Why are Verbs So Hard to Remember?

Effects of Semantic Context on Memory for Verbs and Nouns

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Abstract

Three experiments test the theory that verb meanings are more malleable than noun meanings in different semantic contexts, making a previously-seen verb difficult to remember when it appears in a new semantic context. Experiment 1 revealed that changing the direct object noun in a transitive sentence reduced recognition of a previously-seen verb, whereas changing the verb had little impact on noun recognition. Experiment 2 revealed that verbs exhibited context effects more similar to those shown by superordinate nouns rather than basic-level nouns. Experiment 3 demonstrated that the degree of meaning change in a target word resulting from changes in semantic context influenced the magnitude of context effects, but context effects remained larger for verbs than for nouns even when the degree of meaning change was similar for nouns and verbs. These results are discussed with respect to the imageability and the grammatical roles played by nouns and verbs in a sentence.

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Over forty years ago, Loftus and Palmer (1974) demonstrated that the verb used to describe an event can influence one's later memory for the event, showing that if a traffic accident was described using the verb "smashed," participants were more likely to remember having seen broken glass than if the accident was described using the verb "hit." Despite such demonstrations of the importance of verbs for one's later memory for an event, the vast majority of memory research has focused exclusively on memory for nouns. Research into the variables that influence memory for verbs will lead to a better understanding of how linguistic descriptions of events shape later reconstructive memory for those events.

The present research was designed to examine the nature of event representations and how those representations relate to representations of the meanings of nouns and verbs in language. It tests the theory, proposed by Gentner & Boroditsky (2001) and further developed by Kersten and Earles (2004), that the nouns in a sentence typically serve as stable reference points in the linguistic description of an event, indexing concrete objects in the physical world, but that the meanings of verbs are more variable and dependent upon the particular objects whose actions are being described. The meanings of verbs may thus change more than the meanings of nouns when they are used in different contexts. For example, the verb, "catch," can refer to an athlete catching a ball, a kite catching the wind, or a baby catching a cold. Because of this change in meaning, it may be difficult to remember having seen a verb previously if it is being used in a new context.

In support of this theory, Kersten and Earles (2004) demonstrated that recognition memory for verbs was dramatically reduced when the same verb appeared in different semantic contexts at encoding and at retrieval, while a change in semantic context had a much smaller effect on memory for nouns. We proposed that such changes in the meanings of verbs brought to mind in different contexts may contribute to the more general difficulty people have in remembering verbs (e.g., Earles & Kersten, 2000; Earles, Kersten, Turner, & McMullen, 1999). In particular, the context in which a verb is retrieved (e.g., the physical environment, preceding stimuli, and mental state of the participant) will always differ to some extent from the context that was present at encoding, thus bringing to mind somewhat different nuances of meaning in the verb. This change in meaning may make it difficult to remember having encountered that verb before. The present experiments were designed to test the generality of this finding that memory for verbs is more strongly impacted by changes in semantic context than is memory for nouns, stemming from the greater degree of meaning malleability of verbs than of nouns.

Noun and Verb Meanings

Gentner (1981) established that verbs generally have more dictionary entries than do nouns. According to Gentner and Boroditsky's (2001) natural partitions theory, verbs have more interpretations than nouns because the meanings of nouns are typically anchored by nonlinguistic object categories that are often formed before a child learns language. For example, a child knows what falls into the category of BALL long before he or she knows the noun "ball." According to Gentner and Boroditsky's (2001) relational relativity theory, on the other hand, the meanings of verbs cannot be easily mapped onto preexisting nonlinguistic categories. Thus, the meanings of verbs are more malleable than the meanings of nouns and are therefore more likely to change with changes in context.

Consistent with the natural partitions/relational relativity theory, Gentner and France (1988) demonstrated that if the noun and verb in a sentence were inconsistent, people were more likely to change the meaning of the verb to be consistent with the noun rather than changing the meaning of the noun to be consistent with the verb. For example, if the sentence were “The flower kissed the rock,” participants were likely to paraphrase the sentence as something like “a daisy drooping over the rock, with its petals pressed against the rock.” Participants were much more likely to create a paraphrase in which the meaning of the verb changed than to create a paraphrase in which the meaning of the noun changed.

Pickering and Frisson (2001) provided additional evidence that how an adult interprets a verb depends on the verb’s context. They recorded participants’ eye movements as they read sentences. When the initial part of a sentence did not favor one specific meaning of the verb, participants dwelled longer on the words following the verb and regressed more often to previous parts of the sentence. It is difficult to make assumptions about cognitive processes based on eye movements (Anderson, Bothell, & Douglass, 2004), but one possible interpretation of these eye movement data is that people are waiting to resolve the meaning of a verb until they process the context of the verb. This means that if there are multiple meanings of a verb, a person may access these multiple meanings until the interpretation can be resolved when the other elements of the context are processed.

Research on language comprehension has provided extensive evidence that semantic context influences the resolution of a word’s meaning (e.g., Simpson & Krueger, 1991; Vu, Kellas, Peterson, & Metcalf, 2003). Language comprehension may involve the activation of general situational representations that are constantly revised as new constraints are processed (Taraban & McClelland, 1988). Vu, Kellas, and Paul (1998) developed a model of language processing based on sensitivity to context. If the context does not encourage the activation of a particular interpretation of an ambiguous word, then multiple meanings of the word are activated. The stronger the activation of a specific context, the more likely it is that there will only be activation of the biased meaning of the ambiguous word (Vu, Kellas, Metcalf, & Herman, 2000). Vu et al. (2003) proposed that a subject noun causes a specific situational representation to be activated so that the interpretation of later words in the sentence depends on the actions that the agent would be expected to perform. Thus, only the situation-relevant meaning of those later words, including the verb, is activated.

McRae, Hare, Elman, and Ferretti (2005) proposed that not only the agent, but also the patient, location, and instruments in a sentence set up expectations for the rest of the sentence. The event schema that is activated when a noun is processed primes the interpretation of the verb in the sentence, and the verb meaning that is activated is the one that is typically associated with the event. McRae et al. (2005) found large priming effects for verbs when they were named after the processing of either typical agents or typical patients. This priming evidence provides support for their theory that both agents and patients activate event-based expectancies. Thus one would expect a large effect of semantic context on the interpretation of verbs both when the context consists of a subject noun and when the context consists of a direct object noun.

Memory for Verbs, Subject Nouns, and Object Nouns

Since the meanings of verbs are likely to change more than the meanings of nouns when embedded in new contexts, semantic context should have a larger effect on memory for verbs than on memory for nouns. Kersten and Earles (2004) provided initial evidence in support of this hypothesis. In three experiments, participants were asked to remember nouns or verbs from intransitive sentences (e.g., The puppies played.). A recognition test included sentences with the same verb and a different noun and sentences with the same noun but a different verb, in addition to old sentences and entirely new sentences. As expected, changing the semantic context decreased memory for verbs more than memory for nouns.

Because Kersten and Earles (2004) used intransitive sentences in which the noun was the subject of the sentence, the noun always preceded the verb. Thus, the larger effects of context on verbs than nouns could have been due to the order of presentation of the words. This potential alternative hypothesis could be ruled out by presenting participants with sentences in which the verb precedes the noun (e.g., Feed the baby.). Thus, in Experiment 1 of the current project, participants were asked to remember the noun or the verb from sentences in which the noun played the role of direct object rather than subject. It was expected that the greater effects of semantic context on memory for verbs than on memory for nouns would be replicated when using object nouns.

