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Word Selection in Reading Sentences: Preceding Versus Following Contexts

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A new task, double-word selection, simulated lexical ambiguity by presenting 2 words between which the reader had to choose while reading a sentence shown at 133 or 150 ms/word, following a procedure called rapid serial visual presentation. The double-word pair was presented for less than 100 ms. In immediate recall of the sentence, readers made a correct selection on most trials, both when the relevant context came before the double words and (less accurately) when the relevant context came shortly afterward (Experiments 1 and 2) or with a delay of up to 1 s (Experiment 3). Both words could often be reported if the sentence was stopped one word after the double words (Experiment 2). In Experiment 4, a single function word determined selection between double words differing in syntactic category. The results are consistent with a 2-stage modular interactive model of word perception (M. C. Potter, A. Moryadas, I. Abrams, & A. Noel, 1993) and extend this model to word selection and lexical disambiguation.

Although lexical ambiguity is pervasive in both written and spoken English, readers and listeners normally resolve such ambiguity before they become aware of it. Thus, it is apparent that there are powerful and rapidly acting mechanisms available for using context and relative frequency to make a selection among multiple meanings of words. Swinney (1979) claimed that the multiple meanings of a word are activated in parallel when the word is encountered, prior to selection; other theorists (e.g., Forster, 1979) proposed that meanings are activated serially in the order of frequency, with acceptance of the first meaning that fits the context. Mixed models have also been proposed, such as staggered parallel activation on the basis of frequency (e.g., Simpson, 1981) and reordering of access on the basis of prior context (e.g., Duffy, Morris, & Rayner, 1988). Although experimental tests of the various theories have not been conclusive, the preponderance of the evidence suggests that meanings compete in parallel, at least to some extent.

Whatever their differences, these theories of ambiguity resolution have in common the requirement that meanings be selected and rejected. To study this process of selection, in the present study we simulated lexical ambiguity by presenting readers with an overt choice between two words presented in parallel. The two words—double words—were embedded in a sentence that provided relevant context either before or only after the double words. The whole sequence was shown using rapid serial visual presentation (RSVP); the double-word pair appeared briefly, one word above the other. Our working hypothesis was that the same processes that result in selection of the appropriate meaning of an ambiguous word would be engaged in this new task, and that selection of one of the double words would result in rapid loss of information about the other word.

The background for the present study comes from two domains of research and theory, one concerned with lexical ambiguity resolution and the other with word perception in context. In a previous article, Potter, Moryadas, Abrams, and Noel (1993) reported studies of contextual effects on word and nonword perception; they proposed a two-stage model, the modular interactive model, as an account of their findings. In a first, modular stage of word perception, multiple candidates that are orthographically similar to the stimulus are momentarily activated in parallel, together with their meanings. These candidates are weighted by the amount of stimulus support each receives. For example, the written word *park* would activate "park," and would also activate orthographically similar lexical entries such as "pork," "pare," and "perk." The latter entries would receive lower stimulus weightings than "park." Similarly, a nonword such as *purk* would activate "pork," "perk," "purr," and so forth.[1] In a second stage, context interacts

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[1] When the stimulus information is sufficiently strong and is incompatible with any lexical entry, a nonword is correctly perceived. Otherwise, the nonword may be misperceived as a word, particularly when the nonword looks like that word and the latter fits the context. When reading is speeded by using RSVP, perceptual evidence is less strong and hence biasing context is more likely to influence the outcome (Potter et al., 1993).

with these weights to select the single best lexical candidate, which is normally the only word the viewer becomes aware of.

The modular interactive model of contextual bias in word perception is similar to a class of models of lexical disambiguation. Potter et al. (1993) proposed that the same mechanism is used to bias perception of an unambiguous word and to select the relevant meaning of a homonym (see Norris, 1986, for a similar model). For example, in the case just described the word *park* has at least two meanings, "park$_1$" (place of recreation) and "park$_2$" (to park a car). If one assumes that each meaning has a separate lexical entry (e.g., Levelt, 1989), both entries would be activated when *park* is presented. For the two lexical entries of homonyms, the stimulus weightings are always the same, so that selection would rely only on context and the frequency of each meaning (see Miyake, Just, & Carpenter, 1994, for a similar model of homonym disambiguation in which frequency plays a role).[2] The modular interactive model can readily be extended to account for word selection in the double-word task: As in the other cases, two or more words are activated (this time overtly), and one must be selected.

In the three cases under discussion—a single word in the process of perception, a single ambiguous word, and two words in the double-word selection procedure—the source of the multiple candidates differs. In word perception, the candidates are orthographic neighbors; in lexical ambiguity resolution, the competition is among multiple meanings of that word; in double-word selection, two overt words are in competition. Moreover, there are other factors that differ in the three cases: For example, the clarity of the stimulus (the stimulus evidence or weight of each candidate) is critical in the case of word perception, such that contextual effects are greatly reduced or even eliminated when stimulus conditions are optimal. Nonetheless, we propose that the selective process, to the extent that it involves the use of context to make a choice among words based on their meanings, is the same in all three cases. That is, whenever there is some uncertainty (from whatever source) about which of several word concepts has been presented, this selective process will be engaged.[3]

Contextual Bias in Word Perception

Studies indicate that words that mismatch the context are often misperceived as perceptually similar words that would fit the context (e.g., Connine, Blasko, & Hall, 1991, for auditory words; Potter et al., 1993; Rueckl & Oden, 1986, for written words). Potter et al. (1993) found that sentence context exerted a substantial influence on word and nonword perception, in experiments in which the RSVP sentences were presented at 10 words/s. The task in this study was to recall the sentence immediately after it had been presented; participants were informed that some words might be anomalous or misspelled and that they were to recall them exactly as they had seen them. In each sentence, there was one critical word (such as *wasp*) that had an orthographic neighbor differing only by one letter (such as *wisp*) and also a nonword differing by the same letter (such as *wesp*). In some sentences, the wrong word or the nonword replaced the critical word. Conversions of the wrong word or the nonword to the missing target word were frequent when the relevant context was presented before the critical item. More surprising was that there was still a marked biasing effect of this kind when the selective context arrived as much as 300 ms after the offset of the critical stimulus. In this condition, one to three additional words intervened between the critical item and the relevant context, as in Sentences 1A and 1B, in which the first selective word of each of the contexts is capitalized.

(1A) She brushed the w_sp aside because INSECTS bothered her.

(1B) She brushed the w_sp of her HAIR aside because it was in her eyes.

In the experiment, the letter marked by a blank in *w_sp* was either *a* (*wasp*), *i* (*wisp*), or *e* (the nonword *wesp*). By the time the first strongly biasing word appeared, the initial visual representation of the critical stimulus (*wasp, wisp,* or *wesp*) was presumably no longer available because of masking from intervening words (including the biasing word itself), ruling out a single interactive stage of perception and context-driven selection. Activation would continue to flow upward even after the stimulus had been masked and the lower level feature and letter detectors were occupied with the subsequent stimuli, so that a representation of the critical stimulus would still be available when relevant context appeared subsequently. By then, however, the representation of the critical stimulus would be in a late form, presumably at the lexical level, because the feature- and letter-processing levels would be occupied with subsequent stimuli (see, e.g., McClelland & Rumelhart, 1981).

Thus, any interaction between context and an earlier stimulus would be restricted, according to this line of reasoning, to lexical or lexical–semantic representations of the earlier stimulus. That subsequent context can bias identification of a written word or nonword indicates that more than one possible identity for the stimulus was still active when the relevant context arrived, a result consistent with the modular interactive model. Bias effects were greater when the context appeared before the critical stimulus, suggesting that the multiple meanings that are initially activated decay rapidly, making prior context more effective than subsequent context.

The additional finding that a word stimulus such as *wasp*

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[2] Relative frequency is not included as a factor in the modular interactive model, but adding it would be straightforward. In the case of homonyms, relative frequency of meanings affects retrieval, although exactly how remains unclear. See, for example, Rayner, Pacht, and Duffy (1994) and Simpson and Burgess (1985).

[3] The three cases, perceptual, lexical, and double-word ambiguity, may co-occur: One or both double words may themselves be ambiguous, an ambiguous word may be presented briefly so that its orthographic neighbors become part of the competition, and so forth. If we assume that a single process is making a selection, then these mixed cases present no theoretical difficulty. For simplicity, however, we do not consider such mixed cases in this article.

was less readily biased toward the contextually appropriate "wisp" than was a nonword stimulus such as *wesp* supports the claim of the model that word candidates are weighted by their stimulus support: The stimulus *wasp* provides more evidence for "wasp" than for "wisp," whereas *wesp* provides approximately equal evidence for "wasp" and for "wisp," allowing a proportionally greater effect of context (Potter et al., 1993).

In summary, misperception of nonwords and of words in the presence of biasing context shows that word perception is sensitive to meaningful context when the perceptual conditions are not ideal. The fact that context that arrives several words after the critical item can still have a biasing effect suggests that more than one word candidate is activated during initial perception and remains active for at least a short period of time thereafter.

Lexical Disambiguation

As mentioned earlier, Swinney and his colleagues (Onifer & Swinney, 1981; Swinney, 1979) used a crossmodal priming method to obtain evidence that all meanings of an ambiguous word are retrieved initially, even when the word is preceded by relevant sentential context. However, other studies (e.g., Tabossi, 1988) found that preceding context that strongly supports the dominant meaning of a homonym can suppress the activation of a subordinate meaning (see Tabossi & Zardon, 1993, for a recent review of the conflicting literature on this issue). Other models suggest that prior context and relative frequency of meanings affect the order in which meanings are activated. In any case, when relevant context appears before the ambiguous word, resolution of the ambiguity occurs within a few hundred milliseconds, and the rejected meaning is apparently inactivated. When relevant context does not arrive until after the ambiguous word, as is fairly common in normal language use, successful resolution of the ambiguity still occurs in most cases (Miyake et al., 1994; cf. Rayner & Frazier, 1989). It is not clear whether successful disambiguation in these cases indicates that more than one possible meaning remains active until there is disambiguating information (as Miyake et al., 1994, proposed for balanced homonyms), or whether one meaning is invariably selected shortly after the ambiguous word, requiring a later reanalysis if the wrong meaning has been selected (e.g., Duffy et al., 1988).

In summary, there is considerable evidence that multiple meanings of ambiguous words are activated initially when a word is encountered, and that either prior context or context arriving later can be used to select the relevant meaning. In these respects, contextual effects on word perception and on ambiguity resolution are similar.

Double-Word Selection: Background

In the double-word method, two words are presented together, but only one word fits into the sentence. An eye-tracker study of reading by Blanchard, McConkie, Zola, and Wolverton (1984) used a similar procedure, although the two words were presented successively. They imposed a visual mask for a 30-ms period during each of the reader's fixations, beginning 50–120 ms after the start of the fixation; thus, readers became accustomed to a brief flicker during each fixation. On certain trials, a word in the sentence changed identity from before to after the mask, during the reader's first fixation on that word. The change in identity involved a change of only one letter in the word (e.g., *tombs–bombs*). Each word was plausible in the text, so readers did not have to make a selection based on context: Rather, the question was whether both or only one word would be seen, and what effect the timing of the shift from one word to the next would have on which word was reported. The investigators found that participants usually reported seeing just one of the two words; which word was seen was influenced both by the Cloze probability of each word (although, as noted, either word was plausible) and by stimulus duration.

Using RSVP, Forster and Hall (cited in Forster, 1974) also presented two words, alternative verbs, in sequence, and found that subsequent context biased which verb was reported. (Other studies in which temporally backward priming was observed are also described later in the article.) In other experiments (see Chiarello, Maxfield, Richards, & Kahan, 1995; Sereno & Rayner, 1992), priming has been demonstrated between the meanings of two words presented simultaneously or near simultaneously. Experiments by Dark and her colleagues (Dark & Scheerhorn, 1994; Dark, Vochatzer, & VanVoorhis, 1996), which are discussed below in connection with Experiment 3, looked at priming of a simultaneously presented pair of words by a preceding word related to one of them and found evidence for both forward and backward priming.

In most of the studies just mentioned, participants were presented with two words that were processed at nearly the same time and in such a way that only one was likely to be reported. The general finding was that meaningful context can bias report of one word over the other word. In none of these experiments, however, were the words presented simultaneously and in sentence context—the condition that we claim to be most similar to lexical ambiguity resolution.

Selection in Models of Word Perception and Disambiguation

The modular interactive model is proposed as the minimal model that is capable of handling the major results in the literature on context effects in word perception and that can also account for the context effects—both forward and backward—found by Potter et al. (1993) in word perception and examined in the present study of double-word selection. In studies of word perception and disambiguation in which context is presented before the critical word appears, it has proved difficult to discriminate empirically between two-stage models that include a modular, autonomous first stage and fully interactive models. Both types of models can account for most results (see Simpson & Kang, 1994). When the relevant biasing context appears only after the critical item, however, the item is necessarily perceived first without relevant context, as it would be in a two-stage model of the

type we propose. To the extent that contextual influences on perception and interpretation of a word are shown to be similar when context precedes and when it follows the critical stimulus, one can conclude that a two-stage model is supported.

The modular interactive model is similar to Norris's (1986) checking model of word recognition, but with the added assumption that more than one competing word candidate may remain under consideration as succeeding words are processed, at least when presentation is sequential and rapid. In Norris's model, many lexical candidates may be activated in parallel on the basis of initial stimulus information, and the candidates are then narrowed down dynamically by changes in their recognition criteria (thresholds) to reflect both the context (against which candidates are checked) and the current perceptual support for each candidate. Word frequency also enters into the setting of the recognition criterion for a given word. The first word candidate to reach its (dynamically changing) recognition criterion is recognized, or in our terms, selected. In this model, each stage is autonomous, and information is passed in only one direction, but all stages operate in cascade as new information is passed up continuously from the previous stage. Thus, as in the present model, there is a separation between bottom-up multiple accessing of lexical candidates and subsequent recognition of one of them. As in the present model, Norris proposed that the same mechanism is responsible for context effects on word perception and on the interpretation of lexically ambiguous words. It is not clear, however, that Norris's model could be extended to a case in which two possibilities remain in contention as subsequent words are processed.

Other models of word recognition that have major features in common with the present model but that differ from it in one or more significant respects include Morton's (1969) logogen model, Becker's (e.g., 1985) verification model, Forster's (1976; see also Forster, 1989) search model, and Marslen-Wilson and Welsh's (1978; see also Marslen-Wilson, 1987) cohort model for auditory word recognition.[4] The main differences between these models and the present model are as follows: (a) Lexical candidates in the present model are suggested solely by their visual similarity to the stimulus (without top-down interaction); (b) activation occurs in parallel (without search); (c) lexical candidates are weighted by the stimulus evidence for them (not activated in an all-or-none fashion); (d) interaction or comparison with context occurs in parallel for all activated candidates (not serially); and (e) the effect of context is to bias word selection (not to affect search or verification order). As discussed by Norris (1986), the preponderance of the experimental evidence supports a model with these properties. We add the stipulation that the model should be able to account for selection that can occur only some time after the critical stimulus, which in our model is achieved by maintaining activation of two or more candidates until selective context is available, with some probability that one or more candidates will be lost.

An approach suggested by Rueckl and Oden (1986) and endorsed by Simpson, Peterson, Casteel, and Burgess (1989) shares a central characteristic with the present model: Context begins to have an influence on candidates suggested by the stimulus, before there is a final selection. Like Potter et al. (1993; see also Norris, 1986), they reject a purely intralexical basis for context effects: That is, pragmatic information, not simply lexical priming, can affect selection.

The models just discussed, including the modular interactive model, are all qualitative rather than quantitative, in contrast to computational models such as the model of McClelland and Rumelhart (1981) and McClelland (1991) for written-word perception and Kawamoto's model (1993) for lexical ambiguity resolution. These and other computational models have provided important demonstrations of the ability of parallel distributed processing models and related computational approaches to give a detailed account of processes that are described in more general terms in the models just discussed. Computational models have, however, proved less successful as tests of the validity of subtly different architectures, as the debate between McClelland (1991) and Massaro (1989; Massaro & Cohen, 1991) about fully interactive versus staged models illustrates.

