Verb Type and Trial (Experiment 2)

	Verb Type			Trial		
	LC	MC	Movement	One	Two	Three
M	87.77	62.29	83.70	92.59	80.82	60.36
SD	29.30	38	32.08	24.35	32.18	39.30

Note. LC, MC, and Movement stand for lexical causatives, morphological causatives, and movement verbs respectively.

Appendix I

ANOVA Summary Tables (Experiment 3)

Table 16

ANOVA Summary Table for Percentage Correct Recall as a Function of Trial

Source	df	SS	MS	F
Word Type	4	11301.16	2825.29	4.36*
Trial	3	80995.38	26998.46	33.44*
Subject	27	114548.86	4242.55	
Interaction	12	35213.24	2934.43	4.09*

$p^* < .05$

Table 17

ANOVA Summary Table: Percentage Correct Recall for Perception Verbs as a Function of Trial

Source	df	SS	MS	F
Subject	27	36240.79	1342.25	
Trial	3	12666.71	4222.23	6.78*

P*<.05

Table 18

ANOVA Summary Table: Percentage Correct Recall for Lexical Causatives as a Function of Trial

Source	df	SS	MS	F
Subject	27	36825.74	1363.91	
Trial	3	22640.24	7546.74	9.43*

$P^* < .05$

Table 19

ANOVA Summary Table: Percentage Correct Recall for Morphological Causatives as a Function of Trial

Source	df	SS	MS	F
Subject	27	42902.56	1588.98	
Trial	3	28230.48	9410.16	10.61*

P*<.05

Table 20

ANOVA Summary Table: Percentage Correct Recall for Complex Transitives as a Function of Trial

Source	*df*	*SS*	*MS*	*F*
Subject	27	38551.36	1427.82	
Trial	3	37475.00	12491.66	22.55*

$P^* < .05$

Table 21

ANOVA Summary Table: Percentage Correct Recall for Vegetables as a Function of Trial

Source	df	SS	MS	F
Subject	27	29897.64	1107.32	
Trial	3	15196.17	5065.39	6.24*

P*<.05

Table 22

ANOVA Summary Table for Percentage Correct Recall as a Function of Verb Type and Trial

Source	df	SS	MS	F
Verb Type	3	14053.86	4684.62	6.35*
Trial	2	45754.94	22877.47	31.36*
Subject	27	92529.64	3427.02	
Interaction	6	10006.49	1667.75	2.11

P*<.05

Appendix J

<u>Means and Standard Deviations for Word Type and Trial (Experiment 3)</u>

	Word Type					Trial			
	Perception	CT	LC	MC	Vegetable	One	Two	Three	Four
M	89.87	76.20	83.03	80.07	83.33	94.53	73.12	68.09	94.26
SD	29.90	33	33.46	35.88	31.59	22.35	35.05	35.76	28.18

<u>Note</u>: Perception, CT, LC, and MC stand for perception verbs, complex transitives, lexical causatives, and morphological causatives, respectively.

Appendix K

Means and Standard Deviations for Verb Type and Trial (Experiment 3)

	Verb Type				Trial		
	Perception	CT	LC	MC	One	Two	Three
M	86.11	68.66	78.57	73.45	93.17	69.36	67.57
SD	31.09	33.69	34.95	34.62	22.76	36.12	35.67

Note. Perception, CT, LC, and MC stand for perception verbs, complex transitives, lexical causatives and morphological causatives, respectively.