Basic-Level and Superordinate Nouns

In Experiment 2, we tested whether effects of semantic context on memory for verbs are greater when the encoding context encourages participants to generate a specific interpretation of the verb as opposed to activating some more general meaning. We manipulated the specificity of the interpretation of the verb by presenting the verbs either with basic-level or with superordinate nouns at encoding. Basic-level nouns are likely to bring to mind a more specific interpretation of the verb than do superordinate nouns. For example, Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976) demonstrated that when participants listed motions associated with basic-level nouns, they listed many specific movements that are associated with all members of the category. When they listed the motions associated with superordinate nouns, they listed very few common movements. Basic-level nouns, therefore, may activate knowledge of specific motions.

Consistent with this conjecture, Kersten (1998a; 1998b; see also Kersten et al., 2010) demonstrated that learners of a miniature artificial language associated novel basic-level nouns not only with particular bug-like creatures but also with the unique manners of motion associated with each of those creatures. Furthermore, when a manner of motion verb was used for the first time in the presence of one of these nouns, participants altered their interpretation of the verb to make it consistent with that new noun. Thus, if a basic-level noun activates a particular meaning of the verb, the meaning of the verb may change substantially in the presence of a new basic-level noun. In contrast, when a noun labeled a set of creatures that varied in the appearances of the body parts responsible for the motions of those creatures, as is more typical for superordinate nouns, participants were less likely to use motion information associated with the noun to help them interpret the verb (Kersten, 2003). The effects of semantic context on memory for verbs should, therefore, be greater when the context consists of basic-level nouns (e.g., mosquito) than when the context consists of superordinate nouns (e.g., bug), which may not carry as much information about the motions that can be carried out by the referents of that noun.

In addition to examining the effects of basic-level and superordinate nouns on memory for verbs, Experiment 2 also tested for reciprocal influences of verbs on memory for both types of nouns. Kersten and Billman (1997) proposed that verbs and superordinate nouns are similar in their level of generality. If this is the case, then superordinate nouns may exhibit context effects similar to those exhibited by verbs. In particular, the same superordinate noun may convey somewhat different meanings in the context of two different verbs, making a superordinate noun difficult to remember if it is accompanied by different verbs at encoding and at retrieval. In contrast, basic-level nouns may be much more specific in meaning than either superordinate nouns or verbs, making basic-level nouns less sensitive to changes in semantic context.

Similarity in Meaning Across Changes in Context

In Kersten and Earles (2004) we proposed that the greater malleability in meanings of verbs caused the greater effects of semantic context on memory for verbs than on memory for nouns. In order to test this theory, in Experiment 3, we directly manipulated the extent to which verbs changed in meaning in the presence of a new noun and the extent to which nouns changed in meaning in the presence of a new verb. We predicted that semantic context would have a greater influence on memory when the meaning of the verb or noun changed more between encoding and retrieval. Moreover, if the theory of Kersten and Earles (2004) is correct, one would expect that when nouns and verbs were equated in terms of the degree of meaning change between encoding and retrieval, similar effects of semantic context would be observed for the two types of words. It is also possible, however, that verbs may have other properties that may also contribute to their sensitivity to changes in context. For example, the grammatical role of the verb as organizer of a sentence may make it particularly interactive with other sentence elements, making it difficult to process the verb independently of those other sentence elements. If this is the case, then semantic context may have larger effects on memory for verbs than on memory for nouns, even when the two types of words are equated in terms of degree of meaning change between encoding and retrieval.

Experiment 1

Experiment 1 compared the influences of semantic context on memory for verbs and direct object nouns in transitive sentences (e.g., Drop the spoon.). We predicted that memory for verbs would be strongly affected by changing the accompanying noun from encoding to retrieval, whereas memory for nouns would be more immune to changes in the accompanying verb from encoding to retrieval.

Method

Participants

Sixty undergraduate students from Florida Atlantic University received course credit in a general psychology course for their participation.

Materials

Encoding Lists. Sixty sentences each contained a verb and a noun (e.g., Drop the spoon.). Each verb-noun pair (e.g., drop spoon) corresponded to a second verb-noun pair (e.g., bend photograph), such that the verb from each pair (e.g., drop) could be paired with both nouns (e.g., spoon or photograph), and the noun from each pair (e.g., spoon) could be paired with both verbs (e.g., drop or bend) (See Appendix for sentences).

There was no significant difference in the average frequency of the nouns (M = 3.10, SD = .77) and the verbs (M = 2.96, SD = .64), $t(238)=1.50$, p = .135, based on the $\text{SUBTLEX}_{\text{US}}$ norms including part of speech information (Brysbaert, New, & Keuleers, 2012) and a log linear transformation of the frequencies.

For each participant, 60 encoding sentences were created by randomly selecting one verb and one noun from each pair of verb-noun pairs. A different random order of sentences was created for each participant.

Recognition Lists. At recognition, each participant viewed 15 sentences that were the same as at encoding (e.g., Drop the spoon.), 15 sentences containing the same verb but a different noun (e.g., Drop the photograph.), 15 sentences containing a different verb but the same noun (e.g., Bend the spoon.), and 15 new sentences (e.g., Bend the photograph.). For each encoding sentence, the recognition item type was randomly chosen, with the constraint that there were 15 test items of each type. Each participant viewed a different random order of 60 sentences.

Procedure

Participants saw 60 sentences, each containing one verb and one noun, on a computer screen. Half of the participants were asked to remember the noun from each sentence, and half were asked to remember the verb. To encourage participants to process the entire sentence, during the presentation of each sentence, participants answered the question, "How often do you do this?" on a scale of 1 (never) to 5 (very often). After a participant made a selection, that selection was highlighted. Each sentence remained on the screen for 7 s.

Following the presentation of the 60 sentences, participants completed a brief demographics questionnaire and 10 min multiple choice vocabulary task. No word from the vocabulary test was also used in the memory stimuli.

Following the intervening task, participants received a recognition test for the words that they had been asked to remember. Each participant saw 15 items that were the same as at encoding, 15 with the same verb but a different noun, 15 with a different verb but the same noun, and 15 new items. Participants clicked on a button labeled 'yes' if the target word had been presented at encoding and 'no' if it had not. Participants could take as much time as they needed to respond to each sentence.

Results

To assess the recognition of words in the same context as at encoding, we computed the proportion of hits to old target words that were presented in the same context as encoding and the proportion of false alarms to new words that were accompanied by an old context word. To assess the recognition of words in a different context from that at encoding, we computed the proportion of hits to old target words that were presented in a different context from encoding and the proportion of false alarms to new words that were accompanied by a new context word. These proportions are presented in Table 1. We then used these proportions to compute A’, a measure of recognition sensitivity described by Rae (1976).

A 2 X 2 ANOVA was conducted using A’ as the dependent variable, with word type (verb or noun) as a between-subjects factor and retrieval context (same or different) as a within-subjects factor. An alpha level of .05 was adopted for all analyses. As expected, recognition sensitivity was significantly better for nouns than for verbs, $F(1, 58) = 15.16$, $MSE = .008$, $p < .001$, $\eta^2_p = .208$, and there was a significant interaction of word type and context, $F(1, 58) = 11.76$, $MSE = .006$, $p = .001$, $\eta^2_p = .169$. Recognition sensitivity for verbs was significantly better in the same than in a different context, $F(1, 29) = 19.76$, $MSE = .007$, $p < .001$, $\eta^2 = .405$, but there was no significant effect of context on recognition sensitivity for nouns, $F(1, 29) < 1$.

Discussion

In Kersten and Earles (2004), we demonstrated that semantic context affected memory for verbs more than memory for nouns when the nouns served the role of subject in the sentences. The results of Experiment 1 clearly demonstrate that the larger effect of semantic context on memory for verbs than on memory for nouns is a more general finding and is not limited to subject nouns or a certain word order. Semantic context was shown to influence memory for verbs more than memory for nouns that played the role of direct object in the sentences, even though nouns always followed verbs in these sentences.