The Present Study

If the proposed two-stage model of visual word perception is correct, then it should be possible to simulate the output of the first stage by actually presenting two perceptually and conceptually distinct stimulus words in such a way that they compete for a single slot in the sentence, as in the double-word procedure. This would allow one to study the operation of the hypothesized second stage, selection. In the present experiments, double words were embedded in sentences, and participants were told that only one of the words would fit in the sentence. They were instructed to include that word when recalling the sentence. We predicted that the biasing effects of preceding and following context observed by Potter et al. (1993) in the reading of single words or nonwords would influence word choice in this new task.

The initial experiments in the present study were designed both to test the double-word method and to address the question of whether sentence context would determine which word in the pair was reported as part of the sentence. We were also interested in the fate of the word not selected: Would it be immediately forgotten, or would it be as likely to be remembered as the selected word? Participants in Potter et al.'s (1993) experiments with perceptually ambiguous words or nonwords rarely reported more than one word candidate for each letter string. Indeed, when people read or listen to speech in daily life, they only occasionally become aware of competing word candidates. To approach these

[4] Auditory and visual stimuli differ in the temporal availability of information, with each syllable of a spoken word unfolding over 300–400 ms, while a visual word appears simultaneously. Models, such as Marslen-Wilson's (1987; Marslen-Wilson & Welsh, 1978) cohort model, that narrow down the lexical possibilities interactively as further auditory information arrives are therefore not directly applicable to recognition of written words.

normal conditions of reading, in the present experiments we attempted to set the timing so that participants could select the appropriate word on a substantial majority of trials but would have difficulty remembering the rejected word immediately after recalling the sentence.

In the first three experiments, we contrasted conditions in which the context that determined which of the two words was appropriate came before versus only after the double words. An example of the sentence sets used in Experiment 1 is given in Table 1. When the biasing context came after the double words, the first biasing word appeared one to three words later: In the example in Table 1, the second word following *pencil/basket* was *write* or *carry*, marking the first point at which the sentence became biased. In Experiment 2, we assessed the representation of the double words immediately after they had been presented; in Experiment 3, we investigated the effect of delaying the relevant sentence context for a longer period after the double words; and in Experiment 4, the effect of syntactic constraints on selection was investigated.

Experiment 1

The purpose of Experiment 1 was to examine the ability of readers to use sentence context to select between two briefly exposed words. RSVP was used to control processing time. The double words were presented briefly and nearly simultaneously, immediately above and below the line on which the rest of the words of the sentence appeared. The participants were instructed to read and immediately recall the sentence, including in their recall the one of the double words that fit into the sentence, and then to report the other double word if they remembered it.

Method

Participants. The participants were 16 MIT undergraduates who had volunteered to be part of a participant pool. All were native English speakers and reported normal or corrected-to-normal vision. An additional 5 participants were replaced because they fell below a performance criterion (see the *Scoring and analyses* section). Participants were paid.

Materials and design. We wrote 64 sets of materials, each consisting of 4 sentences and a critical word pair, the double words, that appeared in each of the 4 sentences. The average length of the sentences was 9.8 words. An example is shown in Table 1. In each set, 2 sentences were biased toward one word and 2 were biased toward the other word. The biasing context appeared before the double words in 1 of the 2 sentences biased toward a given word, and only after the double words in the other sentence. When the bias appeared after the double words, it began with the first word following the double words in 8 sentences, with the second word in 40 sentences, and with the third word in 16 sentences. Each participant saw only one version of each set of materials, in a randomized within-subject design. The position of the two critical words (the "upper word" above the line and the "lower word" below the line) was counterbalanced. Appendix A lists the sentences and double words.

The temporal sequence of the double-word array, which was centered on the spot where other words of the sentence appeared, is shown in Figure 1. A row of asterisks appeared in the center, and then the two words appeared on the lines above and below the asterisks. The durations of the overlapping events composing the array were multiples of the refresh rate of the computer screen, 17 ms (60 Hz). As shown in Figure 1, the first event was the presentation of a row of asterisks in place of the previous word in the sentence; the asterisks stayed in view for the duration of the array (83 ms). The second event was the presentation of a word on the line below, 17 ms after the onset of the asterisks (the lower word appeared first, to counteract the tendency to begin to read the upper word first). After another 17 ms, the second word appeared on the line above the asterisks. At this point the array consisted of the asterisks and two words, one on the line above and one below. After another 17 ms, the lower word was replaced by a blank; 17 ms later, the upper word was replaced by a blank; and finally after another 17 ms, the asterisks were replaced by the next word of the sentence. The total duration of the double-word display was 83 ms, and each of the double words was in view for 33 ms. Note that the double words were not visually masked, although they were presented too briefly to permit an eye movement to the location of either word before it disappeared from the screen. Subjectively, the two words and the row of asterisks appeared and disappeared simultaneously. Apart from the double-word array, the sentences were presented in RSVP at 133 ms/word.

Apparatus. The experiment was presented on an IBM AT with a fast-fade screen (B22) and a refresh rate of 60 Hz.

Procedure. The task was to read and immediately recall the sentence aloud. Participants were told that there would be one double word presented in each sentence, and they were instructed to try to complete the sentence by selecting one of the double words as they viewed the sentence, to recall the sentence with this word, and then to report the other word if it had been seen and remembered. Each trial began when the participant pressed the space bar on the keyboard. A row of asterisks appeared for 533 ms

Table 1
Double-Word Sentences With Bias Before or After the Double-Word Array

Bias	Sentence
Before	Maggie wrote the letter with a basket/pencil she had with her
	Maggie carried the kitten in a basket/pencil to her house
After	Maggie used a basket/pencil to write the letter
	Maggie used a basket/pencil to carry the kitten

Note. The sentence was shown using rapid serial visual presentation (see Figure 1); participants were instructed to recall the sentence with the appropriate word from the double-word array, reporting the nonmatching word after the sentence. The upper–lower position of the double words was counterbalanced.

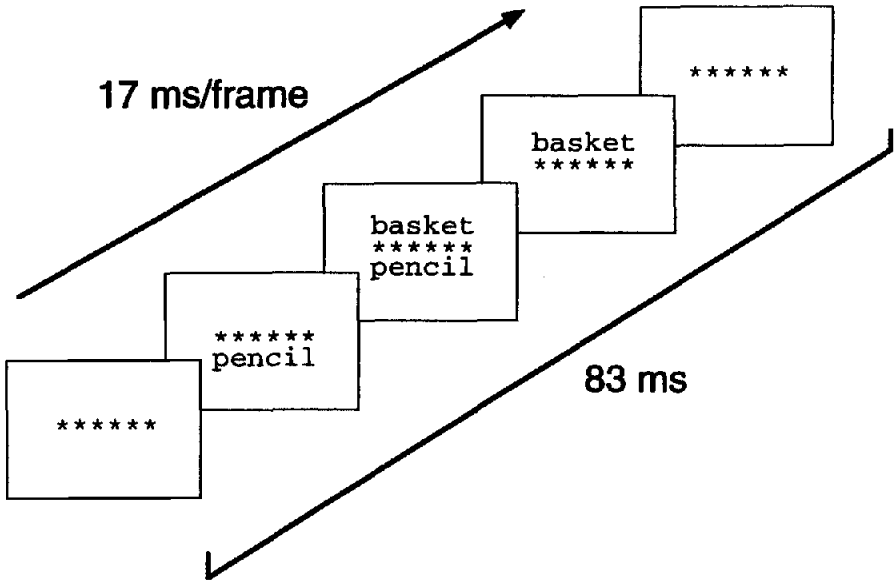

Figure 1. Stimulus sequence in presenting a double-word pair in a rapid serial visual presentation sentence.

as a fixation point, followed by a blank screen for 133 ms and then the sentence at 133 ms/word. There were 10 practice trials.

Pilot studies. Three other combinations of sentence rate and double-word timing were also investigated in three pilot experiments using the same materials as in Experiment 1. All used somewhat longer presentations of the double words, and in one the context sentences were presented at 200 ms/word rather than 133 ms/word. Appendix B gives a description of these pilot experiments and their main results; in summary, the main differential effect of the longer presentation of the double words used in the pilot experiments was to increase the likelihood of also recalling the nonmatching word.

Scoring and analyses. The response to each of the words in a double-word pair was scored as recalled in the sentence, recalled after the sentence, or not recalled. Rarely (in 1.2% of the trials in Experiment 1 and from 1% to 3% in subsequent experiments), participants recalled both words as part of the sentence; in that case, the first word recalled was scored as within the sentence, and the second was scored as outside the sentence. (It was never the case that both double words were recalled outside of the sentence.) Thus, a maximum of one of the two words on a given trial was scored as within the sentence, and a maximum of one word was scored as outside the sentence.

Criteria were established for replacing participants who had unusual difficulty with the task. Participants were replaced if they recalled less than 70% of the words of the sentences (excluding the double words) or if they included neither double word in the sentence on more than 40% of the trials. These criteria ensured that participants were attending both to the sentence and to the double-word array. Five of the participants (24%) did not meet one or both of these criteria and were replaced.

Three main analyses were carried out in this and the later experiments, on the basis of the within-sentence score unless otherwise specified. Both subject (F_1) and item (F_2) analyses were carried out in each case. The first was an analysis of the number of trials in each condition on which the matching word (the double word consistent with sentence context) was included in the recalled sentence. The second was a bias-ratio analysis, $P_m = M/M + O$, where P_m is the proportion of match responses out of all in-sentence responses that included one of the two double words; M is the number of match responses, and O is the number of other (nonmatching double-word) responses. This bias measure ranges from .0 to 1.0, with .5 indicating no bias and a ratio above .5 indicating positive bias. It was calculated separately for each participant (and each item) in each condition, and conditions were compared to assess whether they differed in amount of bias. The third analysis tested whether the ratio in each condition differed from .5, thus showing significant bias; the results of these two-tailed t tests are shown in Table 2, together with the bias ratios for all the experiments. All results reported in this article were significant at $p < .01$ or better, unless otherwise specified.

Results

Apart from the double words, participants recalled an average of 94% of the words of the sentences (range = 84%–100%). Turning to the double words, the percentage recalled in each condition is shown in Table 3; separate percentages are given for recall of a double word as part of the sentence ("in") and for recall of a double word following recall of the sentence ("out"). In summary, matching words were markedly more likely to be recalled as part of the sentence (70%) than nonmatching (other) words (13%): That is, readers were usually able to select the relevant word. The selective effect was more marked when relevant context preceded the double words, but there was a strong selective effect even when context came afterward. The word in the double-word array that was not incorporated into the sentence was sometimes reported after recall of the sentence, but usually it was forgotten. When the extra word was recalled, it was almost always the nonmatching double word.

In the analysis of match responses, significantly more matches were made when the context came before (75%) the

Table 2
Bias Ratios for Experiments (Exps.) 1–4, Showing the Bias Toward the Matching Versus the Nonmatching Word in Each Condition and the Significance of the Difference From .50

Experiment and condition	Context		
	Before	After	Delayed
Exp. 1: Double word	.88**	.80**	
Exp. 2:			
Full sentence	.88**	.80**	
Full sentence both[a]	.72**	.67**	
Truncated both[a]	.61**	.50[b]	
Exp. 3: Double word	.88**	.79**	.73**
Exp. 4: Double word	.72*		

Note. The bias ratios shown are the means of ratios calculated for each participant in each condition; ratios were also calculated for each item in each condition. Except as noted, all are based on in-sentence recall. The ratio is $M/M + O$, where M = number of matching word responses, O = number of other (nonmatching) word responses. A ratio of .50 indicates that there was no bias from sentence context; ratios significantly larger than .50 signify bias toward the context-matching word. Two-tailed t tests were carried out on the difference from .50 of each ratio, by subjects and by items; the significance levels for subjects and items analyses were the same in each case, except that the item analysis for Experiment 4 was significant at the .001 level.
[a]Ratios based on recall inside plus outside the sentence (for full sentences) and recall of both words (for truncated sentences). [b]For the truncated condition in Experiment 2, matching–nonmatching was a dummy distinction when the context came after the double words.
*$p < .01$. **$p < .001$.

double word than when it came after (65%), $F_1(1, 15) = 13.00$, $MSE = 6.50$; $F_2(1, 63) = 16.89$, $MSE = 1.25$.[5] The bias ratios for the two conditions (before = .88, after = .80) are shown in Table 2: An analysis comparing them again showed an advantage for context coming before the double word, $F_1(1, 15) = 9.25$, $MSE = 0.01$; $F_2(1, 63) = 8.47$, $MSE = 0.02$. Each of the ratios was significantly different from .5, showing that there was substantial bias toward the match word whether the context came before or after the double words.

There was a tendency for the word in the upper position to be recalled more often, even though that word appeared 17 ms after the lower word (see Figure 1). Analyses that are not reported in detail showed that this effect interacted with the locus of context: There was an increased advantage to the upper position when the context came only after the double words. This pattern of results, found in most of the subsequent experiments as well, suggests that participants often saw both words but were more likely to retain the upper than the lower word if context was not already available to determine which word to select. The effect of upper versus lower position was small, compared with the match and the before–after effects. The effect did not compromise the main results, either in Experiment 1 or in the other experiments in this article, and it is not discussed further except when it is theoretically informative (see Experiment 2).

Table 3
Percentage of Double Words (Matching and Nonmatching) Recalled in Each Context Condition (Before and After) as Part of the Sentence (In) and Following the Sentence (Out) in Experiment 1

Scoring condition	Matching word			Nonmatching word		
	Before	After	*M*	Before	After	*M*
In	75	65	70	10	15	13
Out	1	2	1	8	9	8
Total (in + out)	76	66	71	18	24	21

Analyses were also carried out on the total double-word recall score, summing responses inside and outside the sentence separately for the matching- and nonmatching-word responses (see Table 3). In most respects, these combined analyses mirrored the analyses for recall of a word in the sentence, which is not surprising given the relatively small proportion of words recalled outside the sentence in the present experiment. These analyses, also carried out for later experiments, are not presented except when relevant (see Experiment 2).

Discussion

The results indicate that readers can use sentence context, particularly context that precedes a word, to select which of two words belongs in the sentence, even when they are reading at the relatively high rate of 7.5 words/s and viewing the double-word array for only 83 ms (with each word in view for 33 ms). The word not selected was sometimes recalled after the sentence, but (almost always) only when it was the mismatching word. If participants encoded the matching word at all, they were almost always able to incorporate it into the sentence.

Relevant context before the double words led to more accurate selection than context appearing only after the pair. That is what one would expect if readers used the selective information in the first part of the sentence, on-line, to pick out the relevant word. Still, context had a major influence on selection even when it came afterward, indicating that the matching word was both encoded and retained at least briefly on at least 65% of the trials. In the context-after condition, the participant had no basis for choosing between the words until after they had been presented (and no opportunity for selective priming). If we assume that the probability of encoding each word was independent, we can infer that *both* words were encoded and retained briefly on about 42% of the trials ($.65^2$). The indication that on many trials two word candidates were entertained briefly is consistent with earlier results with nonwords that were ambiguous between two words (e.g., *purk–park–pork*), with context presented before or after the nonword (Potter et al.,

[5] The analyses were based on the number of trials on which there was a matching word response, with a maximum of 32 per condition per subject and 8 per condition per item.

1993, Experiment 5). This result gives further support for the modular interactive model.

In normal word perception, we assume that the stage at which multiple candidates are considered is unconscious, whereas in the present procedure participants knew there were two words to consider. However, participants often reported that they were unconscious of the identity of the nonmatching word; they just seemed to pick the right word automatically, without a conscious decision. Indeed, given that they had included the matching word in the sentence on a given trial, readers could remember the nonmatching word after the sentence on only 7% of the context-before and 10% of the context-after trials. Thus, the double-word procedure seems to have succeeded in tapping into the automatic context-sensitive process of lexical selection that we propose as the second stage of processing.

Experiment 2

Although the results of the context-after condition in Experiment 1 suggest that both words in the double-word array were processed and retained briefly on many trials, a more direct test of that assumption was made in Experiment 2. The design of Experiment 2 was the same as that of Experiment 1, except that a random half of the sentences were truncated one word beyond the double-word array. On those trials, the participants' only task was to report *both* of the double words. On the other trials, the sentence was complete, and the task in that case was the same as in Experiment 1: Recall the sentence (including the relevant double word), and then report the other word if possible.

We expected that on many of the interrupted trials, both words would be reported but that some bias toward the matching word would be evident when relevant context preceded the double-word array. The lack of such bias would contradict our conclusion that available context is used to constrain selection when the array is first presented. Because interrupted and complete sentences were intermingled randomly, the participants had to attend to the sentence on all trials.

Method

The general method was like that of Experiment 1, except as noted below.

Participants. Thirty-two students from the same pool as in Experiment 1 participated in Experiment 2; none had been in Experiment 1. An additional 10 participants were replaced because they fell below the minimal performance criterion (see the *Scoring* section).

Materials and design. The materials were those used in Experiment 1. The design included an additional variable: presentation of the full sentence or truncation of the sentence one word after the double words. This variable was counterbalanced with the other variables: context before versus context after, upper–lower position of the matching word, and bias toward one or the other word. Thus, there were 16 versions of the experiment. For the eight sentences in which the immediately following word was biasing, a neutral word was substituted on the truncated trials.

Procedure. Participants were instructed as in Experiment 1 to recall the sentences that were complete and to include the appropriate word from the double-word array and then to report the other word if possible. When the sentence was truncated, they were to report both of the double words, not the sentence fragment. On the truncated trials, the sentence ended one word after the double-word array and was followed by a row of capital *X*s.

The timing of the fixation asterisks, the sentence, and the double-word array was the same as in Experiment 1: Each word appeared for 133 ms, the double-word array appeared for a total of 83 ms (see Figure 1), and the final row of *X*s on the truncated trials appeared for 133 ms. There were 18 practice trials.

Scoring. The scoring of double-word recall on the full-sentence trials was the same as in Experiment 1. For the truncated sentences, recall of both words was scored and was equivalent to the in-sentence plus outside-sentence recall score for the full sentences. (A separate analysis of the first of the two words recalled was also performed.) For the truncated version of the sentences in which relevant context came only after the double words, the matching versus nonmatching word was a dummy distinction.

Criteria were established for replacing participants who had unusual difficulty with the task. Participants had to recall an average of at least 80% of the words (other than the double words) when they recalled full sentences, and they had to have a minimum of 50% of the trials on which at least one of the two double words was recalled either inside or after the sentence. Ten participants (24%) were replaced because they did not meet one or both of these criteria.

Results

Table 4 gives the percentages of matching and nonmatching words recalled; separate percentages are given for the full-sentence and truncated trials. The results of the full-sentence condition generally replicated those of Experiment 1: Recall of the matching word was markedly higher than recall of the nonmatching word, whether relevant context came before or only after the double words, although the effect was reduced somewhat when the context came afterward. When the sentence was truncated, the matching word was again likely to be recalled (see Table 4), but so was the nonmatching word, much more frequently than in the full-sentence condition. For truncated sentences, the difference between context-before and context-after (i.e., no differential context) conditions was strongly present, suggesting that prior context acted immediately on the processing of the double words.

Separate analyses were carried out on the full-sentence trials and the truncated-sentence trials. In addition, analyses were carried out for all recalls for the experiment as a whole.

Full-sentence recall. Participants recalled an average of 92% (range = 82%–100%) of the words of the sentence, other than the double words. An analysis of within-sentence recall of the matching word showed that recall was higher in the context-before condition (69%) than in the context-after condition (62%), $F_1(1, 31) = 4.80$, $MSE = 4.22$, $p < .05$; $F_2(1, 63) = 5.81$, $MSE = 1.74$, $p < .05$. Bias ratios ($M/M + O$), shown in Table 2, were calculated separately for the context-before and context-after conditions. A comparison of the two conditions showed a significantly higher bias when context came before (.88) than when it came after (.80) the double words, $F_1(1, 31) = 8.19$, $MSE = 0.01$; $F_2(1, 63) = 6.92$, $MSE = 0.03$, $p < .05$. Each of the ratios was

Table 4
Percentage of Double Words (Matching and Nonmatching) Recalled in Each Condition in Experiment 2

Sentence type and scoring condition	Matching word			Nonmatching word		
	Before	After	*M*	Before	After	*M*
Full sentence						
In	69	62	65	9	15	12
Out	2	4	3	22	21	22
Total (in + out)	71	65	68	31	36	33
Truncated sentence[a]						
First word[b]	54	39	47	29	43	36
Second word	15	20	18	20	17	18
Total (1st + 2nd)	69	59	64	49	60	54

Note. $N = 32$. In the full-sentence condition, participants viewed a complete sentence and recalled it. In the truncated-sentence condition, the sentence was interrupted one word after the double-word array, and participants were instructed to recall the two double words. These conditions were randomly intermixed. In = words recalled as part of the sentence; Out = words recalled following recall of the sentence.
[a]For the context-after condition, matching–nonmatching was a dummy distinction when the sentence was truncated. [b]First word reported (if any).

significantly different from .5, showing that as in Experiment 1, there was substantial bias toward the matching word whether the context came before or after the double words.

A separate set of analyses of the sum of double-word recalls, both inside the sentence and afterward (see Table 4), was carried out for comparison with recall on the truncated trials. The percentages of matching responses for context-before (71%) and context-after (65%) conditions were not significantly different, $F_1(1, 31) = 3.09$, $MSE = 3.96$, $p < .09$; $F_2(1, 63) = 3.04$, $MSE = 2.01$, $p < .05$. Bias ratios, shown in Table 2, were significantly different from .5 both for the context-before condition (.72) and for the context-after condition (.67), but the before and after ratios did not differ significantly, $F_1(1, 31) = 3.60$, $MSE = 0.01$, $p < .07$; $F_2(1, 63) = 1.82$, $MSE = 0.02$, $p > .18$.

The overall results for the full-sentence condition were like those of Experiment 1, which this condition replicated. One difference, however, is that more nonmatching words were reported after the sentence in the present experiment (an additional 21% as compared with 6%). One explanation is that the random mixture of trials in which both double words had to be reported led participants to attend more closely to both words (not just to the matching one).

Truncated-sentence recall. The instruction in this condition was to report both of the double words, ignoring the sentence fragment. Analyses were carried out on the sum of first and second double words recalled (see Table 4). The percentage of match responses in the context-before condition (69%) was compared with that in the context-after condition (59%). (Note that match vs. nonmatch response was a dummy variable in the context-after condition, because there was no relevant context following the double words when the trial was truncated.) These percentages differed significantly, $F_1(1, 31) = 10.03$, $MSE = 3.74$; $F_2(1, 63) = 10.04$, $MSE = 1.87$, indicating that even when the sentence stopped one word after the double words, the effect of prior context had already influenced the availability of the match word. Bias ratios were calculated (see Table 3); for the context-before condition, the ratio of .61 was significantly different from .50, but, as expected, the ratio in the context-after condition was .50, at chance (both *t*s were < 0.1). The two ratios differed significantly, $F_1(1, 31) = 13.76$, $MSE = 0.01$; $F_2(1, 63) = 27.46$, $MSE = 0.01$.

On truncated trials, when participants were attempting to recall both words, they were very likely to recall the upper word first and then the lower one. Considering only the trials on which both words were reported, the upper word was reported first on about 95% of the trials except when the context came before and the matching word was the lower word. Then, the upper-then-lower reports dropped to 81%. The marked effect of position on the first word recalled in the truncated condition suggests that when viewers received the cue to recall both words they drew on a representation that preserved spatial position. For full sentences, in contrast, they appropriately reported the matching word first (in the sentence), with the usual advantage when the matching word was in the upper position in the array (70% vs. 61% of recall as part of the sentence for upper and lower positions, respectively).

Combined analyses of full-sentence and truncated conditions. These comparisons were based on the sum of recall inside and outside of the sentence in the case of full sentences and on the sum of recall of the two words in the truncated condition (see Table 4). We hypothesized that the matching word would be equally likely to be perceived and selected for report in the full-sentence and truncated conditions, and indeed there was only a marginally significant difference in recall, $F_1(1, 31) = 3.82$, $MSE = 3.78$, $p < .07$; $F_2(1, 63) = 3.91$, $MSE = 1.85$, $p < .06$, with the matching word more often recalled in the full-sentence condition (68% vs. 64%). In an analysis of the bias ratios (see Table 2), which reflect the relative recall of the matching and nonmatching word, bias was substantially greater in the full-sentence than in the truncated-sentence condition,

$F_1(1, 31) = 35.47$, $MSE = 0.02$; $F_2(1, 63) = 53.11$, $MSE = 0.02$, consistent with the hypothesis that selection of the matching word results in rapid forgetting of the nonmatching word in the full-sentence condition.

Recall of both words: Were the two words processed in parallel? Table 5 shows a breakdown of the results into trials on which only one, both, or neither of the double words was recalled. Subject analyses were carried out on the number of trials on which both words were recalled (note that item analyses are not relevant here). Overall, both words were recalled on 20% of the full-sentence trials and 36% of the truncated trials, $F(1, 31) = 15.64$, $MSE = 13.11$. Neither the main effect of before–after context nor the interaction of context with truncated versus full-sentence conditions was significant (both Fs < 1.0).

The data in Table 5 allow one to evaluate the dependency in processing the two words in a double-word array, for a given overall level of report of the matching and nonmatching double word. Take, for example, the column in Table 5 that shows recall in the context-before, full-sentence condition. A parallel–independent model of encoding and retrieval of the two words would predict that the probability of both-words trials would be the product of the total probabilities of reporting the matching words (.71, from Line E) and the nonmatch words (.31, from Line F), namely, .22 (Line G). (The percentages in the tables are treated as probabilities in these calculations.) A strictly serial, nonoverlapping model of processing of the two words would predict an overrepresentation of one-word-only trials relative to both-words trials, so the both-words frequency should be lower than .22. Finally, an all-or-nothing model in which viewers were likely to see either both words or neither word on a given trial would predict an overrepresentation of both-words trials: The probability should be higher than .22.

Comparing Line G with Line C, which gives the observed percentage of both-word reports, shows that the independence hypothesis is fairly consistent with the results in each of the four sentence conditions. Performance in the full-sentence condition was slightly more serial than the independence model predicts; performance in the truncated-sentence condition was slightly more all-or-nothing. This general pattern suggests that viewers did in fact process the two words largely in parallel, as we had aimed for when devising the presentation method, rather than processing one before processing the other. Nonetheless, the word that matched the context still benefited, relative to the nonmatching word, either because it was processed more efficiently, or because it was retained better, or both.

Discussion

The two-stage model of word recognition that we propose assumes that multiple word candidates are briefly activated in parallel in Stage 1, and in Stage 2 selection of a single word (which is the word that is consciously perceived) is based both on the degree of stimulus support for each candidate and on sentence context. Once a single word has been selected, other candidates are quickly forgotten. In the present experimental simulation of this process, two word candidates are actually presented. Consistent with the model's predictions, in Experiment 2 participants were substantially more likely to recall both words on interrupted trials (36%) than on full-sentence trials (20%), and this advantage was entirely due to better recall of the irrelevant nonmatching word in the interrupted condition than in the full-sentence condition. Because viewers did not know until 133 ms after the double-word pair had been presented whether they would need to recall the full sentence with the matching word or whether they would recall just the two double words, their initial processing of the pair was presumably the same in both conditions. The results support the hypothesis that both words are available momentarily (consciously or unconsciously) but that the nonmatching one is rapidly lost, particularly in the full-sentence condition.

Both the full-sentence condition and the truncated condition showed substantial effects of prior context, indicating that context and stimulus information begin to interact promptly, evidently before the arrival of the signal to recall both words. Recent studies by Dark and her colleagues (Dark & Scheerhorn, 1994; Dark et al., 1996) used a method

Table 5
Experiment 2: Percentage of Trials With Recall of Matching, Nonmatching, Both, or Neither Double Word

	Sentence condition			
	Full sentence		Truncated sentence	
Recall pattern	Before	After	Before	After[a]
A. Only matching	51	45	34	23
B. Only nonmatching	12	15	14	23
C. Both matching and nonmatching	20	21	35	37
D. Neither	17	19	17	18
E. Total matching	71	66	69	59
F. Total nonmatching	31	36	49	60
G. P(matching) × P(nonmatching)[b]	.22	.24	.34	.35

Note. The percentages in each column are based on a total of 512 trials. In each column, the sum of Lines A, B, C, and D is 100, apart from rounding errors.
[a]For the context-after condition, matching–nonmatching was a dummy distinction when the sentence was truncated. [b]Product of Lines E and F expressed as probabilities (see text).

of presentation similar to the present double-word method to investigate semantic priming and its interaction with selective attention. In Dark et al.'s (1996) experiments, a single word—a semantic prime or a control—preceded the word pair by 250 ms or more. The pair was presented for 100 ms, followed by a visual mask, and participants attempted to report the pair. Significant semantic priming was obtained in the form of greater recall of the word related to the prime relative to the other word and a greater likelihood of reporting both words when one (vs. neither) was related to the prime. Priming was greater with a stimulus onset asynchrony (SOA) of 1,000 ms than with an SOA of 250 ms. Using much the same method, Dark and Scheerhorn (1994) observed an automatic effect of semantic relatedness even when the participant was cued by an arrow as to which of the two simultaneous words to report. Likewise, in the present experiment, when the trial was truncated and both words were to be reported, prior relevant context led to an increase in recall of the matching word that was almost exactly offset by a decrease in recall of the other word. This rapid selective effect of relevant context is consistent with the modular interactive model.

Experiment 3

In Experiment 1 and in the full-sentence condition of Experiment 2, information that was presented shortly after the double words had a significant effect on selection, indicating that both words were retained at least briefly (consciously or otherwise) on many trials. We have argued that such a result is consistent with the two-stage model, which proposes that the first, stimulus-driven stage of word recognition is modular and results in activation of a set of weighted word candidates. The biasing context information that appeared one to three words (133–400 ms) after the double words participated in the hypothesized second stage of word selection. How much longer, one might ask, would a reader be able to postpone Stage 2 if relevant context came still later in the sentence? One possibility is that correct selection of the matching word would become increasingly difficult with further delay; another possibility is that both words, once encoded in Stage 1, would remain available until selective context was presented (assuming that the relevant context appeared in the same sentence). To investigate this question, in Experiment 3 a third condition was added to the context-before and context-after conditions: The biasing information appeared 400–800 ms later in the delayed condition than in the context-after condition, bringing the lag between the double words and the first relevant context word to about 800–900 ms. Table 6 shows an example of the materials.

Temporally backward-acting semantic effects have been reported in a number of previous studies, in addition to Potter et al.'s (1993) Experiment 5, described earlier. In studies of auditory word perception, Warren and Warren (1970) reported that a later context can affect phoneme restoration (see also Connine et al., 1991). For visually presented words, Kiger and Glass (1983) found that semantic priming from a prime that followed the target word by a delay of 50–65 ms facilitated lexical decision with respect to the target, suggesting to them that the two words were processed in parallel. Briand, den Heyer, and Dannenberg (1988) had participants name the second of two successive words and then make a lexical decision on the first word, a masked prime. Even with their longest SOA of 1,000 ms, there was not only priming by the first, masked word on naming latency to the second word, but there was also a backward-acting effect of relatedness on the accuracy of the lexical decision to the prime. Dark and her colleagues (Dark, 1988; Dark & Benson, 1991; VanVoorhis & Dark, 1995) have reported a series of studies in which masked semantic primes and subsequent targets showed mutual priming, with SOAs as long as 1,000 ms (the longest SOA used). None of these studies investigated backward effects on word perception within a sentence (cf. a study by Forster & Hall, described earlier and cited in Forster, 1974). In the present experiments, the context was not only delayed, but intervening material also had to be processed, unlike the procedure in the studies just reviewed.

Method

The method was similar to that of Experiment 1, except as specified.

Participants. Twenty-four students from the pool described previously were paid for their participation. None had been in Experiments 1 or 2. An additional 7 participants were replaced because they did not meet the accuracy criteria (see the *Scoring* section).

Materials and design. The experimental materials consisted of 72 sets of sentences, an example of which is given in Table 6. Fifty of the sets were modified versions of sentences and double words used in Experiments 1 and 2. Each set included a double-word pair and 6 matrix sentences, 3 biased toward each of the target words. Of these 3 sentences, 1 included some biasing material before the double words; another, the context-after condition, included biasing material within 1–3 words after the double words; and the third,

Table 6
Examples of Materials With Bias Before, After, or Delayed in Experiment 3

Bias	Sentence
Before	Maggie wrote the letter with a basket/pencil she had with her the other day
	Maggie carried the kitten in a basket/pencil to her house the other day
After	Maggie used a basket/pencil to write the letter to her friend in Arkansas
	Maggie used a basket/pencil to carry the kitten to her friend the other day
Delayed	Maggie used a basket/pencil that she bought the other day to write the letter
	Maggie used a basket/pencil that she bought the other day to carry the kitten

the context-delayed condition, included biasing material 6–9 words after the double words. The 3 sentences were similar in propositional content. The sentences averaged 14 words in length, including 1 double word, in each of the three context conditions. In the context-after and context-delayed conditions, the part of the sentence that preceded the biasing information was identical for the 2 target words. The six conditions were crossed with the position of the matching word, which was either the upper or lower double word. Thus, there were 12 possible forms of each sentence set, making 12 counterbalanced versions of the experiment, each seen by 2 participants. Each version included 24 trials in each of the three context conditions. There were 12 practice sentences. Appendix C lists the sentences and double words.