Experiment 2

One potential explanation for why semantic context affects memory for verbs more than memory for nouns is that the meanings of verbs are more general than the meanings of nouns, and the context encourages participants to generate a specific interpretation of the verb. A different noun may bring to mind a different interpretation of the verb, thus making it difficult to remember whether or not the verb had been seen during encoding.

The question remains, however, as to why the meanings of verbs are so malleable in different semantic contexts. A possible explanation stems from the theory of Kersten and Billman (1997), who proposed that verbs are similar to superordinate nouns in terms of the level of generality of their meanings. In particular, they proposed that people have knowledge of basic-level event categories, involving particular objects interacting in particular ways and resulting in particular outcomes, but that these basic-level event categories are not labeled by individual verbs. Instead, an entire sentence is typically required to bring to mind one of these categories. For example, the sentence “The cat chases the mouse.” causes one to bring to mind a particular manner of interaction between these two creatures, as well as a likely outcome of that interaction. In contrast, the verb “chase” in isolation may encode a much more general meaning, encompassing a wide array of such basic-level event categories (e.g., “cat chases mouse,” “shuttle chases space station,” “beer chases whisky”), similar to the way a superordinate noun (e.g., pet) can encompass a wide array of different basic-level nouns (e.g., dog, parrot, snake).

If verbs are indeed similar to superordinate nouns in their level of generality, then verbs and superordinate nouns may be affected similarly by changes in semantic context, with memory for both types of words suffering more from changes in semantic context than does memory for basic-level nouns. Experiment 2 was designed to test this prediction. Half of the sentences involved verbs paired with basic-level nouns (e.g., pat the horse), as in Experiment 1, whereas half involved verbs paired with superordinate nouns (e.g., pat the animal).

When verbs were paired with basic-level nouns at encoding, participants were expected to have difficulty recognizing a verb when it was presented in the context of a new noun at retrieval, as in Experiment 1. Participants were expected to have less difficulty recognizing a basic-level noun when it was presented in the context of a new verb. When verbs were paired with superordinate nouns at encoding, however, effects of semantic context were expected not only on memory for verbs but also on memory for nouns, with participants having difficulty recognizing a superordinate noun in the context of a new verb. Moreover, when verbs were encoded in the context of superordinate nouns, effects of semantic context on memory for verbs were expected to be smaller than when verbs were encoded in the context of basic-level nouns, because the meaning of a verb brought to mind in the context of a basic-level noun was expected to be more specific than the meaning of the verb brought to mind in the context of a superordinate noun. Thus, when verbs were paired with superordinate nouns at encoding, reciprocal effects of semantic context were expected, with changes in either type of word negatively affecting memory for the other type of word. In contrast, large effects of semantic context on memory for verbs were expected when verbs were paired with basic-level nouns at encoding, whereas effects of semantic context on memory for basic-level nouns were expected to be negligible.

Method

Participants

Ninety FAU undergraduate students received course credit in a general psychology course for their participation.

Materials

Encoding Lists. We created 42 sentences, each containing a basic-level noun and a verb (e.g., Ride the horse.), an alternate superordinate noun (e.g., animal), and an alternate verb (e.g., pat) (See Appendix).

There was a significant difference in frequencies based on the $\text{SUBTLEX}_{\text{US}}$ norms including part of speech (Brysbaert et al., 2012) and using a log linear transformation, $F(2, 165) = 8.25$, $p < .001$. Post hoc tests using the Tukey HSD revealed no significant difference between basic-level nouns ($M = 2.87$, $SD = .76$) and superordinate-level nouns ($M = 2.57$, $SD = .88$) or between basic-level nouns and verbs ($M = 3.15$, $SD = .73$). There was, however, a significant difference between verbs and superordinate-level nouns, reflecting the dispreferred nature of superordinate nouns in everyday language use (Rosch et al., 1976).

Sentences were randomly assigned to contain a basic-level or superordinate noun with the constraint that each participant viewed 21 sentences with a superordinate noun and 21 sentences with a basic-level noun. The verb for each sentence was randomly selected from the two verbs that could be used with the selected noun. We created a new random order of presentation for each participant.

Recognition Lists. Participants saw 14 sentences that were the same as at encoding, 14 sentences containing the same verb but a different noun, 14 sentences containing a different verb but the same noun, and 14 new sentences. New nouns were generated for use as the different nouns, and these nouns are in the Appendix. For example, if the encoding sentence were "Ride the horse," at retrieval the participant might see the same sentence (i.e., Ride the horse.), the same verb but a different noun (e.g., Ride the bicycle.), a different verb but the same noun (e.g., Pat the horse.), or a new sentence (e.g., Pat the child.). Half of the sentences of each type had contained a basic-level noun at encoding (as in the above example), whereas half had contained a superordinate noun (e.g., animal). For each encoding sentence, the recognition item type was randomly chosen with the constraint that there were 7 test items of each type. We created a new random order of 56 sentences for each participant.

Procedure

The procedure was identical to that of Experiment 1 except that participants viewed 42 sentences at encoding and 56 at retrieval. Each participant saw 14 items that were the same at retrieval as at encoding, 14 with the same verb but a different noun, 14 with a different verb but the same noun, and 14 new items.

Results

The proportions of hits and false alarms to nouns and verbs in the two semantic contexts and with the two noun types are presented in Table 2. A' measures of recognition sensitivity were computed. One participant in the Noun condition did not make any yes responses to any of the different context items, so this participant was excluded from the analyses of A'. All of the results reported below are replicated when an analysis of hits minus false alarms is performed in which this participant's scores are included.

A 2 X 2 X 2 ANOVA was conducted, using A' as the dependent variable, with word type (noun or verb) as a between-subjects factor, and noun type (basic-level or superordinate) and retrieval context (same or different) as within-subjects factors. There was a significant 3-way interaction of noun type, word type, and retrieval context, $F(1, 87) = 7.15$, $MSE = .006$, $p = .009$, $\eta^2_p = .076$.

When verbs were paired with basic-level nouns, there was a significant interaction of word type to be remembered and retrieval context, $F(1, 87) = 9.86$, $MSE = .009$, $p = .002$, $\eta^2_p =$

.102, replicating Experiment 1 and Kersten and Earles (2004). In particular, there was a significant effect of semantic context on memory for verbs, $F(1, 44) = 11.38$, $MSE = .017$, $p = .002$, $\eta^2_p = .205$, but no significant effect of semantic context on memory for basic-level nouns, $F(1, 44) < 1$.

When verbs were paired with superordinate nouns, there was no interaction of word type to be remembered and context, $F(1, 87) < 1$. Nouns were remembered significantly better than verbs, $F(1, 87) = 18.66$, $MSE = .011$, $p < .001$, $\eta^2 = .177$, and recognition sensitivity was significantly better in the same than in a different context, $F(1, 87) = 6.88$, $MSE = .006$, $p = .010$, $\eta^2_p = .073$, but superordinate nouns and verbs showed similar effects of semantic context on recognition sensitivity.

Discussion

As expected, the effects of semantic context on the recognition of verbs were larger when the context consisted of basic-level rather than superordinate nouns. The provision of the superordinate noun at encoding may not have forced the participant to choose a specific interpretation of the verb. Instead, multiple meanings of the verb may have been activated. Thus, when a new noun was presented at retrieval, the meaning of the verb that was brought to mind may not have been inconsistent with the interpretation of the verb that had been made during encoding. The provision of a basic-level noun, on the other hand, may have encouraged the participant to choose a particular interpretation of the verb. When a different noun was then presented during retrieval, the interpretation of the verb may have been inconsistent with the interpretation of the verb that had been accessed during encoding, thus making the verb difficult to recognize.