Procedure. The procedure was like that of Experiment 1 and the full-sentence trials of Experiment 2, except that the rate of presentation was slowed slightly to permit readers to cope with the longer sentences of this experiment (an average of 14 instead of 10 words/sentence). Each word of the context sentence was presented for 150 ms (rather than 133 ms); the double words each appeared for 50 ms rather than the 33 ms of Experiments 1 and 2. The SOA between the lower and upper word remained 17 ms; the total time for the whole double-word sequence was 100 ms instead of the previous 83 ms.

Scoring. The results were scored as in Experiment 1 and the full-sentence condition of Experiment 2. Seven participants (23%) were replaced because they did not meet one or both of two accuracy criteria: correct report of at least one of the double words on 50% or more of the trials, and overall correct report of at least 65% of the words of the sentences other than the double words.

Results

Overall sentence accuracy averaged 82%, apart from the double words. Table 7 shows the recall of the double words in each condition. The results for the context-before and context-after conditions replicate those of Experiment 1: Context located before the double-word pair had a larger influence on selection than context located shortly afterward. In the new condition, with relevant context delayed still longer, there was no further decline in matching word responses: The context-after and context-delayed conditions did not differ. However, the nonmatching responses increased from the context-after to the context-delayed condition, and hence the bias-ratio analysis (measuring the relative advantage of the matching word) showed a decrease with further delay. We have more to say about this result below. Analyses were like those of Experiment 1 (see the *Scoring and analyses* section in that experiment).

In the analysis of matching responses in the sentence, context location had an effect, $F_1(2, 46) = 24.13$, $MSE = 4.78$; $F_2(2, 142) = 24.97$, $MSE = 1.54$. Planned comparisons indicated that there were more matching responses when context came before (70%) than when it came shortly after (53%), $F_1(1, 23) = 76.08$, $MSE = 2.52$; $F_2(1, 71) = 38.84$, $MSE = 1.65$, but there was no difference between the context-after and the context-delayed (55%) conditions (F_1 and $F_2 < 1.0$). The bias ratios for the three conditions are shown in Table 2; all three context conditions showed a highly significant bias effect. In an analysis comparing the ratios, the effect of context was significant, $F_1(2, 46) = 20.36$, $MSE = 0.01$; $F_2(1, 71) = 14.81$, $MSE = 0.03$. Planned comparisons showed that the ratio in the context-before condition (.88) was higher than in the context-after condition (.79), $F_1(1, 23) = 13.38$, $MSE = 0.01$; $F_2(1, 71) = 16.32$, $MSE = 0.03$, which was in turn higher than in the delayed condition (.73) in the subject analysis, $F_1(1, 23) = 9.00$, $MSE = 0.01$, $p < .001$, but not in the item analysis, $F_2(1, 71) = 1.74$, $MSE = 0.04$, $p < .20$.

It was somewhat surprising that there was no difference between the context-after and the context-delayed conditions in the likelihood of recalling the matching word in the sentence. We were able to reject the possibility that readers in the delayed condition compensated for the extra memory load of the two double words by not retaining some of the words in the inserted segment of the sentence. Had that been so, their overall recall of the words of the sentence (other than the double words) would have been lower than in the context-after condition. The proportion of words recalled (omitting the double words) was calculated for each participant and broken down by delay condition. The effect of delay was significant, $F(2, 46) = 7.85$, $MSE = 0.002$: The percentage of words recalled was higher in the context-before condition (84%) than in the other two conditions (both 81% and hence not different). Thus, added delay in resolving the uncertainty about the choice of a double word did not reduce sentence recall overall.

Discussion

The main question in Experiment 3 was whether participants would have greater difficulty in selecting the matching word as the relevant context was delayed further. Although having the context before the double word led to more accurate selection and better overall recall of the sentence than having it afterward, an extra delay had no further effect on either of these measures. The only effect of further delay was to increase the probability of including the other double

Table 7
Percentage of Double Words Recalled in Each Context Condition in Experiment 3

Scoring condition	Matching word				Nonmatching word			
	Before	After	Delayed	*M*	Before	After	Delayed	*M*
In	70	53	55	59	9	14	20	15
Out	1	1	2	2	15	14	15	15
Total (in + out)	71	55	58	61	24	28	35	29

Note. In = words recalled as part of the sentence; Out = words recalled following recall of the sentence.

word in the sentence rather than omitting both double words, which is reflected in the significant decrease in the bias ratio from the context-after to the context-delayed condition.

What might these results imply? A possibility consistent with the two-stage model is that in all conditions, the word candidates, if perceived, simply remained active until selection *could* take place. That is the picture one obtains from studies of sentence perception in which there are temporary ambiguities of phrasal or clausal closure, long-distance dependencies, or the like. The ubiquity of local ambiguities in language suggests that mechanisms are available for managing them efficiently (see, e.g., MacDonald, Pearlmutter, & Seidenberg, 1994), and such mechanisms would assist a reader confronted with the choice between two words, as in the present experiments. In studies of normal reading such as those of Carpenter and Daneman (1981; Daneman & Carpenter, 1983), readers immediately attempted to repair a mistaken interpretation of a homonym once later sentence context disambiguated the word.

Under some conditions, the difficulty of correcting a misinterpretation of a homonym tended to increase when disambiguation was postponed (e.g., Miyake et al., 1994), contrary to the results of the present experiment. In Miyake et al.'s (1994) study, unbalanced homophones whose less preferred meaning was the one required by later context led to slowed reading when disambiguation was postponed, especially for readers who did not have a high memory span. In effect, these readers were led up the garden path, so that they prematurely discarded the low-frequency meaning of the homophone. However, in neither of the experiments did participants have difficulty with balanced homophones, even with delayed disambiguation (but see Rayner & Frazier, 1989, for a contrary finding).

In the present experiments, although participants may have made a tentative initial commitment to one of the two double words, they had little basis for a choice until the selective context appeared. Thus, they evidently kept both words active until selection was possible. Note, however, that selection was always more accurate when appropriate context preceded the double words, showing that there was some cost associated with presenting the relevant context only after the double words. Note also that the longer delay in the present experiment was only about 1 s, whereas with self-paced reading in Miyake et al.'s (1994) studies the delay was about twice as long.

A different hypothesis to account for the equivalence between the context-after and context-delayed conditions in the present study is that when the context came after the double words, the choice was always made reconstructively, after the whole sentence had been read, so that the delay did not matter. This account, however, is unlikely, for the following reason. The nonmatching word was omitted altogether significantly more often in the context-after condition than in the context-delayed condition, suggesting that in the context-after condition, the nonmatching word could be discarded sooner (and therefore had more time to be forgotten) than when context was delayed until near the end of the sentence.[6] Moreover, the advantage of the context-before condition suggests that some processing and selection occurred as the words were presented, ruling out the possibility that all selection occurred during recall. Thus, the results are most consistent with the hypothesis that both double words, if successfully encoded, can be maintained until relevant context permits an appropriate selection to be made, and only then is one of them discarded.

Experiment 4

In Experiments 1–3, the general semantic and pragmatic content of the sentence was varied to produce bias toward one or the other double word. In Experiment 4, we asked whether double-word selection would be sensitive to syntactic bias, holding other factors constant. We wrote sentences that differed by a single word that constrained the syntactic category of the following word. Consider the following two sentences:

(2) Nathan refused to [pie/eat] when Lisa offered him dessert.

(3) Nathan refused the [pie/eat] when Lisa offered him dessert.

If we are right in assuming that an RSVP sentence is being parsed and understood as it is presented, then *to* or *the* should have an immediate effect on double-word selection. If, however, double-word selection depends on associations between substantive content words (e.g., *pie–dessert*), then a mere change in a function word might be expected to have little or no effect on selection. In Experiment 4, a word that directly preceded the double-word array—usually a function word—constrained the grammatical category of the following word, so that only one of the two double words was grammatical. With a different function word, the other double word was grammatical. The two resulting sentences were otherwise identical, as in the example above.

Previous studies have shown that appropriate versus inappropriate syntactic context can affect a target word's naming latency or lexical decision time or both (e.g., O'Seaghdha, 1989; Seidenberg, Waters, Sanders, & Langer, 1984; West & Stanovich, 1986; Wright & Garrett, 1984; see also Deutsch & Bentin, 1994; Kilborn & Friederici, 1994). A single word as a syntactic prime (*the* or *to*) has been shown to influence the disambiguation of a syntactically ambiguous homograph such as *wind* in a naming task (Kroll & Schweickert, 1978). In other studies in which researchers have used a probe word related to one meaning to test activation of homonym meanings in sentence context, both the appropriate and inappropriate meanings seem to be activated when the probe appears immediately, even when only one is syntactically appropriate (Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Tanenhaus, Leiman, & Seidenberg, 1979). Tanenhaus and Lucas (1987) suggested

[6] The nonmatching word, even if it was the only double word encoded, seems to have been more likely to be discarded in the context-after condition (14% included in sentence recall) than in the context-delayed condition (20% included in sentence recall). Possibly readers were more aware of the misfit at the shorter delay.

Table 8
Syntactic Context in Experiment 4: Examples of Double Words Differing in Syntactic Category and Function Words (Shown in Brackets) Used as Immediately Preceding Context

Syntactic category	Sentence
Count versus mass nouns (n = 40)	The umpire saw too [much/many] water/men on the court
	He needed [some/a] help/tutor to pass the course
Nouns versus verbs (n = 24)	Nathan refused [the/to] pie/eat when Lisa offered him dessert
	I called my roommate [for/to] sympathy/complain after I failed my test
	He saw [your/me] umbrella/arrive after everyone had left
Nouns versus adverbs (n = 16)	Alice gave [a/in] pretzel/finally to her yapping puppy
	The squirrel climbed [the/down] tree/quickly and scampered away
	Herbert spoke [with/very] them/softly for several hours at the party
Adjectives versus verbs (n = 4)	Bill loves [overly/to] friendly/frighten people who come to visit him

that the constraints generated by a purely syntactic context (e.g., *he* or *the* before *rose*) act only after initial access to the two relevant meanings, unlike the preactivation that they believe may occur when a relation has already been stored (e.g., *dog* and *bark*).

Whether the effects of syntactic constraints are prelexical or postlexical, these experiments all indicate that syntactic constraints show up early in processing, and therefore we predicted that they would influence double-word selection.

Method

In most respects the method was like that of Experiment 1.

Participants. The 8 participants were from the MIT participant pool. An additional 4 participants (33%) were replaced because they did not meet the minimal criterion of reporting at least one of the double words on at least 50% of the trials and at least 79% of the rest of the words in the sentences, excluding the double words and the prime.

Materials and design. The materials consisted of 84 pairs of sentences that were identical except for a single word that preceded the double-word array. This word, a closed-class word such as a determiner, pronoun, infinitival *to,* verb particle, preposition, or an adverb of degree determined which of the two double words was grammatically acceptable. (In one case, the prime was the adjective *good.*) Both versions of the sentence (e.g., . . . *to eat* . . . or . . . *the pie* . . .) were plausible. The double words consisted of four combinations of word categories: a count versus a mass noun (40 trials), a noun versus a verb (24 trials), an adverb versus a noun (16 trials), and an adjective versus a verb (4 trials). Examples of these four contrasts are given in Table 8; the complete set of sentences is given in Appendix D. The sentences were randomized; the critical priming word that preceded the double-word array and the upper–lower position of the two double words were counterbalanced within and between subjects and within word-category groups, over the four versions of the experiment.

Procedure. The words of the sentence were presented for 133 ms, and the double-word array appeared for 83 ms altogether, with each word presented for 33 ms with an SOA of 17 ms, as in Experiment 1. There were 12 practice trials. As in previous experiments, participants were instructed to recall the sentence aloud, trying to pick the word that fit the sentence, and then to report the other word if they saw it. There was no specific mention of grammaticality.

Scoring. The main score analyzed was the double word (if any) included in the sentence. Separate analyses were carried out on recall of the critical priming word. As in previous experiments, a bias ratio was calculated for each participant: $M/M + O$.

Results and Discussion

In double-word selection, participants were strongly influenced by the immediately preceding priming word: They included the matching word in the sentence on 53% of the trials and included the other double word on 20%. Excluding the double words and the priming word, readers recalled 92% (range = 79%–98%) of the other words of the sentence. They recalled at least one of the double words on 77% of the trials (range = 66%–96%). Table 9 shows the main results, broken down by syntactic contrast. It is not surprising, given the minimal nature of the differential context, that the influence of context was smaller in this experiment than in Experiments 1–3. We combined all 84 sentences to calculate bias ratios for each participant and for each item (see Table 2). The mean of .72 (range = .59–.96) differed significantly from .50. Ratios were also calculated separately for each of the four kinds of materials: adverb–noun (.72), count–mass noun (.74), noun–verb (.69), and adjective–verb (.77); t tests on each of these ratios showed them all to differ from .50 at the $p < .05$ level or better in both subject and

Table 9
Influence of Syntactic Context in Experiment 4: Percentage of Matching and Nonmatching Responses in Each Syntactic Comparison

Syntactic contrast	Scoring condition					
	Matching word			Nonmatching word		
	In	Out	Total	In	Out	Total
Adverb–noun	50	5	55	19	23	41
Count–mass	59	2	61	21	28	48
Noun–verb	48	5	53	20	15	35
Adjective–verb	38	9	47	13	0	13
All sentences	53	4	57	20	22	42

Note. Each cell percentage is based on the following *n*s: adverb–noun = 128, count–mass = 320, noun–verb = 192, adjective–verb = 32. For the all-sentence percentages, n = 672. In = words recalled in the sentence; Out = words recalled after recall of the sentence; Total = sum of in and out recalls.

item analyses, except that no item analysis was carried out on the four items in the adjective–verb condition. The ratios for the four kinds of materials did not differ significantly from each other. A further subject analysis of only matching responses looked at the relative success in priming each of the two categories in each comparison. The only (marginally) significant differences were for nouns and adverbs (56% vs. 44% of matching responses in the sentence, respectively), $p = .05$, and for nouns and verbs (54% vs. 41%), $p < .06$: Thus, there appears to have been a noun bias.

Overall, the priming word was recalled correctly on 80% of the trials. When the matching word was recalled in the sentence, the prime was recalled correctly 98% of the time. When the other word was recalled in the sentence, in most cases the prime was deleted or changed so that the recalled sentence became grammatical. For the count versus mass nouns, however, recalls of the nonmatching word (although much less frequent than recalls of the matching word) were accompanied by the supposedly ungrammatical prime 56% of the time. An examination of these grammatical "errors" suggests that many participants found *much* plus a plural noun acceptable, especially when the plural was irregular, such as *men, people,* or *oxen.*

The results show clearly that viewers were parsing the sentence as they read, when each RSVP word appeared for 133 ms (with the double word appearing for 83 ms), and that they were able to use a single syntactic indicator word to make a correct double-word choice on a substantial proportion of trials. This finding not only strengthens the assumption that readers parse RSVP sentences in the first pass rather than reconstructing them later, but also shows that readers know and are constrained by the syntactic category of a candidate word and not just by the word's general fit to the scenario suggested by the sentence context. This congruence between double-word selection and normal syntactic disambiguation in sentence processing (as found in studies cited earlier) supports the claim that the same processes are involved in both cases.

General Discussion

In the present double-word experiments, participants read and then recalled single sentences presented rapidly, one word at a time, at rates of 6.7–7.5 words/s. In each sentence, a choice had to be made at some point between two nearly simultaneous and more briefly presented words, only one of which would result in a meaningful, syntactically acceptable sentence. The central finding in these experiments was that readers typically made the appropriate choice. Participants were asked to report the nonmatching, unselected word after recalling the sentence, but they were much less likely to recall it than to recall the matching word. In contrast, when the sentence was stopped shortly after the double words with a signal to recall both double words, the participant was able to recall them both on a substantial proportion of the trials (Experiment 2). Together, these findings indicate that the participant did initially process both words, then selected the correct one and concomitantly forgot the other one (in most cases) as the sentence continued.