Consistent with the theory of Kersten and Billman (1997), verbs behaved more like superordinate than basic-level nouns, even though verbs were more similar in frequency of usage to basic-level nouns than to superordinate nouns. Superordinate nouns, like verbs, allow a broad range of interpretations. The provision of a verb during the encoding of the superordinate noun may have encouraged a specific interpretation of the superordinate noun; similar to the way the provision of a basic-level noun encouraged the specific interpretation of a verb. It is important to note, however, that the effects of context on memory for verbs in the basic-level noun condition were still substantially larger than the effects of context on memory for superordinate nouns. This may reflect the fact that verbs are themselves superordinate terms, and thus may not narrow down the meanings of accompanying nouns to the same degree as basic-level nouns narrow down the meanings of accompanying verbs. Alternatively, it is possible that verbs have other properties apart from meaning malleability that make them especially sensitive to changes in context. If this is the case, then semantic context may affect memory for verbs more than memory for nouns even when the two types of word are matched in terms of the degree to which their meanings change between encoding and retrieval.

Experiment 3

Experiment 3 was designed to test whether verbs may have other properties beyond meaning malleability that may make them especially sensitive to changes in semantic context. We manipulated the degree of meaning change in the verb between encoding and retrieval. We generated pairs of sentences in which the meaning of the verb did not differ much in the two sentences and pairs of sentences in which the meaning of the verb differed to a greater extent in the two sentences. We expected that the effects of semantic context would be greater for verbs when there was a larger difference in the interpretation of the verb between encoding and retrieval.

We also manipulated the degree of meaning change in the noun between encoding and retrieval. We generated pairs of sentences in which the meaning of the noun did not differ much in the two sentences and pairs of sentences in which the meaning of the noun differed to a greater extent in the two sentences. We expected that the effects of semantic context would be greater for nouns when there was a greater difference in the interpretation of the noun between encoding and retrieval.

We attempted to match nouns and verbs in the degree of meaning change between encoding and retrieval for those conditions in which the meaning of the target word changed little in the two contexts. For those conditions in which the meanings of the words were allowed to vary more freely from encoding to retrieval, on the other hand, nouns and verbs exhibited patterns more typical of their respective grammatical classes, with a greater degree of meaning change between encoding and retrieval for verbs than for nouns. Thus, if the greater effects of semantic context on memory for verbs than on memory for nouns are entirely a function of the degree of meaning change between the two contexts, then nouns and verbs should behave similarly in the conditions in which the degree of meaning change is small and equated for the two types of words. In contrast, in the conditions in which the degree of meaning change is more typical (and thus larger for verbs than for nouns), larger effects of semantic context should be evident for verbs than for nouns. Alternatively, if verbs have other properties beyond meaning malleability that make them particularly sensitive to changes in semantic context, then memory for verbs may be more strongly affected by changes in semantic context than are nouns, even when the two types of words are matched in terms of degree of meaning change between encoding and retrieval.

Method

Participants

Fifty-six FAU undergraduate students received course credit in a general psychology course for their participation.

Materials

Four lists of 32 pairs of sentences were generated (See Appendix). As in Experiments 1 and 2, each sentence contained one verb and one noun.

In two of the lists, the two sentences in each pair contained the same noun but a different verb. In one of these lists, the interpretation of the noun was similar in the two sentences (e.g., Pick the flowers, and Smell the flowers.). The other list was designed so that there was a greater difference in the interpretation of the noun in the two sentences (e.g., Polish the furniture, and Rip the furniture.).

For the other two lists, the two sentences in each pair contained the same verb but a different noun. In one of these lists, the meaning of the verb differed greatly in the two sentences (e.g., Toss the salad, and Toss the frisbee.). The other list was designed so that the meaning of the verb was more similar in the two sentences (e.g., Buy the pants, and Buy the shoes.).

A pilot study was conducted in which 20 undergraduate students were asked to rate the similarity of the meaning of the verb in each pair of sentences containing the same verb and were asked to rate the similarity of the meaning of the noun in each pair of sentences containing the same noun. In particular, when instructed to rate the verbs, participants were instructed that "Each of the verbs is presented in two different sentences. How similar is the meaning of the verb in the two sentences? Please circle your answer." For each pair of sentences, participants indicated whether they thought the meaning of the verb was (1) "very different," (2) "somewhat different," (3) "somewhat similar," (4) "very similar," or (5) "the same" in the two sentences. The procedure when rating nouns was identical except that the word "noun" replaced the word "verb" in the instructions and test items. A 2 (Meaning Similarity: similar or different) X 2 (Word Type: noun or verb) ANOVA on the similarity ratings revealed a significant interaction of Similarity and Word Type, $F(1, 19) = 63.54$, $MSE = .052$, $p < .001$, $\eta^2_p = .770$. There was no significant difference in the similarity ratings for similar verbs ($M = 4.10$, $SD = .48$) and similar nouns ($M = 4.09$, $SD = .84$), $F(1, 19) < 1$. The different nouns ($M = 3.49$, $SD = .98$), however, were rated as significantly more similar than the different verbs ($M = 2.70$, $SD = .67$), $F(1, 19) = 16.61$, MSE = .384, $p = .001$, $\eta^2 = .467$.

There was no significant difference in frequencies for the similar verbs ($M = 3.41$, $SD = .91$), different verbs ($M = 3.40$, $SD = .83$), similar nouns ($M = 3.20$, $SD =.60$), and different nouns ($M = 3.36$, $SD = .74$) based on the $\text{SUBTLEX}_{\text{US}}$ norms including part of speech information (Brysbaert et al., 2012) and a log linear transformation of the frequencies, $F(3, 127) < 1$.

<u>Procedure</u>

The procedure for Experiment 3 was identical to that of Experiments 1and 2 except that participants viewed 96 sentences at encoding and 128 at retrieval. Of the 128 retrieval sentences, 32 were identical to ones seen during encoding, and 32 were entirely new. Thirty-two sentences contained an old verb and a new noun, 16 in which the verb retained a similar meaning to that generated during encoding, and 16 in which the verb generated a more different meaning. Thirty-two sentences contained a new verb and an old noun, 16 in which the noun retained a similar meaning to that generated during encoding, and 16 in which the noun generated a more different meaning.

Results

The proportions of hits and false alarms to nouns and verbs in the two semantic contexts are presented in Table 3. A 2 X 2 X 2 ANOVA was conducted using A' as the dependent variable, with word type (verb or noun) as a between-subjects factor and retrieval context (same or different) and meaning similarity (similar or different) as within-subjects factors. As predicted, there was a significant interaction of context and meaning similarity, $F(1, 54) = 8.21$, $MSE = .004$, $p = .006$, $\eta^2_p = .132$. In particular, the effect of semantic context was significantly larger for dissimilar items, $F(1, 55) = 41.09$, $MSE = .007$, $p < .001$, $\eta^2 = .428$, than for similar items, $F(1, 55) = 15.98$, $MSE = .004$, $p < .001$, $\eta^2 = .225$. There was also a significant interaction of context and word type, $F(1, 54) = 18.13$, MSE = .005, $p < .001$, $\eta^2_p = .251$. Verbs were remembered significantly better in the same than in a different context, $F(1, 27) = 32.171$, $MSE = .004$, $p < .001$, $\eta^2 = .544$. Nouns were also remembered better in the same than in a different context, $F(1, 27) = 9.37$, $MSE = .005$, $p < .001$, $\eta^2 = .258$, but the effect of context was smaller for nouns than for verbs. Thus, as in Experiment 1, there was a larger effect of semantic context on memory for verbs than on memory for nouns.