In Experiments 1–3, relevant context preceded the double words on some trials but came only after the double words on other trials. It is not surprising that selection was more accurate when the relevant context was presented before the double words. More surprising was that selection was still well above chance when the relevant context did not appear until after the double words—and it did not matter whether the first biasing word appeared within the next three words or after six or more words (Experiment 3). This finding indicates that readers can postpone a choice until relevant information is presented.

We suggest that this tolerance for temporary uncertainty in the double-word task is analogous to tolerance for temporary lexical or structural ambiguity in sentence comprehension generally (e.g., MacDonald et al., 1994) and that the same mechanisms that resolve ambiguity in normal processing are engaged when a reader processes an RSVP sentence with a double-word array. A strong argument in support of this conjecture is that sentences presented at 7 words/s would be impossible to process except by highly practiced routines. Random lists of words cannot be recalled accurately at such rates (Potter, 1983, 1993b, in press), indicating that the syntactic and semantic structure inherent in a sentence is used during initial processing and encoding and is not reconstructed after presentation from a remembered list of the individual words (see also Potter, 1984; Potter, Kroll, Yachzel, Carpenter, & Sherman, 1986, for further evidence of on-line processing in RSVP).

Other work on immediate recall of sentences (Lombardi & Potter, 1992; Potter & Lombardi, 1990, in press) has shown that readers regenerate the sentence from a representation of its meaning, rather than relying on some form of verbatim trace. In producing the sentence, participants tend to select words that have been recently activated (rather than synonyms that have not been activated); likewise, they tend to reuse in recall the surface syntactic structure that was activated during comprehension (see also Bock and her colleagues, e.g., Bock & Loebell, 1990). Both of these biases contribute to verbatim recall. One may ask what effect such regenerative recall might have had in the present task. In particular, when participants began recall, both double words would have been activated recently: Would selection between them actually have been made during recall, rather than during perception of the sentence? Inasmuch as recall was driven by a representation of the meaning of the sentence, that meaning presumably already incorporated one of the double words. The alternative would be that the participant represented the meaning of the sentence except for the double words and sought some word to fill in the blank, choosing a recently activated word that was a suitable candidate, namely, the matching double word. We cannot rule out this strategy (which assumes separate retention of the sentence context and the double words), but it seems less plausible than that the selection was done during the initial processing of the sentence.

Equating the problem of selection between two double words with the problem presented by a single ambiguous word is reasonable if we make the assumption that the two (or more) meanings of an ambiguous word are represented

by separate lexical entries (e.g., Levelt, 1989). Then, the output of the first, modular stage of word perception would be two (or more) lexical entries for homonyms and, likewise, for double words. In both cases, the sentence context would be used to make a choice on the basis of the meanings of the competing lexical entries. Consider, for example, the lexical ambiguity in Sentences 4 and 5:

(4) He gave the *ball* to celebrate his daughter's wedding.
(5) He gave the *ball* to his nephew for his birthday.

In these examples, the selective context follows the critical word, and the ease with which a reader resolves the ambiguity suggests that both meanings of *ball* are retrieved initially. If the double-word pair *dance–baseball* replaced the ambiguous word *ball* in Sentences 4 and 5, then the selective process would presumably be much the same. If there is appropriate prior context, the relative speed of access to the two meanings of a homonym may be affected (e.g., Morris, 1994), and under some circumstances, a subordinate meaning may never be measurably activated (e.g., Tabossi & Zardon, 1993). Similarly, with double words, even when the sentence was interrupted and the participant attempted to report both words, prior context gave the matching word an advantage, suggesting an immediate effect of context on the participant's representation of the two words.

As just illustrated, ambiguous words may be disambiguated successfully when the relevant context comes some time after the word, as we found for double words. This shows that two (or more) lexical candidates (for a single slot in the sentence) can remain available for a time. Few studies have explored the lag over which a reader or listener can tolerate delay in lexical disambiguation, although, as noted, Miyake et al. (1994) found that increasing the delay increased reading time around the point of disambiguation when the resolution required a subordinate meaning—but not when the two meanings were balanced.

The present modular interactive model proposes that visual word perception begins in a context-free, bottom-up manner. Multiple candidate words (lexical entries) are activated, with the degree of activation proportional to their orthographic similarity to the stimulus (and probably to their word frequency, although we did not examine that variable). These lexical entries include semantic and syntactic information, and at a second stage this information, activated or weighted in proportion to the stimulus support for each word candidate, interacts with concurrent information from sentence context (both syntactic and semantic) and probably from discourse. The outcome of this process is the selection of a single word candidate with an optimal combination of stimulus and contextual support. The bias introduced by the context, far from increasing reading errors, contributes to the speed and accuracy of word processing in most circumstances, because words normally do fit their contexts.[7]

To account for double-word performance within the same model, we hypothesize that the double words are processed in parallel in the first stage and then compete in the second stage for a single slot in the sentence, just as do the two meanings of an ambiguous word. In nonword conversion (Potter et al., 1993) and ambiguity resolution, the winning word is ordinarily the only one that the reader or listener is conscious of. For double words, although both double words may be reported correctly when the sentence is interrupted shortly after the pair (showing that they are both available to consciousness), the rejected word is likely to be forgotten by the time the sentence has been recalled, just as in the case of words with multiple meanings.

However, both words may remain available until the point at which there is enough contextual information to make an appropriate selection, when the relevant context is presented only after the critical item. In the present experiments, the maximum interval between the double words and relevant context was about 1 s (in the delay condition of Experiment 3). In an earlier study using nonwords such as *wesp,* there was only marginal evidence that readers could make use of context at such long delays (Potter, 1993a), suggesting that in most cases only one or neither of the (implicit) candidates remained available, and it is possible that participants never became even momentarily aware of the other candidate. For double words, however, both remained available at the longer delay in an estimated 20% of the trials, and it seems likely that readers were often aware of both.

In what form were the double words retained? Because the following context was able to influence selection, it is clear that item meanings were retained. What about item orthography or phonology? We have no direct information on this point, although we argued earlier that a prelexical visual representation of the double words would be unlikely to persist as subsequent words were processed. It is notable that in two further double-word experiments using words that were orthographic neighbors and phonologically similar except for the vowel (e.g., *deck* and *duck;* Potter, 1993a), we obtained results that were very similar to those of the present experiments with orthographically and phonologically distinct words. This suggests that form retention plays little or no role in selection, or one might have expected systematic facilitation (or else interference) with delayed selection between words similar in form.

In models of lexical representation such as that of Levelt (1989), word form (the *lexeme*) is represented and processed separately from word meaning and syntax (which are both represented in the word's *lemma*).[8] In this kind of model, it is the lemma representation that would control selection in the double-word case, and thus the lexeme (form) would not necessarily play any role in selection itself. Similarly, disambiguation of a homonym would depend solely on the

[7] In strong contexts such as apparent idioms (*a dog in the manager*), a reader may be led to select the wrong candidate (*manger* rather than *manager*), but such cases are not common outside the laboratory.

[8] Levelt (1989) made a further distinction between a level at which the concept corresponding to a word is represented and the lemma level; others have collapsed these two levels. For the present purposes, either model is sufficient: All that is required is a distinction between a level that specifies meaning and a level that specifies form.

lemma level, at which the two or more meanings would be represented by different lemmas, whereas the lexeme level would not distinguish between the two underlying lexical entries. This view of the lexicon is consistent with our view that word selection in the present procedure is fundamentally the same process as lexical disambiguation.

The present study demonstrated that not only sentential meaning but also syntactic structure can determine selection between double words. In Experiment 4, a single function word or an adverb such as *very* that has little independent semantic content controlled double-word choice. Similarly, syntactically ambiguous words such as *watch* may be immediately controlled by a single function word in a sentence such as Sentence 6:

(6) He decided *the* [or *to*] watch was wrong.

Thus, double-word selection, like resolution of lexical ambiguity, responds to at least two kinds of constraints, one pragmatic–semantic and the other syntactic. The modular interactive model proposed by Potter et al. (1993) and extended here provides a unified framework for understanding such effects of preceding and also subsequent context on word perception, lexical ambiguity, and double-word selection.

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(Appendixes follow)

Appendix A

Materials in Experiments 1 and 2

Each set of sentences consisted of two sentences biased toward each of the two double words, one in which the bias came before the double words and one in which the bias came only after the double words. The double words are separated by a slash; the upper–lower position of the words was counterbalanced.

Set 1

Before: The glittering crown had a jewel/flame in the center
After: Helen saw the jewel/flame glitter in the crown
Before: The flicker of the flame/jewel in the wind cast strange shadows
After: Helen saw the flame/jewel flicker in the wind

Set 2

Before: The noisy flush of her pillow/toilet was heard downstairs
After: She bought a pillow/toilet that would flush quietly
Before: On her bed she put a toilet/pillow she had just bought
After: She bought a toilet/pillow for her bed yesterday

Set 3

Before: Tom put his shoe on his clay/foot with ease
After: Tom held his clay/foot above his shoe and put it on
Before: The pottery wheel spun the foot/clay as Tom molded it
After: Tom held his foot/clay on the pottery wheel and molded it

Set 4

Before: She could not drink the sour tire/milk and had to throw it out
After: She realized that the tire/milk was sour and could not be drunk
Before: She had a flat milk/tire and had to change it
After: She realized that the milk/tire was flat and needed changing

Set 5

Before: Maggie wrote the letter with a pencil/basket she had with her
After: Maggie used a pencil/basket to write the letter
Before: Maggie carried the kitten in a basket/pencil to her house
After: Maggie used a basket/pencil to carry the kitten

Set 6

Before: Susan spent a lot of fruit/money on her last shopping spree
After: Susan talked about the fruit/money she spent on her last shopping spree
Before: Susan looked over the vegetables and money/fruit at the store
After: Susan talked about the money/fruit and vegetables at the store

Set 7

Before: I wore a thimble because the meadow/needle was sharp
After: Because the meadow/needle was sharp I wore a thimble
Before: When they mowed the needle/meadow the wildflowers disappeared
After: Because the needle/meadow was mowed the wildflowers disappeared

Set 8

Before: The curtain by the window/cheese fluttered in the breeze
After: By the window/cheese the curtain fluttered in the breeze
Before: The mouse nibbled the cheese/window as it sat quietly
After: By the cheese/window a mouse sat nibbling quietly

Set 9

Before: The ticking of the sugar/clock showed that it wasn't broken
After: With the sugar/clock ticking away he knew it wasn't broken
Before: The pancakes tasted better with a sprinkling of clock/sugar on top of them
After: With the clock/sugar sprinkled on top the pancakes tasted better

Set 10

Before: Out of the nest flew an angry hornet/jingle right toward Dan
After: Dan realized that the hornet/jingle from the nest was flying angrily toward him
Before: The sleigh bells made a pleasant jingle/hornet as they passed by
After: Dan realized that the jingle/hornet from the bells meant a sleigh was coming

Set 11

Before: Flowing through the valley the color/river could be seen
After: Kate saw the color/river that was flowing through the valley
Before: The rainbow had a bright river/color after the storm
After: Kate saw the river/color of the rainbow after the storm

Set 12

Before: After we buttered the sliced bread/smoke it was put on the table
After: Although the bread/smoke was sliced it had not been buttered
Before: From the smoldering fire thick smoke/bread rose in the air
After: Although the smoke/bread was thick the fire was only smoldering

Set 13

Before: When the birthday party/nurse was over the girl was cranky
After: After the party/nurse the birthday girl was cranky
Before: The cut was bandaged by the nurse/party before he left
After: After the nurse/party had bandaged the cut he left

Set 14

Before: She played the role/hair she had worked so hard to get
After: When she worked with the role/hair the character came to life
Before: She shampooed the hair/role before she worked with it
After: When she worked with the hair/role she shampooed it first

Set 15

Before: After it was washed the power/dress was still stained
After: The generator broke so the dress/power went out yesterday
Before: Although the dress/power had died the generator wasn't broken
After: Although the power/dress was washed it was still stained

Set 16

Before: The burglar set off the alarm/snack and was discovered immediately
After: Because of their alarm/snack the burglar was discovered immediately
Before: They had cookies and milk for their snack/alarm at bedtime
After: Because of their snack/alarm of cookies and milk they weren't hungry at bedtime

Set 17

Before: On the battlefield the cannon/garlic was near the monument
After: Richard noticed the cannon/garlic on the battlefield near the monument
Before: In the spaghetti sauce the garlic/cannon was very strong
After: Richard noticed the garlic/cannon in the spaghetti sauce

Set 18

Before: From the mountains the view/heap of the plain below was incredible
After: She commented on the view/heap of mountains from the plain below
Before: In the barnyard was a large dung heap/view from the horses
After: She commented on the heap/view of dung in the barnyard

Set 19

Before: The saddle for the tree/pony is kept in the barn
After: Because of the tree/pony the saddle is kept in the barn
Before: The shade of the pony/tree is pleasant in summer
After: Because of the pony/tree the shade is pleasant in the summer

Set 20

Before: As I sliced the potatoes with the knife/earth I cut my finger
After: I felt the knife/earth cut my finger as I sliced the potatoes
Before: As the volcano erupted the earth/knife began to shake
After: I felt the earth/knife shake as the volcano erupted

Set 21

Before: The soldier was wounded when the weapon/island was fired
After: Since the weapon/island was fired the soldier was wounded
Before: The tropical climate of the island/weapon caused the birds to flock there
After: Since the island/weapon was tropical the birds flocked there

Set 22

Before: There were many blueberries on the note/bush that summer
After: On the note/bush the blueberries were thick
Before: The ink on the bush/note was smeared and hard to read
After: On the bush/note the ink was smeared and hard to read

Set 23

Before: The shrimp were floating in the movie/ocean and were easily netted
After: In the movie/ocean the shrimp were easily netted
Before: The actor cried in the ocean/movie in every scene
After: In the ocean/movie the actor cried in every scene

Set 24

Before: The wedding bait/veil was worn by the bride
After: I chose the bait/veil the bride wore for the wedding
Before: Our fishing veil/bait included worms and salmon eggs
After: I chose the veil/bait the fish liked on our fishing trip

Set 25

Before: The files in the regime/drawer were organized
After: In the regime/drawer the files were organized
Before: The dictator during the drawer/regime appointed only his friends
After: In the drawer/regime the dictator appointed only his friends

Set 26

Before: Near the kitchen table sat a wooden stool/hinge for the child
After: Cathy noticed the stool/hinge near the table in the kitchen
Before: The door had a creaking hinge/stool that needed fixing
After: Cathy noticed the hinge/stool on the door creaking

Set 27

Before: Yesterday Nora had a hotdog with mustard/thunder on it
After: Nora noticed the mustard/thunder her hotdog had on it
Before: Nora noticed the lightning and thunder/mustard during the storm
After: Nora noticed the thunder/mustard and lightning during the storm

Set 28

Before: At the zoo Amy saw the engine/turtle in its shell
After: Amy saw the engine/turtle in its shell at the zoo
Before: At the train station Amy saw the turtle/engine of the train
After: Amy saw the turtle/engine of the train at the station

Set 29

Before: When the war was over the rash/army returned to the mainland
After: With the return of the rash/army the war was over
Before: He scratched his arm where the army/rash had flared up again
After: With the return of the army/rash he scratched his arm

Set 30

Before: The rose looked elegant in the sand/vase on the table
After: In the sand/vase a rose looked elegant
Before: A shell was buried in the vase/sand near the water
After: In the vase/sand a shell was buried

Set 31

Before: The ants had a feast because of the picnic/pebble in the park
After: Because of the picnic/pebble in the park the ants had a feast

Before: My toe hurt because of the pebble/picnic in my shoe
After: Because of the pebble/picnic in my shoe my toe hurt

Set 32

Before: Wax dripped on the table as the candle/violin burned down
After: When the candle/violin burned down it dripped wax on the table
Before: The lively tune he played on the violin/candle started us dancing
After: When the violin/candle played the lively tune we all danced

Set 33

Before: At the ski slope the snow/bird was very deep
After: We saw the snow/bird on the ski slope that morning
Before: Sitting in the nest was the bird/snow we were looking for
After: We saw the bird/snow in the nest that evening