There was no significant three way interaction of context, word type, and similarity, $F(1, 54) < 1$. The interaction of context and word type remained significant both when analysis was limited to items that changed substantially in meaning from encoding to retrieval, $F(1, 54) = 7.72$, $MSE = .006$, $p = .007$, $\eta^2_p = .125$, and when analysis was limited to items that retained similar meanings from encoding to retrieval, $F(1, 54) = 13.63$, $MSE = .003$, $p = .001$, $\eta^2_p = .202$. Thus, the effects of semantic context were larger for verbs than for nouns, even when the degree of meaning change from encoding to retrieval was matched for nouns and verbs (i.e., for the items that retained similar meanings from encoding to retrieval).

Discussion

Kersten and Earles (2004) proposed that semantic context has a larger effect on memory for verbs than on memory for nouns because the meaning of a verb is likely to change in the context of a different noun more than the meaning of a noun changes in the context of a different verb. The results of Experiment 3 provide some support for this proposal, demonstrating larger effects of semantic context when there is a greater degree of meaning change between the two contexts.

The results of Experiment 3 also suggest that there are other differences between verbs and nouns that lead to larger semantic context effects for verbs than for nouns, however. In particular, verbs continued to exhibit larger semantic context effects than nouns, even when both verbs and nouns were rated as changing little in meaning between encoding and retrieval. Thus, there may be something special about verbs above and beyond their susceptibility to meaning change that makes them especially sensitive to effects of semantic context. In the General Discussion we propose some other possible differences between verbs and nouns that may also lead to larger effects of semantic context on memory for verbs than on memory for nouns.

General Discussion

The effects of semantic context are larger on memory for verbs than on memory for nouns that play either the role of subject, as in Kersten and Earles (2004), or the role of direct object, as in the current set of experiments. We hypothesized that because the meanings of verbs are typically more general than the meanings of nouns, the noun helps one to interpret the verb, and if one wants to remember the verb, it is important for the same noun to be present at retrieval as was present during encoding.

Meaning Change and Memory for Nouns and Verbs

The present results provide evidence that when the interpretation of the verb that is encouraged by the noun during encoding is altered by the provision of a new noun at retrieval, this makes the verb more difficult to remember. On the surface, these results would appear to be quite similar to previous demonstrations of context effects in memory for nouns. For example, Light and Carter-Sobell (1970) demonstrated that participants had difficulty recognizing a noun when it was accompanied by different modifiers at encoding and retrieval, thus encouraging different interpretations of the noun in the two cases. The nouns involved in these prior demonstrations were homonyms, however, involving two distinct meanings that through historical accident happen to be associated with the same surface form (e.g., river bank vs. money bank). In contrast, the nouns and verbs employed in the present experiments are better characterized as polysemes, involving multiple, related meanings associated with the same surface form. Although homonyms have received a great deal of scientific study because of what they can tell us about text comprehension processes in the face of ambiguity, homonymy would appear to be the exception rather than the norm, whereas some degree of polysemy is typical of most word meanings (Frisson, 2009).

The present results suggest that when the different interpretations of a word are related by polysemy rather than homonymy, effects of semantic context are likely to be greater on memory for verbs than on memory for nouns. These differences between nouns and verbs in their susceptibility to semantic context effects are relative rather than absolute, however, with greater effects of semantic context accompanying a greater degree of meaning change between alternate senses of a word, regardless of whether that word is a noun or a verb. For example, in the present Experiment 3, when we decreased the amount of meaning change in the verb upon changing the noun, we demonstrated a decrease in the effects of semantic context on recognition of the verb. Furthermore, when we increased the amount of meaning change in the noun stemming from changes in the verb, we demonstrated an increase in the effects of semantic context on recognition of the noun. Because verb meanings may typically allow for a greater degree of polysemy than do noun meanings (Gentner, 1982), however, memory for verbs may generally be more strongly affected by semantic context than is memory for nouns.

It may be possible to interpret the present results in terms of models of text comprehension. Although the primary dependent measure in these experiments involved memory for individual words, when those words were initially presented at encoding, they were accompanied by a question (i.e., “How often do you do this?) that encouraged comprehension of the sentences in which the words were embedded. Thus, the words to be remembered may have been encoded in the context of text comprehension processes. For example, in Kintsch’s (1988) construction-integration model, when a word is first encountered in text, a broad set of associates of that word is initially activated, regardless of whether or not those associates are consistent with the current discourse context. In a later integration phase, competitive interactions among these associates allow only those associates that are consistent with the larger discourse context to remain activated. Thus, when participants in the present experiments who were instructed to remember verbs encountered a verb at encoding, they may have activated a diverse set of associates reflecting the different possible interpretations of the verb. When these participants then encountered a noun as the direct object of that verb, however, this discourse context may have supported some of the activated associates at the expense of others, ultimately yielding a set of activated associates that represented only a subset of the possible interpretations of the verb.

If these participants later encountered the same verb at test in the context of the same noun that had accompanied it earlier, the discourse comprehension processes brought into play by the presentation of this sentence may have yielded a similar set of activated associates to the ones that had been activated at encoding, helping participants to recognize that they had seen this same verb earlier. If, on the other hand, participants encountered this same verb in the context of a different noun, these same discourse comprehension processes may have yielded a somewhat different set of activated associates of the verb, making it more difficult for participants to recognize that they had seen the verb earlier.

Discourse comprehension processes may have proceeded quite similarly at encoding for participants who were instructed to remember the noun in each sentence. When these participants were later presented with the same noun in the context of a new verb, however, the activated set of semantic associates of the noun may still have overlapped substantially with the set of associates that were activated at encoding, reflecting greater consistency in noun meanings over multiple discourse contexts. Thus, participants may have been more likely to recognize a familiar noun than to recognize a familiar verb in a novel discourse context.

The present results thus suggest that although the presentation of a verb may initially lead to the activation of a rich set of semantic associates, some of this activated information may be mutually contradictory, reflecting the different senses of the meaning of the verb. Thus, integration with the surrounding discourse may lead to only some of that information remaining active, with different information remaining active in different discourse contexts. In contrast, although the presentation of a noun may similarly lead to activation of a rich set of semantic associates, much of this activated information may be mutually facilitatory, reflecting greater consistency in the interpretation of a noun over multiple discourse contexts (except in the case of homonyms). Thus, similar sets of associates may be activated in different discourse contexts involving the same noun, making it easier to recognize having seen that noun previously.

Verbs and Superordinate Nouns

Although the meanings of many nouns may be quite stable across different discourse contexts, some classes of nouns may resemble verbs in their context specificity. For example, superordinate nouns (e.g., “animal,” “food,” “vehicle”) may be interpreted differently in different discourse contexts, with different contexts encouraging different basic-level interpretations of those nouns (e.g., “ride the animal” may cause one to think of horses rather than dogs). The comprehension of a superordinate noun within a text may thus proceed similarly to the comprehension of a verb, with Kintsch’s (1988) theory suggesting that a large set of potentially contradictory associates (e.g., riding, sitting on one’s lap, dangerous) may be initially activated, but that only a much smaller subset of these associates may survive a later integration process with the discourse context. Thus, when that same superordinate noun is encountered in a different discourse context, a different set of associates survive the integration process, making it difficult to remember having seen that superordinate noun previously.