Set 34

Before: The tree limb/odor was broken but it continued to grow
After: Although the limb/odor of the tree was broken it continued to grow
Before: The skunk odor/limb was strong but we continued our hike
After: Although the odor/limb of skunk was strong we continued our hike

Set 35

Before: Ellen prays in the market/chapel every Sunday morning
After: Ellen walked to the market/chapel to pray on Sunday
Before: Ellen bought groceries at the chapel/market on Saturday morning
After: Ellen walked to the chapel/market for groceries on Saturday

Set 36

Before: The army prepared for battle/dinner by cleaning their guns
After: Before the battle/dinner the army was nervous
Before: The hostess served dinner/battle after the appetizers
After: Before the dinner/battle the hostess served appetizers

Set 37

Before: The crying of the door/baby kept everyone from sleeping
After: While the door/baby was crying no one could sleep
Before: We couldn't open the baby/door and get into the room
After: While the baby/door was closed we couldn't get into the room

Set 38

Before: The ambulance had its bloom/siren on so Larry pulled over
After: Noticing the bloom/siren on the ambulance Larry pulled over
Before: The plant had a siren/bloom so Larry watered it
After: Noticing the siren/bloom on the plant Larry watered it

Set 39

Before: The editor will be unhappy if there is no book/hole to publish
After: If there is no book/hole to publish the editor will be unhappy
Before: The groundhog cannot come up if there is no hole/book in the ground
After: If there is no hole/book the groundhog cannot come up

Set 40

Before: Pat picked up the maple fork/leaf and looked at it
After: Pat picked up the fork/leaf the maple tree had dropped
Before: Pat picked up the knife and leaf/fork to cut the steak
After: Pat picked up the leaf/fork and knife to cut the steak

Set 41

Before: Seeing the hoodlum being pursued by the street/police he decided he was safe
After: Seeing that the street/police had pursued the hoodlum he decided he was safe
Before: Seeing the rain flooding the police/street he went another way
After: Seeing that the police/street had flooded with rain he went another way

Set 42

Before: The barking of the puppy/ashes was annoying to the neighbors
After: Ann brushed the puppy/ashes until it barked and ran away
Before: In the fireplace the ashes/puppy were still hot from the fire
After: Ann brushed the ashes/puppy into the fireplace and lit a fire

Set 43

Before: The dam built by the beaver/insect stopped the stream from flowing
After: Although the beaver/insect built a dam the stream flowed freely
Before: The buzzing of the insect/beaver kept me awake all night
After: Although the insect/beaver buzzed around my ear I fell asleep

Set 44

Before: The scout tied the ship/knot in the rope
After: He saw the ship/knot tied by the scout
Before: The captain sailed the knot/ship out of the harbor
After: He saw the knot/ship sail out of the harbor

Set 45

Before: The lettering on the sign/band was hard to read
After: When we saw the sign/band the lettering was hard to read
Before: The trombones in the band/sign were in front
After: When we saw the band/sign the trombones were in front

Set 46

Before: The highway had heavy message/traffic going north
After: Sam studied the message/traffic on the highway going north
Before: Sam's answering machine played back a traffic/message from his friend
After: Sam studied the traffic/message on his answering machine yesterday

Set 47

Before: He went to the formal dinner wearing a garden/jacket and a tie
After: With a garden/jacket and tie he was prepared for the formal dinner
Before: I can grow vegetables in the jacket/garden to save money
After: With a jacket/garden to grow vegetables I can save money

Set 48

Before: The key broke in the lock/worm when it jammed
After: Because the lock/worm was jammed the key broke
Before: She baited the hook with a worm/lock so she could catch fish
After: Because the worm/lock was squirming on the hook she caught a fish

Set 49

Before: While Bill was at the beach the results/weather was beautiful
After: Bill was pleased with the results/weather at the beach
Before: After Bill took the history test the weather/results were posted
After: Bill was pleased with the weather/results of the test in history

Set 50

Before: The car had a good sale price/candy that week
After: Fred liked the price/candy of cars during the sale
Before: Fred liked the nuts and chocolate candy/price best of all
After: Fred liked the candy/price with nuts and chocolate best

Set 51

Before: I can fly home with a flower/ticket for the airplane
After: With a flower/ticket for the airplane I can fly home
Before: The gardener put a ticket/flower in the pot
After: With a ticket/flower in the pot the gardener was satisfied

Set 52

Before: The thief committed the crime/music at the grocery store yesterday
After: He found that the crime/music was committed yesterday by the thief
Before: He played the music/crime much too loudly
After: He found that the music/crime was playing much too loudly

Set 53

Before: The conductor rehearsed the orchestra carefully for the last concert/example of the summer
After: For the last concert/example the conductor rehearsed the orchestra carefully
Before: The textbook used a hard problem for the last example/concert in the chapter
After: For the last example/concert the textbook used a hard problem

Set 54

Before: The pizza had one photo/slice left and he took it
After: He took a photo/slice of pizza from the plate
Before: With his new camera he took a color slice/photo of the couple
After: He took a slice/photo in color with his new camera

Set 55

Before: On her left hand she was wearing a ring/flea and a watch
After: George noticed the ring/flea on her finger when they met
Before: The dog had a flea/ring in its fur
After: George noticed the flea/ring in the dog's fur when petting it

Set 56

Before: By lighting the bulb/tent you will be able to see
After: If the bulb/tent is lit you will be able to see
Before: The camp will be ready after the tent/bulb has been pitched
After: If the tent/bulb is pitched the camp will be ready

Set 57

Before: When the girl popped the plumber/balloon her friend screamed
After: When the plumber/balloon popped it startled the girl
Before: The pipe was leaking until the balloon/plumber came and fixed it
After: When the balloon/plumber fixed the pipe the leak stopped dripping

Set 58

Before: His pants stayed up with the belt/wind he wore
After: With the belt/wind his pants stayed up
Before: It was unbearably cold in the wind/belt that night
After: With the wind/belt the cold became unbearable

Set 59

Before: Under the boy's bed the fist/dust was thick
After: The woman saw the fist/dust pile under the boy's bed
Before: The boy clenched his dust/fist when he got angry
After: The woman saw the dust/fist clench as the boy got angry

Set 60

Before: At the circus the clown/light shook Mike's hand
After: Mike saw the clown/light at the circus
Before: Mike turned on the light/clown in the dark room
After: Mike saw the light/clown from the lamp

Set 61

Before: The sculptor carved the banana/statue and sold it soon after
After: Soon after the banana/statue was carved by the sculptor it was sold
Before: Jim peeled the statue/banana and then ate it
After: Soon after the statue/banana was peeled Jim ate it

Set 62

Before: The corn growing on the dune/farm was ripening fast
After: On the dune/farm the corn was ripening fast
Before: The sand on the farm/dune was hot to walk on
After: On the farm/dune the sand was hot to walk on

Set 63

Before: The restaurant was closed because of the special luncheon/medicine yesterday
After: Because of the special luncheon/medicine the restaurant was closed to the public
Before: The patient improved dramatically because of the special medicine/luncheon the doctor ordered
After: Because of the special medicine/luncheon the patient improved dramatically

Set 64

Before: The shingles on the stem/roof needed replacing badly
After: On the stem/roof the shingles needed replacing badly
Before: The sharp thorns on the roof/stem of the rose were painful
After: On the roof/stem the rose had sharp thorns that were painful

Appendix B

Pilot Experiments, Experiment 1

Table B1 shows the N and presentation timing in each of the three pilot experiments, compared with Experiment 1, and Table B2 gives the main results. In all other respects, the method in each pilot study was identical to that of Experiment 1. Analyses of the pilots gave substantially the same results as those reported for Experiment 1.

Table B1
N and Timing Parameters of Three Pilot Experiments and Experiment 1

Experiment	N	Sentence context in ms/word	Double-word array			
			Duration for lower word	Duration for upper word	SOA of words	Total duration
Pilot 1	16 + 5	133	83	67	33	133
Pilot 2	16 + 3	133	67	50	33	117
Pilot 3	8 + 0	200	67	50	33	117
Experiment 1	16 + 5	133	33	33	17	83

Note. See Figure 1 for an illustration of the sequence of events, in Experiment 1. N = number of participants analyzed plus number replaced because their performance did not meet the cutoff criterion; SOA = stimulus onset asynchrony between the lower and upper words.

Table B2
Percentage of Double Words (Matching and Nonmatching) Recalled in Each Context Condition (Before and After) as Part of the Sentence and Following the Sentence in Three Pilot Experiments and Experiment 1

Experiment	Matching word			Nonmatching word		
	Before	After	M	Before	After	M
			Recall in the sentence			
Pilot 1	82	71	77	6	13	10
Pilot 2	81	68	75	4	13	9
Pilot 3	78	66	72	9	19	14
Experiment 1	75	65	70	10	15	13
M[a]	79	68	74	7	14	11
			Recall outside the sentence			
Pilot 1	1	2	2	35	31	33
Pilot 2	2	2	2	35	28	31
Pilot 3	1	2	1	25	23	24
Experiment 1	1	2	1	8	9	8
M[a]	1	2	2	26	23	24
			Recall inside and outside the sentence			
Pilot 1	83	73	78	41	45	43
Pilot 2	83	70	77	39	41	40
Pilot 3	79	67	73	34	41	38
Experiment 1	76	66	71	18	24	21
M[a]	80	69	75	33	37	35

[a]Means were weighted to take into account the smaller N in Pilot 3.

Appendix C

Materials in Experiment 3

Each set of sentences consisted of three sentences biased toward each of the two double words, one in which the bias came before, one in which it came shortly after, and one (the context-delayed condition) in which it came three or more words later than in the context-after condition. The double words are separated by a slash; the upper–lower position of the words was counterbalanced.

Set 1: Candle–violin

Before: Wax dripped on the table as the candle/violin slowly burned down in the kitchen
After: When the candle/violin burned down it dripped wax all over my friend's table
Delayed: When the candle/violin that my friend gave me burned down the wax dripped
Before: The lively tune he played on the candle/violin started us dancing with all our friends
After: When the candle/violin played the lively tune we all began to dance with our friends
Delayed: When the candle/violin that my friend gave me played the lively tune we all danced

Set 2: Dish–shoe

Before: The shattered dish/shoe was in pieces all over the floor after it fell
After: The new dish/shoe was shattered into many pieces when it fell onto the floor
Delayed: The new dish/shoe fell onto the floor and was shattered into many pieces
Before: The chewed dish/shoe was carried around by the dog and left on the floor
After: The new dish/shoe was chewed by the dog when it was left on the floor
Delayed: The new dish/shoe fell onto the floor and was chewed by the dog

Set 3: Needle–meadow

Before: I wore a thimble because the needle/meadow was sharp and I needed to use it
After: Because the needle/meadow was sharp I wore a thimble whenever I was using it
Delayed: Because the needle/meadow that I happened to like was sharp I wore a thimble
Before: The wildflowers had been in the needle/meadow until it was mowed and they disappeared
After: Because the needle/meadow was mowed the wildflowers that I happened to like had disappeared
Delayed: Because the needle/meadow that I happened to like was mowed the wildflowers had disappeared

Set 4: Knife–earth

Before: As I sliced the potatoes with the knife/earth I cut my finger
After: I felt the knife/earth cut my finger as I sliced the potatoes
Delayed: I felt the knife/earth as it suddenly began to cut my finger
Before: As the volcano erupted the knife/earth began to quake and I heard the rumble
After: I felt the knife/earth quake as the volcano erupted suddenly with a loud rumble
Delayed: I felt the knife/earth as it suddenly began to quake when the volcano erupted

Set 5: Drawer–regime

Before: The files in the drawer/regime were disorganized and some had been removed
After: In the drawer/regime the files were disorganized and some had been removed
Delayed: In the drawer/regime that was removed last week the files were disorganized
Before: The dictator during the drawer/regime ruled by force until he was removed
After: In the drawer/regime the dictator ruled by force until he was removed
Delayed: In the drawer/regime that was removed last week the dictator ruled by force

Set 6: Water–movie

Before: The shrimp were floating in the water/movie and were netted by the crew
After: In the water/movie the shrimp were easily netted by the fisherman's crew
Delayed: In the water/movie that John was in the shrimp were easily netted
Before: The actor's performance in the water/movie was panned by the critics
After: In the water/movie the actor's performance was panned by the critics
Delayed: In the water/movie that John was in his performance was panned

Set 7: Belt–wind

Before: His pants stayed up with the belt/wind and he was more comfortable
After: With the belt/wind his pants stayed up and he was more comfortable
Delayed: With the belt/wind it was obvious that his pants could stay up
Before: It was unbearably cold in the belt/wind and he began to run
After: With the belt/wind the cold became unbearable and he began to run
Delayed: With the belt/wind it was obvious that the cold would become unbearable

Set 8: Baby–door

Before: The crying baby/door kept everyone in the upstairs bedroom from sleeping
After: Since the baby/door was crying no one could sleep in the upstairs bedroom
Delayed: Since the baby/door in the upstairs bedroom was crying no one could sleep
Before: We couldn't open the baby/door and get into the upstairs bedroom to sleep
After: Since the baby/door was closed we couldn't get into the bedroom to sleep
Delayed: Since the baby/door in the upstairs bedroom was closed we couldn't get in

Set 9: Gift–meal

Before: They hastily wrapped the gift/meal and gave it to Mark to celebrate his graduation
After: On the table the gift/meal was wrapped and given to Mark for his graduation
Delayed: On the table the gift/meal to celebrate Mark's graduation was hastily wrapped and tied
Before: They hastily served the gift/meal and ate it with Mark to celebrate his graduation
After: On the table the gift/meal was served and ready to eat at Mark's celebration
Delayed: On the table the gift/meal to celebrate Mark's graduation was hastily served and eaten

Set 10: Turtle–engine

Before: At the zoo Amy saw the turtle/engine in the pond as she was walking by
After: Amy saw the turtle/engine in the pond at the zoo as she was walking by
Delayed: Amy saw the turtle/engine as she was walking by the pond at the zoo
Before: At the train station Amy saw the turtle/engine start up as she was walking by
After: Amy saw the turtle/engine of a train at the station when she was walking by
Delayed: Amy saw the turtle/engine as she was walking by the train at the station

Set 11: Sink–barn

Before: She washed the dishes in the sink/barn with lots of soapy water before she left
After: She filled the sink/barn with soapy water and washed the dirty dishes before she left
Delayed: She filled the sink/barn before she left with lots of soapy water and dirty dishes
Before: She provided the horses in the sink/barn with lots of hay before she left
After: She filled the sink/barn with hay for the horses before she left for town
Delayed: She filled the sink/barn before she left with lots of hay for the horses

Set 12: Tire–milk

Before: Her old car had a very worn tire/milk and she needed a new one
After: She realized that the tire/milk was worn and her car needed a new one
Delayed: She realized that the tire/milk was getting very old and worn on her car
Before: She tasted the very old and sour tire/milk before deciding to pour it out
After: She realized that the tire/milk was sour when she tasted it before pouring it out
Delayed: She realized that the tire/milk was getting very old and sour after tasting it

Set 13: Statue–banana

Before: Jim carved the statue/banana and exhibited it before he finally put it on sale
After: Soon after the statue/banana was carved it was exhibited and Jim bought it
Delayed: Soon after the statue/banana that Jim was holding had been carved it was exhibited
Before: Jim peeled the statue/banana and ate it before deciding to throw out the rest
After: Soon after the statue/banana was peeled Jim ate it and threw out the rest
Delayed: Soon after the statue/banana that Jim was holding had been peeled he ate it

Set 14: Knot–ship

Before: The scout tied the knot/ship that was in the competition they saw yesterday
After: He saw the knot/ship tied by the scout he had met that morning
Delayed: He saw the knot/ship that he knew had been tied by the scout
Before: The launching of the knot/ship in the harbor happened soon after he arrived
After: He saw the knot/ship launched in the harbor several days after he arrived
Delayed: He saw the knot/ship that he knew had been launched in the harbor

Set 15: Clown–light

Before: Behind the circus tent the clown/light had suddenly appeared in costume as Mike watched
After: Mike eyed the clown/light behind the circus tent where he suddenly appeared in costume
Delayed: Mike eyed the clown/light that had suddenly appeared behind the circus tent in costume
Before: From the lamp the clown/light had suddenly appeared in the house as Mike watched
After: Mike eyed the clown/light from the lamp that had suddenly appeared in the house
Delayed: Mike eyed the clown/light that had suddenly appeared from a lamp in the house

Set 16: Vase–sand

Before: The roses on the table in the decorated vase/sand reminded me of Mexico
After: In the vase/sand some roses decorated the table and reminded me of Mexico
Delayed: In the vase/sand that reminded me of Mexico some roses decorated the table
Before: Some shells were buried in the vase/sand deep below the surface
After: In the vase/sand some shells were buried deep below the surface
Delayed: In the vase/sand that reminded me of Mexico some shells were buried

Set 17: Dust–fist

Before: Under her son's bed the dust/fist had accumulated when she looked in to check the room
After: The woman saw the dust/fist had accumulated under her son's bed when she looked in
Delayed: The woman saw the dust/fist when it first started to accumulate under her son's bed
Before: Her son clenched his right dust/fist as he became angry and his mother watched him with concern
After: The woman saw the dust/fist had clenched when she looked at her angry son's right hand
Delayed: The woman saw the dust/fist when it first started to clench as her son became angry

Set 18: Pillow–toilet

Before: She bought a soft and fluffy pillow/toilet at the store the other day
After: She bought a pillow/toilet that was fluffy and soft from the store
Delayed: She bought a pillow/toilet at the store that would be fluffy and soft
Before: The flushing of her pillow/toilet was much quieter after the new one was installed

After: She bought a pillow/toilet that would flush quietly to install in her new bathroom
Delayed: She bought a pillow/toilet at the store that would flush quietly in her bathroom

Set 19: Tuna–army

Before: They set up the fishing nets when the tuna/army began to return
After: With the return of the tuna/army the fishing nets were set up
Delayed: With the return of the tuna/army they set up the fishing nets
Before: They set up the military barracks when the tuna/army was due to return
After: With the return of the tuna/army the military barracks were set up
Delayed: With the return of the tuna/army they set up the military barracks

Set 20: Pony–tree

Before: The saddle for the pony/tree is kept by Dan at the back of the barn
After: Because of the pony/tree a saddle is kept by Dan at the back of the barn
Delayed: Because of the pony/tree in the grassy field a saddle is kept in the barn
Before: The shade of the pony/tree is very pleasant in the summer in the grassy field
After: Because of the pony/tree the shade is pleasant in summer in the grassy field
Delayed: Because of the pony/tree in the grassy field the shade is pleasant in summer

Set 21: Lock–worm

Before: The key jammed the lock/worm she was using and broke when she tried it
After: Because the lock/worm was jammed the key broke in it when she tried it
Delayed: Because the lock/worm that she was using was jammed the key broke in it
Before: On the hook wiggled the lock/worm she was using to get the fish to bite
After: Because the lock/worm was wiggling on the hook she got the fish to bite quickly
Delayed: Because the lock/worm that she was using was wiggling on the hook the fish bit

Set 22: Column–valley

Before: The marble of the beautiful column/valley in the square was admired by Anne
After: The beautiful column/valley of white marble that Anne admired stood alone in the square
Delayed: The beautiful column/valley that Anne admired was a marble shaft standing alone
Before: The river in the beautiful column/valley flowed quietly as Anne stood admiring it
After: The beautiful column/valley with a river flowing through it was admired by Anne
Delayed: The beautiful column/valley that Anne admired had a river flowing through it

Set 23: Party–nurse

Before: Before the birthday invitations were sent out the party/nurse was almost all arranged for
After: Before the party/nurse the birthday invitations were sent out and all arrangements were made
Delayed: Before the party/nurse had been arranged for the birthday some invitations were sent out
Before: Before the sick patient went to the hospital the party/nurse was arranged for and hired
After: Before the party/nurse came the sick patient had been arranging to go to the hospital
Delayed: Before the party/nurse had been arranged for the sick patient he went to the hospital

Set 24: Odor–limb

Before: The skunk had a strong odor/limb but we decided to continue our hike along the trail
After: Although the odor/limb of the skunk was strong we decided to continue our hike along the trail
Delayed: Although the odor/limb that I knew was from a skunk was strong we continued our hike
Before: The oak had a broken odor/limb but even so it continued to sprout for some time
After: Although the odor/limb of the oak was broken it continued to sprout for a long time
Delayed: Although the odor/limb that I knew was from an oak was broken it continued to sprout

Set 25: Hair–robe

Before: She shampooed and conditioned her hair/robe before working on it later that evening
After: When she worked on her hair/robe she shampooed and conditioned it the same evening
Delayed: When she worked on her hair/robe later that same evening she shampooed and conditioned it
Before: She patched the torn fabric of her hair/robe when she was working on it that evening
After: When she worked on her hair/robe she patched the torn fabric that same evening
Delayed: When she worked on her hair/robe later that same evening she patched the torn fabric

Set 26: Luncheon–medicine

Before: The restaurant where the special luncheon/medicine was held was closed to the public
After: Because of the special luncheon/medicine the restaurant was closed early to the public
Delayed: Because of the special luncheon/medicine that had been requested the restaurant closed early to the public
Before: The patient who got the special luncheon/medicine improved dramatically and returned home quickly
After: Because of the special luncheon/medicine the patient improved dramatically and returned home quickly
Delayed: Because of the special luncheon/medicine that had been requested the patient improved dramatically

Set 27: Beaver–insect

Before: The dam built by the beaver/insect near the lake did not stop the stream from flowing
After: Although the beaver/insect built a dam that I saw near the lake the stream flowed freely

Delayed: Although the beaver/insect that I saw near the lake built a dam the stream flowed freely
Before: The buzzing of the beaver/insect around my head as I sat by the lake was annoying
After: Although the beaver/insect buzzed around my head as I sat by the lake I ignored it
Delayed: Although the beaver/insect that I saw near the lake buzzed around my head I ignored it

Set 28: Bush–note

Before: The blueberries on the bush/note were thick and grew in large clumps
After: On the bush/note the blueberries were thick and grew in large clumps
Delayed: On the bush/note that I saw today the blueberries were growing thickly
Before: The ink on the bush/note was smeared and hard to read
After: On the bush/note the ink was smeared and hard to read
Delayed: On the bush/note that I saw today the ink was smeared

Set 29: Book–hole

Before: The publisher needs a book/hole soon that he can use or he will go broke
After: If there is no book/hole the publisher can use he will probably soon go broke
Delayed: If there is no book/hole soon that he can use the publisher will go broke
Before: The groundhog needs a book/hole that he can use or he will not come up
After: If there is no book/hole the groundhog can use he will probably not come up
Delayed: If there is no book/hole soon that he can use the groundhog cannot come up

Set 30: Clock–sugar

Before: He heard the noisy ticking of the clock/sugar when he placed it on the shelf
After: He placed the clock/sugar where it ticked less noisily than it had on the shelf
Delayed: He placed the clock/sugar on the shelf where it ticked less noisily than before
Before: He spilled the clock/sugar and made a mess when he placed it on the shelf
After: He placed the clock/sugar where it spilled and made a mess on the table
Delayed: He placed the clock/sugar on the shelf where it spilled and made a mess

Set 31: Crime–music

Before: An addict committed the crime/music that he had heard about in the neighborhood drugstore
After: He found that the crime/music was committed by an addict in the neighborhood drugstore
Delayed: He found that the crime/music in the neighborhood drugstore was committed by an addict
Before: He played the crime/music much too loudly and it was heard in the neighborhood drugstore
After: He found that the crime/music was played much too loudly in the neighborhood drugstore
Delayed: He found that the crime/music in the neighborhood drugstore was playing much too loudly

Set 32: Fence–ocean

Before: The wooden fence/ocean needed repainting that summer on the east side of the pasture
After: The distant fence/ocean was wooden and needed repainting before the end of the summer
Delayed: The distant fence/ocean to the east of the property was wooden and needed repainting soon
Before: The stormy fence/ocean and crashing surf could be seen and heard in the distance
After: The distant fence/ocean was stormy with crashing surf that the boys could hear clearly
Delayed: The distant fence/ocean to the east of the property was stormy with crashing surf

Set 33: Pipe–nest

Before: The rusty and flaking pipe/nest was found by the janitor on the roof of the building
After: The janitor found that a pipe/nest was rusty and flaking on the roof of the building
Delayed: The janitor found that a pipe/nest on the roof of the building was rusty and flaking
Before: The robin's eggs in the pipe/nest were found by the janitor on the roof of the building
After: The janitor found that a pipe/nest had robin's eggs in it on the roof of the building
Delayed: The janitor found that a pipe/nest on the roof of the building had robin's eggs in it

Set 34: Band–sign

Before: The trombones in the band/sign were playing when we saw them driving past the park
After: When we saw the band/sign the trombones were playing as we drove past the park
Delayed: When we saw the band/sign as we drove past the park the trombones were playing
Before: The lettering on the band/sign was unclear when we saw it driving past the park
After: When we saw the band/sign the lettering was unclear as we drove past the park
Delayed: When we saw the band/sign as we drove past the park the lettering was unclear

Set 35: Ticket–flower

Before: The airplane that the ticket/flower was bought for would take him home any time
After: With the ticket/flower for the airplane he can fly home whenever he wants to
Delayed: With the ticket/flower that he had bought for the airplane he can fly home
Before: The pot with the ticket/flower in the gardener's display was complete and ready to show
After: With the ticket/flower for the pot the gardener's display was complete and ready to show
Delayed: With the ticket/flower that he had bought for the pot the gardener's display was complete

Set 36: Prison–salary

Before: The inmates were taken to another prison/salary because the old penitentiary was crowded
After: A larger prison/salary for all inmates was demanded by the crowded prisoners

Delayed: A larger prison/salary was demanded by the angry inmates of the crowded penitentiary
Before: The employees were given a higher prison/salary because the union threatened to strike
After: A larger prison/salary for all employees was demanded by the clerical union
Delayed: A larger prison/salary was demanded by the angry employees of the clerical union

Set 37: Message–traffic

Before: The answering machine had the message/traffic that Sam studied when he got home
After: Sam studied the message/traffic on the answering machine that he found yesterday afternoon
Delayed: Sam studied the message/traffic that he found on the answering machine yesterday afternoon
Before: The highway had the message/traffic that Sam studied as he approached the ramp
After: Sam studied the message/traffic on the highway he was approaching from the ramp
Delayed: Sam studied the message/traffic that he found on the highway he was approaching

Set 38: Snow–bird

Before: The tall spruce tree shed the melted snow/bird and its branches sprang up
After: After the snow/bird melted the branches of the tall spruce tree sprang up
Delayed: After the snow/bird on the tall spruce tree had melted the branches sprang up
Before: Leaving its nest empty the snow/bird flew far away from the tall spruce tree
After: After the snow/bird flew away the nest on the tall spruce tree was empty
Delayed: After the snow/bird on the tall spruce tree flew away the next was empty

Set 39: Hornet–jingle

Before: Buzzing as it flew the angry hornet/jingle circled the room before it headed for John
After: John knew that the hornet/jingle was buzzing with anger as it flew around the room
Delayed: John knew that the hornet/jingle he could hear in the distance was buzzing with anger
Before: The sleigh bells made a merry hornet/jingle as the sled approached John from a distance
After: John knew that the hornet/jingle of sleigh bells meant that the sled would soon appear
Delayed: John knew that the hornet/jingle he could hear in the distance was the sled approaching

Set 40: Pencil–basket

Before: Maggie wrote the letter with a pencil/basket she had with her the other day
After: Maggie used a pencil/basket to write the letter to her friend in Arkansas
Delayed: Maggie used a pencil/basket that she bought the other day to write the letter
Before: Maggie carried the kitten in a pencil/basket to her house the other day
After: Maggie used a pencil/basket to carry the kitten to her friend the other day
Delayed: Maggie used a pencil/basket that she bought the other day to carry the kitten

Set 41: Coach–woods

Before: Bob went to plan the football schedule with the coach/woods at the end of the day
After: Bob went to the coach/woods to plan the football schedule at the end of the day
Delayed: Bob went to the coach/woods at the end of the day to plan the football schedule
Before: Bob went to chop down a tree in the coach/woods at the end of the day
After: Bob went to the coach/woods to chop down a tree at the end of the day
Delayed: Bob went to the coach/woods at the end of the day to chop down a tree

Set 42: Siren–bloom

Before: The shrill sound of the siren/bloom was filling the air so Larry immediately pulled over
After: Noticing the siren/bloom with the shrill sound that was filling the air Larry pulled over
Delayed: Noticing the siren/bloom that was filling the air with a shrill sound Larry pulled over
Before: The sweet odor of the siren/bloom was filling the air so Larry decided to pick it
After: Noticing the siren/bloom with the sweet odor that was filling the air Larry picked it
Delayed: Noticing the siren/bloom that was filling the air with a sweet odor Larry picked it

Set 43: Money–fruit

Before: Susan bought a book with the money/fruit that she had received as a gift
After: Susan used the money/fruit to buy a book that she planned to give away
Delayed: Susan used the money/fruit that she received as a gift to buy a book
Before: Susan ate a dessert of money/fruit that she received as a gift that day
After: Susan used the money/fruit to eat with her dessert instead of in the salad
Delayed: Susan used the money/fruit that she received as a gift to eat with dessert

Set 44: Dress–power

Before: Although the department store had sold the dress/power quickly it was returned by the customer
After: Although the dress/power had sold quickly in the department store it was later returned
Delayed: Although the dress/power in the department store had sold quickly it was later returned
Before: The generator broke so the dress/power failed suddenly in the department store last night
After: Although the dress/power had failed suddenly the generator in the department store wasn't broken
Delayed: Although the dress/power in the department store had failed suddenly the generator wasn't broken

Set 45: Candy–price

Before: Fred ate the candy/price at the party that he and the other kids attended
After: Fred liked the candy/price that he ate at the party with the other kids
Delayed: Fred liked the candy/price that he had been given at the party to eat
Before: The car sold at the candy/price that Fred had hoped that it would get
After: Fred liked the candy/price for the car that he got when he sold it
Delayed: Fred liked the candy/price that he had been given for the car he sold

Set 46: Weapon–island

Before: The soldier was wounded with the loaded weapon/island that he had found
After: Since the weapon/island was loaded the careless soldier who had found it was wounded
Delayed: Since the weapon/island that he had found was loaded the soldier was wounded
Before: The tropical climate of the weapon/island caused many birds to flock there
After: Since the weapon/island was tropical he saw the many birds that flocked there
Delayed: Since the weapon/island that he had found was tropical many birds flocked there

Set 47: Coin–doll

Before: Ellen spent the coin/doll on a candy bar for herself and her best friend
After: Ellen snatched up the coin/doll to buy some candy for herself and her friend
Delayed: Ellen snatched up the coin/doll that was on the floor to buy some candy
Before: Ellen cuddled the coin/doll and sang to it as she lay in bed
After: Ellen snatched up the coin/doll to cuddle it and put it to bed
Delayed: Ellen snatched up the coin/doll that was on the floor to cuddle it

Set 48: Pebble–picnic

Before: In my shoe I had a pebble/picnic that made my toe hurt for several minutes
After: Because of the pebble/picnic in my shoe my toe hurt for most of the day
Delayed: Because of the pebble/picnic that I had in my shoe my toe hurt all day
Before: The ants had a feast at my pebble/picnic in the park that I had yesterday
After: Because of the pebble/picnic in the park the ants had a feast on our food
Delayed: Because of the pebble/picnic that I had in the park the ants had a feast

Set 49: Chapel–market

Before: Ellen prays in the chapel/market that is behind the town hall every Sunday morning
After: Ellen walked to the chapel/market to pray on Sunday dressed in her nicest clothing
Delayed: Ellen walked to the chapel/market that is behind the town hall to pray on Sunday
Before: Ellen bought groceries at the chapel/market on Saturday morning to prepare for the picnic
After: Ellen walked to the chapel/market for groceries on Saturday since the weather was so pleasant
Delayed: Ellen walked to the chapel/market that is behind the town hall for groceries on Saturday

Set 50: Angel–rebel

Before: A white gown and halo was worn by the angel/rebel in the new movie
After: The actor playing the angel/rebel wore a white gown and halo in the movie
Delayed: The actor playing the angel/rebel in the movie wore a white gown and halo
Before: A black leather outfit was worn by the angel/rebel in the new movie
After: The actor playing the angel/rebel wore a black leather outfit in the movie
Delayed: The actor playing the angel/rebel in the movie wore a black leather outfit