Kersten and Billman (1997) in fact proposed that there are similarities between verbs and superordinate nouns in the generality of the meanings that they convey, perhaps explaining in part the similar effects of semantic context on memory for the two types of words. Kersten and Billman found that participants viewing a series of novel events in an unsupervised setting formed event categories involving rich predictive structure, similar to the predictive structure thought to be associated with basic-level nouns (Rosch, 1978). This result is interesting because the meanings of verbs are widely acknowledged not to carry such predictive structure, instead often conveying only a single attribute of meaning (Graesser, Hopkinson, & Schmid, 1987; Huttenlocher & Lui, 1979; Talmy, 1985). For example, the verb “fall” in isolation conveys only a downward trajectory, not providing any information about the nature of the object that is falling or the likely outcome when the fall is completed. Kersten and Billman (1997) proposed that people do have knowledge of event categories that involve rich predictive structure, but that such categories are not typically described by a single verb, but rather by a verb together with its arguments. For example, the sentence “The toddler fell” allows a number of predictions, such as that crying would be the likely outcome and that this would lead to adults coming to help.

A verb together with its arguments may thus convey a basic-level event category involving detailed predictive structure. If this is the case, then a verb in isolation may be thought of as a superordinate event category, describing a variety of different events (e.g., toddler fell, leaves fell, stock market fell) involving perhaps only a single unifying theme (e.g., a downward trajectory). A possible exception to this rule may be instrument verbs (e.g., vacuuming, faxing, spooning), which often afford a number of predictions. For example, “vacuuming” implies the existence of a vacuum, a human agent, a dirty floor, particular motions of the vacuum across the floor, and the likely outcome of the floor becoming clean. Thus, instrument verbs may label basic-level event categories. There appear to be a limited number of such verbs in most languages (Behrend, 1990), however, perhaps because most objects are capable of performing a variety of different actions.

Language instead seems to have adopted the strategy of using multiple words to bring to mind basic-level event categories. If we again adopt Kintsch’s (1988) theory as an explanatory mechanism, one may propose that when one is initially presented with a verb, a large set of associates may be activated, representing the range of possible meanings of that verb. When these associates are integrated with the surrounding discourse context, however, only some of those associates may remain active, representing one of a number of basic-level event categories associated with that verb. Superordinate nouns may function similarly, bringing to mind a range of possible meanings, one of which may ultimately be selected on the basis of the discourse context.

Because the meanings of verbs and superordinate nouns are both quite general by this account, when the two are used in combination, as was done in Experiment 2, it may not be possible to ascertain a specific meaning for either term, especially in the absence of a larger discourse context. This state of affairs could be represented in Kintsch's (1988) model by postulating that the absence of semantic constraint imposed by the discourse context allows multiple candidate meanings of each word to remain active even after the integration process has taken place. Thus, when later presented with the same target word in a new context, the meaning brought to mind in that new context may still overlap to some extent one of the candidate meanings that was activated at encoding. This would explain the smaller effects of semantic context on memory for verbs presented in the context of superordinate nouns than for verbs presented in the context of basic-level nouns in Experiment 2. It would also explain why the largest effects of semantic context that we observed in memory for nouns (i.e., the effects of changing the verb on memory for superordinate nouns) were still not as large as the largest effects of semantic context that we observed in memory for verbs (i.e., the effects of changing a basic-level noun on memory for verbs). In particular, because verbs may themselves be superordinate terms, they may provide relatively little constraint on the meanings of accompanying nouns, whereas the more specific meanings of basic-level nouns may provide much greater constraint on the meanings of accompanying verbs.

Other Differences between Nouns and Verbs

Although semantic context effects were evident for nouns as well as verbs when nouns changed substantially in meaning between encoding and retrieval, there were effects of semantic context on memory for verbs even when verbs retained quite similar meanings from encoding to retrieval in Experiment 3. These results suggest that there might be something special about verbs above and beyond their degree of meaning change that makes them especially susceptible to semantic context effects. One possibility involves the extent to which nouns and verbs lend themselves to visual imagery. Begg and Pavio (1969) demonstrated that we remember sentences better when we are able to produce a visual image of the action. Nouns can be imaged in isolation, but it is usually necessary to include an object when forming an image of a verb. When a basic-level noun is provided as context for a verb, therefore, the specific interpretation of the verb may assist the person in generating an image of the verb-noun pair. Thus, at retrieval if the noun that accompanies the verb is the same as the noun provided at encoding, this encourages the same interpretation of the verb, and thus the same image should be produced, making it easier to recognize the verb. If a different noun is provided, this may encourage a different interpretation of the verb, and thus a different image may be produced, making it more difficult to recognize the verb.

Using a somewhat different methodology, Imai, Haryu, and Okada (2005) have provided evidence that images of objects and actions differ in their stability across encoding and retrieval contexts, consistent with the idea that images of objects elicited by nouns may be more stable than images of actions elicited by verbs. Rather than presenting participants with nouns and verbs to elicit images of absent objects and actions, as in the present research, they presented their participants (3-year-old children) with videos of actors performing novel actions on novel objects, thus directly presenting children with the visual images they wanted the children to remember. One day later, children were tested on their ability to discriminate the original videos from new videos, each involving either a novel object or a novel action. Children were found to perform quite well at discriminating old videos from videos involving an old action performed on a new object. This suggests that children recognized as familiar an old action performed on the same object as before, whereas an old action performed on a new object failed to register as familiar to the children, making it easy to determine which of the two events they had seen previously. In contrast, children had greater difficulty discriminating old videos from videos involving a new action performed on a familiar object. This suggests that a familiar object, even when presented in the context of a different action, still registered as familiar with the children, making it more difficult to distinguish this somewhat familiar event from the entirely familiar alternative.

Verbs and nouns may thus differ in their susceptibility to semantic context effects in part because there is greater stability or overlap in the visual images produced by nouns in different contexts (e.g., an encoding vs. a retrieval context) than in the visual images produced by verbs in these different contexts. If this account is correct, then the present findings may also be related to findings from the literature on enactment effects in recall of verb phrases. It has been repeatedly demonstrated (e.g., Earles, 1996; Earles & Kersten, 2002; Engelkamp, 1998; Steffens, Buchner, Wender, & Decker, 2007) that participants recall verb phrases (e.g., drop the ball) better if they perform those phrases at encoding as opposed to simply reading them. One explanation for such enactment effects (e.g., von Essen, 2005) is that enactment leads to an especially well-integrated memory representation of the action-object relation. Thus, if one later brings to mind the object with which the action was performed, one is likely to be able to use this object as a retrieval cue for the performed action. This use of the object to retrieve the action is especially likely if the object is physically present at the time of retrieval (Steffens, Buchner, & Wender, 2003; Steffens, Jelenec, Mecklenbräuker, & Thompson, 2006).

Participants in the present research were not asked to perform the presented verb phrases, but they were asked to rate how often they perform them. This rating may have encouraged participants to imagine themselves performing the described actions, likely activating the same brain regions that are active when physically performing those actions (Raposo, Moss, Stamatakis, & Tyler, 2009). When participants were later presented with the same verb accompanied by the same noun, they may thus have been able to use an image of the object described by the noun to retrieve the previously-formed image of the action. If, on the other hand, participants were presented with the same verb accompanied by a new noun, the image of the object described by this new noun would not make a good retrieval cue for the previously-formed image of the action described by that verb, and thus participants would be less likely to remember having seen that verb before. The present results may thus be related to results from the enactment literature, except that the objects and actions would only be imagined rather than directly perceived.

The present results may thus reflect an asymmetry between nouns and verbs in the extent to which they are dependent upon the other type of word in the formation of a visual image. It may be possible to test this possibility by employing nouns and verbs that are both low in imageability (e.g., “Justice prevailed.”). If this theory is correct, differences between nouns and verbs in susceptibility to semantic context effects should disappear when sentences cannot be readily imaged.

Another possibility, however, is that the differences between nouns and verbs stem from their different syntactic roles. In particular, verbs are inherently relational, conveying the relationships among the different noun phrases that appear in a sentence. Thus, even when two different context words lead to similar interpretations of the verb, the processing of those context words may be obligatory in order to create a specific instantiation of the verb. Because the context words themselves are different, the resulting interpretations of the sentences in which they appear will also be different, making it difficult to bring to mind a previous sentence involving the same verb. In contrast, it may be possible to create a specific instantiation of a noun independently of the event in which it is participating. The context in which the noun appears may influence the specific instantiation of the noun that is created (e.g., “The dog yipped at the stranger.” may cause one to bring to mind a small rather than a big dog), but once so created, that instantiation may be accessible independently of the event in which it participated. Thus, to the extent that a noun brings to mind a similar instantiation at retrieval, one may recognize having seen that noun before, even if that noun appears in a sentence that describes a quite different event (e.g., “The dog hid behind its master.”). If this account is correct, then the differences between nouns and verbs in imageability may be a reflection within the concrete domain of more general differences between nouns and verbs in their roles within a sentence. Larger effects of semantic context may thus be evident for verbs than for nouns even for sentences that cannot be readily imaged.

Conclusions

People have difficulty recognizing a verb when presented in the context of a new noun, not only when the noun plays the role of subject in a sentence but also when it plays the role of direct object. Verbs may be similar to superordinate nouns in that they refer to categories of a very general nature, and other words must be used in conjunction with these words in order to bring to mind a specific, basic-level category. Verbs may thus bring to mind different basic-level event categories when used in combination with different context words, making it difficult to recognize having seen those verbs before. In addition to these changes in the meanings of verbs produced by changes in context, the grammatical role played by verbs may also contribute to their contextual sensitivity. In particular, the role of the verb as organizer of the various thematic roles in a sentence may cause it to be especially interactive with other sentence elements, thus making it difficult to recognize the verb independently of these other sentence elements.

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This research truly represents a joint effort between the two authors, and the choice of order of authorship was determined in a fairly arbitrary manner. Preliminary data were presented at the 45th Annual Meeting of the Psychonomic Society. Please address correspondence to Julie L. Earles, Department of Psychology, Florida Atlantic University, Jupiter, FL 33458. E-mail: jearles@fau.edu.

Appendix

Experiment 1

Verb 1	**Noun 1**	**Verb 2**	**Noun 2**
disturb	ants	feed	baby
touch	bubble	pop	balloon
empty	trash	take	bath
push	cow	kiss	brother
paint	nail	hit	bus
stop	movie	start	automobile
give	reward	lose	present
scare	deer	watch	child
smell	bacon	taste	coffee
read	book	sign	contract
hide	vase	break	cookie
grow	tomato	eat	corn
hug	blanket	wash	dog
unfold	sock	tear	dollar
accept	application	reject	donation
lock	trunk	slam	door
conceal	scar	expose	face
hold	popsicle	lick	jello
boil	egg	fry	fish
raise	hand	wave	flag
toss	frisbee	catch	football
destroy	truck	wax	furniture
play	song	hear	game
send	invitation	receive	gift
tighten	lid	loosen	grip
wear	scarf	buy	hat
enter	building	exit	highway
land	airplane	fly	kite
climb	tree	kick	ladder
bite	peach	dry	cucumber
spill	soup	burn	matches
draw	picture	view	mountain
fold	laundry	gather	napkins
squeeze	arm	scrub	orange
keep	coins	stack	newspapers
fill	hole	cover	pail

rip	sleeve	grasp	document
collect	money	distribute	papers
lead	donkey	follow	parade
drop	spoon	bend	photograph
share	watermelon	slice	pizza
crack	nuts	carry	plates
bake	pie	freeze	casserole
poke	sister	pat	puppy
roll	ball	grab	quarter
shake	salt	throw	rattle
pull	hair	curl	ribbon
clean	shirt	ruin	rug
open	cabinet	close	store
ask	judge	tell	coach
bounce	tire	inflate	basketball
insert	cassette	eject	videotape
remove	wallpaper	apply	glue
replace	roof	fix	clock
unwrap	butter	melt	chocolate
straighten	wires	cross	legs
polish	apple	cut	wood
peel	banana	chew	grapefruit
mix	pudding	cook	cake
water	garden	plant	flowers

Experiment 2

Verb 1	**Basic Noun**	**Verb 2**	**Superordinate Noun**	**Different Noun for Verb 1**	**Different Noun for Verb 2**
scare	frog	discover	amphibian	girl	painting
ride	horse	pat	animal	bicycle	child
steal	sculpture	break	artwork	dollar	stick
drop	coffee	drink	beverage	honey	medicine
find	mosquito	remove	bug	book	sticker
paint	house	enter	building	fence	hole
tear	shirt	wear	clothes	wallpaper	ring
spread	mustard	spill	condiment	blanket	sand
fill	box	open	container	envelope	letter
visit	Netherlands	leave	country	friend	wallet
watch	dog	catch	creature	cloud	fly
rip	banner	hang	decoration	bandage	picture
shred	newspaper	read	document	cheese	sign
pack	camera	carry	equipment	suitcase	bag
sew	silk	drape	fabric	sheets	flag
close	buckle	attach	fastener	trunk	pin
add	milk	taste	ingredient	pepper	chocolate
serve	hamburger	sell	food	volleyball	popcorn
grow	banana	pick	fruit	flowers	card
polish	table	cover	furniture	apple	casserole
finish	puzzle	start	game	race	videotape
load	tent	unpack	gear	bricks	swimsuit
chase	butterfly	capture	insect	bear	donkey
hide	bracelet	clasp	jewelry	cookie	purse
smell	skunk	frighten	mammal	perfume	guests
freeze	fish	fry	meat	ice	okra
eat	pie	bake	pastry	candy	chicken
follow	cat	cuddle	pet	bus	baby
feel	rain	avoid	precipitation	cotton	dentist
squeeze	melons	count	produce	clay	jellybeans
touch	lizard	release	reptile	chair	tiger
sprinkle	salt	pour	seasoning	seeds	soda
measure	triangle	draw	shape	board	hair
clean	fork	bend	silverware	window	wire
create	shriek	hear	sound	homework	teacher
damage	castle	build	structure	shoe	airplane
deliver	pencils	organize	supplies	pizza	closet
store	hammer	lift	tool	junk	weight
stack	blocks	lose	toys	papers	quarter
cook	carrot	peel	vegetable	soup	peach
wash	car	fix	vehicle	potato	radio
shoot	Gun	buy	weapon	target	magazine

Experiment 3

Minimal Meaning Change in the Verb

Bake the cake. **Bake** the pizza.
Hit the wall. **Hit** the chair.
Tell the joke. **Tell** the story.
Chew the cracker. **Chew** the bread.
Create the sculpture. **Create** the statue.
Carry the newspaper. **Carry** the trash.
See the photograph. **See** the movie.
Call the restaurant. **Call** the father.
Slice the pie. **Slice** the lime.
Spit the water. **Spit** the seeds.
Type the paragraph. **Type** the word.
Buy the pants. **Buy** the shoes.
Drive the train. **Drive** the truck.
Hear the voice. **Hear** the music.
Bury the towel. **Bury** the spoon.
Close the window. **Close** the drawer.
Learn the name. **Learn** the number.
Grasp the stone. **Grasp** the banana.
Wash the feet. **Wash** the face.
Find the park. **Find** the hotel.
Swallow the vitamin. **Swallow** the candy.
Walk the dogs. **Walk** the horses.
Move the bed. **Move** the desk.
Heat the coffee. **Heat** the tea.
Label the collection. **Label** the insects.
Open the closet. **Open** the curtains.
Feed the cat. **Feed** the hamster.
Brush the hair. **Brush** the teeth.
Count the nails. **Count** the coins.
Fill the bag. **Fill** the container.
Love the daughter. **Love** the grandmother.
Punish the students. **Punish** the criminals.