Set 51: Taxi–pill

Before: He went to the airport in a taxi/pill for his flight to New York
After: He took a taxi/pill to the airport to catch his flight to New York
Delayed: He took a taxi/pill in the morning for his early flight to New York
Before: His headache was cured by the taxi/pill he took the morning after the party
After: He took a taxi/pill for the headache he got the morning after the party
Delayed: He took a taxi/pill in the morning for his early headache after the party

Set 52: Flag–tray

Before: On the pole hung the flag/tray that he had found in the basement that morning
After: He picked up the flag/tray to hang it on the pole in the front yard
Delayed: He picked up the flag/tray from the basement floor to hang it on the pole
Before: He polished the tarnished flag/tray of silver that he had found in the basement
After: He picked up the flag/tray of silver to polish its tarnished and worn surface
Delayed: He picked up the flag/tray from the basement floor to polish the tarnished silver

Set 53: Battle–dinner

Before: The army prepared for battle/dinner by cleaning their weapons and praying with the chaplain
After: Before the battle/dinner the army was nervous so the chaplain held services and prayed
Delayed: Before the battle/dinner there was a prayer since the army was nervous and afraid
Before: The hostess served the battle/dinner to her guests once their conversation had died down

After: Before the battle/dinner the hostess served the appetizers while the host mixed the cocktails
Delayed: Before the battle/dinner there was a prayer before the hostess served the first course

Set 54: Alarm–snack

Before: The burglar set off the alarm/snack in the middle of the night and was discovered immediately
After: Because of their alarm/snack the burglar was discovered immediately in the middle of the night
Delayed: Because of their alarm/snack in the middle of the night the burglar was discovered immediately
Before: They had cookies and milk for their alarm/snack just before they went to bed that night
After: Because of their alarm/snack of cookies and milk they weren't hungry in the middle of the night
Delayed: Because of their alarm/snack in the middle of the night of cookies and milk they weren't hungry

Set 55: Balloon–plumber

Before: The popping of the balloon/plumber startled the girl by the store in the mall
After: When the balloon/plumber popped it startled the girl by the store in the mall
Delayed: When the balloon/plumber from the store in the mall popped it startled the girl
Before: The leak fixed by the balloon/plumber from the store in the mall soon stopped dripping
After: When the balloon/plumber fixed the leak in the store by the mall it stopped dripping
Delayed: When the balloon/plumber from the store in the mall fixed the leak it stopped dripping

Set 56: Razor–brick

Before: While shaving the customer he dropped the razor/brick because he was holding it carelessly
After: He dropped the razor/brick while shaving the customer because he was holding it carelessly
Delayed: He dropped the razor/brick that he was holding when he finished shaving the customer
Before: While building the wall he dropped the razor/brick because he was holding it carelessly
After: He dropped the razor/brick while building the wall because he was holding it carelessly
Delayed: He dropped the razor/brick that he was holding when he finished building the wall

Set 57: Flame–jewel

Before: The flickering yellow flame/jewel was reflected in the mirror on the wall
After: Helen saw the flame/jewel flicker in the wind as she looked in the mirror
Delayed: Helen saw the flame/jewel reflected in the mirror as it flickered in the wind
Before: The glittering crown had a flame/jewel in the center surrounded by stars of gold
After: Helen saw the flame/jewel glitter in the crown as she looked in the mirror
Delayed: Helen saw the flame/jewel reflected in the mirror as it glittered in the crown

Set 58: Ladder–desert

Before: The broken rungs of the ladder/desert led Julie to throw it out
After: Julie noticed that the ladder/desert had many broken rungs that needed repair
Delayed: Julie noticed that the ladder/desert in the photograph had many broken rungs
Before: The cacti flowering in the ladder/desert gave Julie something special to photograph
After: Julie noticed that the ladder/desert had many flowering cacti she could photograph
Delayed: Julie noticed that the ladder/desert in the photograph had many flowering cacti

Set 59: Youth–color

Before: As he jumped over the fence the youth/color that Kate had seen shouted to her
After: Kate saw the youth/color as he jumped over the fence when she opened the window
Delayed: Kate saw the youth/color as she opened the window and he jumped over the fence
Before: The rainbow made the youth/color in the sky that Kate saw through the window
After: Kate saw the youth/color as the rainbow glowed in the sky through the window
Delayed: Kate saw the youth/color as she opened the window and the rainbow glowed in the sky

Set 60: Leaf–fork

Before: Pat picked up the maple leaf/fork under the tree and looked at it closely
After: Pat picked up the leaf/fork under the maple tree and looked at it closely
Delayed: Pat picked up the leaf/fork that was lying next to the maple tree's trunk
Before: Pat laid the knife and leaf/fork on the table and looked carefully at the setting
After: Pat picked up the leaf/fork and the knife and laid them carefully on the table
Delayed: Pat picked up the leaf/fork that was lying next to the knife on the table

Set 61: Veil–bait

Before: The bride wore a veil/bait that she ordered from a bridal catalog
After: I chose the veil/bait that the bride wore out of a bridal catalog
Delayed: I chose the veil/bait out of a catalog of bridal fashions
Before: Our fishing veil/bait included worms and flies selected from a catalog
After: I chose the veil/bait the fish liked best from a catalog
Delayed: I chose the veil/bait out of a catalog of fishing supplies

Set 62: Puzzle–monkey

Before: The pieces that were missing from the puzzle/monkey were found on the floor
After: The tricky puzzle/monkey had some pieces missing that had fallen out of the box
Delayed: The tricky puzzle/monkey ended up on the floor when the pieces spilled from the box

Before: The banana that was grabbed by the puzzle/monkey ended up on the floor
After: The tricky puzzle/monkey had a banana he had grabbed that he dropped on the floor
Delayed: The tricky puzzle/monkey ended up on the floor with the banana he had grabbed

Set 63: Hawk–mist

Before: Hunting for small animals the hawk/mist was flying over the valley most of the morning
After: Most of the morning the hawk/mist was hunting small animals while flying over the valley
Delayed: Most of the morning the hawk/mist could be seen in the valley hunting small animals
Before: Blanketing the trees and meadows the hawk/mist hid the valley for most of the morning
After: Most of the morning the hawk/mist was blanketing the trees and meadows in the valley
Delayed: Most of the morning the hawk/mist could be seen in the valley blanketing the trees

Set 64: Stool–hinge

Before: Near the kitchen table the oak stool/hinge could be seen as she glanced around
After: Cathy noticed the stool/hinge made of oak near the table in the kitchen
Delayed: Cathy noticed the stool/hinge when she glanced at the table in the kitchen
Before: The door had a creaking stool/hinge that Cathy noticed as she went outside
After: Cathy noticed the stool/hinge on the door that creaked as she went outside
Delayed: Cathy noticed the stool/hinge when she glanced at the door that was creaking

Set 65: Chart–swing

Before: The stars and planets were shown on the chart/swing that was hung by Joseph yesterday
After: Joseph hung the chart/swing showing the stars and planets that he had bought that day
Delayed: Joseph hung the chart/swing that he had just bought to show the stars and planets
Before: The kids were playing in the yard on the chart/swing that was hung up by Joseph
After: Joseph hung the chart/swing for kids playing in the yard that he had just bought
Delayed: Joseph hung the chart/swing that he had just bought for kids playing in the yard

Set 66: Clay–foot

Before: The pottery wheel spun the clay/foot as Tom began to mold a pot
After: Tom held the clay/foot on the pottery wheel and molded a tall pot
Delayed: Tom held the clay/foot and looked closely at the pot he was molding
Before: Tom felt the painful splinter in his clay/foot and looked closely
After: Tom held the clay/foot with the painful splinter and looked closely
Delayed: Tom held the clay/foot and looked closely at the painful splinter

Set 67: Vine–heap

Before: The grapes hanging on the vine/heap were ready to be picked anytime
After: She commented on the vine/heap with grapes hanging down ready to be picked
Delayed: She commented on the vine/heap that could be seen with grapes hanging down
Before: The dung of the horses formed a vine/heap in the yard of the farm
After: She commented on the vine/heap of dung left in the yard by the horses
Delayed: She commented on the vine/heap that could be seen of dung from the horses

Set 68: Puppy–ashes

Before: The fur of the puppy/ashes needed brushing because it had been rolling in the dust
After: Ann brushed the puppy/ashes until its fur was clean and no longer covered with dust
Delayed: Ann brushed the puppy/ashes at her feet to clean off its fur covered with dust
Before: The fireplace with the puppy/ashes spilling on the hearth needed cleaning out for the summer
After: Ann brushed the puppy/ashes until the fireplace and hearth were clean and ready for summer
Delayed: Ann brushed the puppy/ashes at her feet to clean off the fireplace and the hearth

Set 69: Police–street

Before: The hoodlum was chased by the police/street out of the neighborhood so Nancy felt safe
After: Because the police/street had chased the hoodlum out of the neighborhood Nancy felt much safer
Delayed: Because the police/street in the neighborhood had begun to chase the hoodlum Nancy felt safe
Before: The rain had been flooding the police/street in the local neighborhood so Nancy stayed home
After: Because the police/street had flooded with rain in the neighborhood Nancy decided to stay home
Delayed: Because the police/street in the neighborhood had begun to flood with rain Nancy stayed home

Set 70: Bread–smoke

Before: After she buttered the slice of bread/smoke it was brought from the kitchen
After: Although the bread/smoke was sliced it had not been buttered in the kitchen
Delayed: Although the bread/smoke in the kitchen was sliced it had not been buttered
Before: Blackening the walls of the kitchen the bread/smoke from the smoldering fire was still rising
After: Although the bread/smoke was blackening the walls of the kitchen the fire was only smoldering
Delayed: Although the bread/smoke in the kitchen was blackening the walls the fire was only smoldering

Set 71: Garlic–cannon

Before: In the spaghetti sauce the garlic/cannon was very strong and aromatic
After: Richard noticed the garlic/cannon in the spaghetti sauce that Sue had made
Delayed: Richard noticed the garlic/cannon that had been put in the spaghetti sauce
Before: On the battlefield the garlic/cannon was located near the Civil War monument
After: Richard noticed the garlic/cannon on the battlefield near the Civil War monument
Delayed: Richard noticed the garlic/cannon that had been put on the battlefield near the monument

Set 72: Garden–jacket

Before: George grew vegetables in the garden/jacket in order to save the money he needs
After: With a garden/jacket to grow vegetables in George can save the money he needs
Delayed: With a garden/jacket that he wanted to grow vegetables in George can save money
Before: George dressed up in the garden/jacket he had decided to wear to the dinner
After: With a garden/jacket to wear to the dinner George was able to dress up
Delayed: With a garden/jacket that he wanted to wear George dressed up for the dinner

Appendix D

Materials for Experiment 4

The two primes are in brackets and are divided by a slash, and the two double words that follow are separated by a slash.

Nouns Versus Verbs

1. Nathan refused [the/to] pie/eat when Lisa offered him dessert
2. I called my roommate [for/to] complain/sympathy after I failed my test
3. Maggie chose [the/to] winner/decide by flipping a coin
4. Oscar wanted [the/to] girl/flee because she was seducing him
5. Stuart liked [the/to] pony/skip across the field
6. Pete managed [the/to] cheat/team more successfully than anyone else
7. After his interview Vince wanted [the/to] enlist/job more
8. The student had nothing [in/to] say/class when the professor asked for his homework
9. I did not have [good/to] luck/think during the exam
10. He saw [your/me] umbrella/arrive after everyone had left
11. Jerry continued [the/to] ramble/speech even after everyone had fallen asleep
12. I started [the/to] van/argue when it was time to begin our journey
13. I ran over [the/to] see/cat although I did not want to
14. Stacy was too tired [the/to] care/week that they left
15. The vampire went out [the/to] dine/door when night fell
16. I wanted [the/to] weep/sequel after I read the book
17. Sasha tried [the/to] strategy/remember but it did not work
18. The soldiers lined up [the/to] prepare/prisoners for inspection
19. She liked [the/to] sing/curtain in the shower
20. He hated [the/to] lady/go across the street
21. I hated [my/to] fiancee/leave though it seemed somehow wrong
22. Carrie often needed [the/to] furnace/stay in her house during the winter
23. Tina loved [the/to] music/draw with all her heart
24. He tried [the/to] write/game in our book of puzzles

Nouns Versus Adverbs

25. Herbert spoke [with/very] them/softly for several hours at the party
26. Charlene turned [the/around] abruptly/corner when she heard a siren
27. Abraham landed [the/quite] airplane/skillfully on the grassy knoll
28. He shouted [my/very] loudly/name up the stairs
29. The lantern lit [the/up] slowly/cavern and exposed the missing jewels
30. Ingrid read [the/very] poorly/tabloid when she was tired
31. I got [the/up] punchline/suddenly after everyone had left
32. Jim and I worked [with/very] Grandma/carefully on the project
33. I called him [a/up] blockhead/frequently on the telephone
34. She climbed [the/up] steadily/mountain until she reached the top
35. I collapsed [the/most] parachute/dramatically in the middle of the field
36. Alice gave [a/in] pretzel/finally to her yapping puppy
37. Biff worried [his/quite] seriously/stepmother when he performed as an acrobat
38. I walked [the/out] sadly/dog while searching for my friends
39. Jack's dog ate [his/rather] hungrily/finger when Jack held out a biscuit
40. The squirrel climbed [the/down] tree/quickly and scampered away

Count Versus Mass Nouns

41. The umpire saw too [much/many] water/men on the court
42. I was surprised to find so [much/many] tension/people at the conference
43. The tomboy broke [some/a] window/furniture while playing with her friends
44. She never knew how [much/many] coins/money to put in the offering plate
45. He needed [some/a] help/tutor to pass the course
46. The china dish held [some/a] sandwich/butter that smelled rather rancid
47. I was not surprised to find [some/a] laundry/pillow on his bed
48. Jon got stuck in [some/a] traffic/storm and never made it to the party
49. I eventually acquired [much/many] things/wisdom in my life
50. Muffy needed [some/a] manicure/hairspray right away or her social life would be over

51. I have too [much/many] problems/homework for my math recitation tomorrow
52. We were happy to have found so [much/many] geese/activity at the lake
53. Behind the picture there was [some/a] hole/dust which I had missed before
54. The professor saw [much/many] potential/mistakes in the student's writing
55. Gretchen had [much/many] talent/skills although she did not realize it
56. The boy had gotten into so [much/many] fights/trouble that he was expelled
57. I took along as [much/many] equipment/witnesses as possible in case I spotted Bigfoot
58. Craig ate so [much/many] pudding/cookies after his meal that he could not move
59. In the cookie batter I tasted too [much/many] vanilla/walnuts for my liking
60. His mother gave him so [much/many] guilt/worries that he became unstable
61. I was excited to see so [much/many] oxen/land on my trip out west
62. In the movie Jimmy saw so [much/many] violence/vampires that he felt upset afterwards
63. Sarah has so [much/many] work/chores that she never has any time for herself
64. Norma had so [much/many] toys/fun that everyone wanted to play with her
65. The article contained so [much/many] diagrams/sarcasm I could barely stand to read it
66. Matt had so [much/many] pain/ulcers that he was all hollow inside
67. I was surprised by how [much/many] mice/effort they had put into one room
68. There was still [some/a] rice/bite left in the bowl
69. The editor found too [much/many] errors/cynicism in the article
70. The janitor saw [some/a] puddle/mud seeping out from beneath the laboratory door
71. The biologist was pleased to find so [much/many] slime/fungi in the petri dish
72. Michelle had so [much/many] stones/sand in her shoes that she got blisters
73. I gave my cat [some/a] food/ball but she did not like it
74. When the alarm clock rang I grabbed [some/a] banana/coffee and dashed out quickly
75. Nancy wanted to get [some/a] perm/clothes at the mall
76. The waitress asked if [some/a] fork/salt was what I wanted
77. I always wondered how [much/many] sugar/calories the corpulent man consumed each day
78. I was startled to discover so [much/many] humor/lies in the mayor's speeches
79. We were pleased to have so [much/many] support/women at the meeting
80. They had too [much/many] children/stuff for such a small house

Adjectives Versus Verbs

81. Bill loves [overly/to] friendly/frighten people who come to visit him
82. The ghost appeared [rather/to] scowl/eerie but I knew he was friendly
83. She seemed [quite/to] sick/vanish but it was just a ploy
84. The witch likes [all/to] cook/little babies because they are so sweet

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