Greater Meaning Change in the Verb

Bite the apple. **Bite** the tongue.
Kiss the boy. **Kiss** the pavement.
Take the shower. **Take** the medication.
Mark the target. **Mark** the calender.
Break the plate. **Break** the habit.
Grab the sock. **Grab** the attention.
Juggle the oranges. **Juggle** the issues.
Lift the spirits. **Lift** the crate.
Watch the television. **Watch** the girl.
Cut the finger. **Cut** the bangs.
Hold the head. **Hold** the wheel.
Push the cart. **Push** the button.
Raise the lever. **Raise** the funds.
Irritate the bees. **Irritate** the allergies.
Sell the fruit. **Sell** the bicycle.
Discover the gold. **Discover** the truth.
Dry the eyes. **Dry** the dishes.
Miss the basket. **Miss** the question.
Release the prisoner. **Release** the breath.
Fight the man. **Fight** the fire.
Make the money. **Make** the mess.
Lug the suitcase. **Lug** the children.
Read the minds. **Read** the magazines.
Serve the master. **Serve** the lunch.
Play the game. **Play** the piano.
Toss the salad. **Toss** the frisbee.
Touch the heart. **Touch** the toes.
Twist the ankle. **Twist** the cap.
Hide the eggs. **Hide** the feelings.
Throw the rock. **Throw** the tantrum.
Try the dessert. **Try** the defendant.
Conduct the orchestra. **Conduct** the experiment.

Minimal Meaning Change in the Noun

Slam the **door.** Lock the **door.**
Squeeze the **glue.** Squirt the **glue.**
Light the **match.** Extinguish the **match.**
Rotate the **arm.** Pinch the **arm.**
Steal the **pen.** Bring the **pen.**
Grill the **dinner.** Order the **dinner.**
Shoot the **marble.** Bounce the **marble.**
Blow the **air.** Breathe the **air.**
Sweep the **floor.** Mop the **floor.**
Mince the **onions.** Chop the **onions.**
Cuddle the **doll.** Pat the **doll.**
Toast the **bagel.** Taste the **bagel.**
Pick the **flowers.** Smell the **flowers.**
Enter the **contest.** Win the **contest.**
Give the **pencil.** Grip the **pencil.**
Smash the **grapes.** Rinse the **grapes.**
Enlarge the **hole.** Dig the **hole.**
Skip the **page.** Skim the **page.**
Kick the **ball.** Catch the **ball.**
Cover the **box.** Empty the **box.**
Insert the **key.** Misplace the **key.**
Instruct the **actress.** Admire the **actress.**
Wind the **clock.** Set the **clock.**
Navigate the **river.** Cross the **river.**
Bother the **baby.** Tickle the **baby.**
Borrow the **clothes.** Wear the **clothes.**
Pop the **balloon.** Inflate the **balloon.**
Scratch the **table.** Clear the **table.**
Tie the **rope.** Pull the **rope.**
Construct the **tower.** Destroy the **tower.**
Iron the **shirt.** Hang the **shirt.**
Organize the **decorations.** Display the **decorations.**

Greater Meaning Change in the Noun

Mold the **artwork.** Draw the **artwork.**
Hug the **brother.** Slap the **brother.**
Highlight the **book.** Publish the **book.**
Shake the **hands.** Clasp the **hands.**
Rest the **muscles.** Strain the **muscles.**
Feel the **carpet.** Vacuum the **carpet.**
Turn the **tool.** Bang the **tool.**
Drink the **milk.** Burn the **milk.**
Answer the **phone.** Drop the **phone.**
Crush the **can.** Store the **can.**
Sing the **song.** Compose the **song.**
Polish the **furniture.** Rip the **furniture.**
Send the **letter.** Sign the **letter.**
View the **picture.** Paint the **picture.**
Plant the **tree.** Climb the **tree.**
Plan the **marathon.** Run the **marathon.**
Waste the **time.** Check the **time.**
Cook the **food.** Fling the **food.**
Warm the **meal.** Share the **meal.**
Pack the **dress.** Sew the **dress.**
Churn the **butter.** Spread the **butter.**
Demand the **respect.** Earn the **respect.**
Fly the **airplane.** Design the **airplane.**
Ride the **animal.** Groom the **animal.**
Solve the **problem.** Explain the **problem.**
Eat the **pear.** Grow the **pear.**
Show the **film.** Develop the **film.**
Spin the **toy.** Roll the **toy.**
Tear the **paper.** Write the **paper.**
Color the **cards.** Deal the **cards.**
Disturb the **people.** Amuse the **people.**
Present the **identification.** Lose the **identification.**

Table 1

Proportion of Hits and False Alarms and Measures of Recognition Sensitivity in Experiment 1

		Verbs		Nouns	
		M	*SD*	*M*	*SD*
Hits					
	Same Context	.94	.07	.92	.12
	Different Context	.61	.17	.88	.21
False Alarms					
	Same Context	.23	.03	.16	.24
	Different Context	.16	.13	.10	.12
Recognition Sensitivity					
	Same Context	.91	.01	.93	.01
	Different Context	.82	.02	.93	.02

Note. Recognition sensitivity was measured using A’.

Table 2

Proportion of Hits and False Alarms and Measures of Recognition Sensitivity in Experiment 2

	Verbs		Nouns	
	M	*SD*	*M*	*SD*
Superordinate Nouns				
Hits				
Same Context	.91	.12	.93	.10
Different Context	.74	.23	.83	.21
False Alarms				
Same Context	.25	.23	.08	.16
Different Context	.16	.17	.08	.13
Recognition Sensitivity				
Same Context	.89	.10	.96	.05
Different Context	.86	.12	.93	.08
Basic Level Nouns				
Hits				
Same Context	.92	.11	.94	.10
Different Context	.62	.23	.90	.20
False Alarms				
Same Context	.30	.25	.09	.16
Different Context	.22	.23	.07	.14
Recognition Sensitivity				
Same Context	.88	.14	.96	.06
Different Context	.79	.15	.96	.05

Note. Recognition sensitivity was measured using A’.

Table 3

Proportion of Hits and False Alarms and Measures of Recognition Sensitivity in Experiment 3

	Verbs		Nouns	
	M	*SD*	*M*	*SD*
Similar Meaning				
Hits				
Same Context	.93	.08	.87	.08
Different Context	.68	.14	.86	.14
False Alarms				
Same Context	.18	.15	.19	.16
Different Context	.17	.14	.21	.18
Recognition Sensitivity				
Same Context	.92	.07	.90	.07
Different Context	.83	.08	.89	.11
Different Meaning				
Hits				
Same Context	.94	.08	.88	.12
Different Context	.56	.19	.66	.17
False Alarms				
Same Context	.24	.19	.24	.20
Different Context	.18	.13	.17	.17
Recognition Sensitivity				
Same Context	.91	.08	.88	.10
Different Context	.77	.14	.82	.13

Notes. Similar Meaning = The meaning of the target word is similar at encoding and at retrieval. Different Meaning = The meaning of the target word differs between encoding and retrieval. Recognition sensitivity was measured using A’.