

Processing Ambiguous Verbs: Evidence From Eye Movements

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In 2 eye-tracking experiments, participants read verbs that had 2 (unrelated) meanings or 2 (related) senses in contexts that disambiguated before or after the verb, to the dominant or subordinate interpretation. A 3rd experiment used unambiguous verbs. The results indicated that the language processor used information about context in the early stages of resolving meaning ambiguities but only during integration for sense ambiguities. Effects of preference were delayed for both types of verbs. The results contrast with findings concerning the processing of nouns (e.g., K. Rayner & S. A. Duffy, 1986). For meaning ambiguities, the authors argue that delays in resolution allow both meanings to reach a high level of activation, thus reducing effects of frequency. For sense ambiguities, the authors argue that the processor does not access multiple senses but activates one underspecified meaning and uses context to home in on the appropriate sense.

Theories of lexical ambiguity resolution that have been proposed over the last 20 years or so have attempted to account for all types of words, but most experiments have focused on ambiguous nouns (e.g., Rayner & Duffy, 1986; Swinney, 1979) or sometimes cross-categorical ambiguities in which at least one interpretation is nominal (e.g., Tanenhaus, Leiman, & Seidenberg, 1979). Such research suggests that resolution can occur very rapidly, with context and frequency playing major roles in this process. However, other categories of words are just as ambiguous as nouns, and a general theory of ambiguity resolution clearly needs to make reference to them as well.

This article is concerned with the resolution of lexically ambiguous verbs—in other words, verbs with two or more semantic interpretations. Most studies of the processing of nouns have been concerned with their semantic properties. In contrast, most research on verbs has been concerned with the effects of their syntactic properties on parsing (e.g., Frazier & Rayner, 1982; Trueswell, Tanenhaus, & Kello, 1993), though there have been some studies of cross-categorical ambiguities and some attempts to integrate these traditions (e.g., MacDonald, Pearlmutter, & Seidenberg, 1994).

A fairly strong intuition suggests that people may deal with semantically ambiguous verbs very differently from nouns. For example, after a reader or listener encounters *The man ruled . . .*, the question that springs to mind is, “What did he rule?” For instance, he might have ruled a country, or he might have ruled a line on something. These two possibilities invoke very different meanings of *rule*. This example suggests that people need the object argument of a transitive verb before knowing which interpretation to assign, and, more important, that they are prepared to delay their decision. In contrast, after encountering, for example, *The ball was . . .*, evidence reviewed below suggests that people are likely to assume that *the ball* refers to a spherical object rather than a dance, because the first meaning is more frequent. If the intuition about verbs is correct, people may delay the resolution of verbs and will not pay such immediate attention to the frequency of the two interpretations. The first purpose of this article is to specify this intuition more precisely and determine whether it is correct.

Most work on lexical ambiguity resolution has focused almost entirely on words with two unrelated interpretations or meanings. Although there are some exceptions (e.g., Frazier & Rayner, 1990; Frisson & Pickering, 1999), there has been much less interest in the resolution of ambiguities in words with two related interpretations or senses, and the little relevant work has concentrated on nouns. The second purpose of this article is to assess the claim that sense ambiguity in verbs is resolved by homing in on the contextually appropriate interpretation, rather than selecting between alternative senses.

Theories of Lexical Ambiguity Resolution and the Processing of Verbs

Much research has demonstrated that the resolution of noun ambiguities with two unrelated meanings occurs very rapidly. Lexical ambiguity effects in eye-tracking experiments (i.e., effects that are related to the specific properties of an ambiguous word) generally occur as soon as the ambiguous word is encountered,

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though they sometimes spill over to the next word (e.g., Duffy, Morris, & Rayner, 1988; Rayner & Duffy, 1986). In priming experiments, evidence for multiple activation of meanings occurs at a stimulus onset asynchrony of 0 ms, and effects of meaning selection occur within about 200 ms (e.g., Swinney, 1979). In general, researchers agree that the selection of the contextually appropriate meaning of an ambiguous noun occurs very soon after the noun is encountered. In addition, most researchers agree that both meanings are always activated when encountered, except perhaps in very constraining contexts (Simpson & Krueger, 1991; Tabossi, 1988; Tabossi, Colombo, & Job, 1987; Tabossi & Zardon, 1993). The evidence for this comes from priming experiments (e.g., Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979; Tanenhaus et al., 1979), with eye-tracking data providing support for this position (e.g., Duffy et al., 1988; Rayner & Duffy, 1986).

A series of papers by Rayner and colleagues suggested that nouns with two meanings of approximately equal frequency (i.e., balanced nouns) cause processing difficulty relative to unambiguous nouns when they are read in neutral contexts (Duffy et al., 1988; Rayner & Duffy, 1986; Sereno, Pacht, & Rayner, 1992). This finding suggests that both meanings are accessed, and that the language processor then has to conduct a time-consuming selection process involving competition between the meanings. According to this account, competition emerges as the meanings are accessed. This selection is, in effect, a decision to adopt a single meaning at this point. For nouns, this selection appears to occur very quickly, as difficulty with balanced words appears as soon as the word is encountered. We call this the assumption of immediate resolution.

Researchers agree that the frequency of the intended meaning of an ambiguity affects processing. In neutral contexts, the more-frequent meaning starts to accrue activation and is accessed before the less-frequent meaning (e.g., Seidenberg et al., 1982; Simpson & Burgess, 1988). In accord with this, Rayner and Duffy (1986) found that biased nouns in neutral contexts were no harder to process than unambiguous controls. This fact is straightforwardly explained as follows: The dominant meaning becomes available before the subordinate meaning, and the processor decides to adopt the first meaning it is presented with. This process again amounts to the assumption of immediate resolution. Hence, there is no competition in such cases.

Balanced nouns do not cause processing difficulty in preceding disambiguating contexts. Biased nouns, in contrast, are difficult when context supports the subordinate meaning (Duffy et al., 1988; Pacht & Rayner, 1993; Rayner, Pacht, & Duffy, 1994). Duffy et al. (1988) explained this so-called subordinate bias effect by proposing the reordered access account, whereby context can boost the availability of the subordinate meaning so that it is accessed at the same time as the dominant (but contextually unsupported) meaning. However, their explanation also makes the assumption of immediate resolution. As with balanced nouns in neutral contexts, the two simultaneously active meanings immediately compete, and hence the choice of the subordinate meaning is slowed.

It should be clear that the reordered access model makes two separate assumptions, the first concerned with the time-course of activation and access and the second concerned with the resolution of any ambiguity. However, we have already noted that immediate

choice of meaning may be more likely to occur with nouns than with verbs. If so, it may be that verb ambiguities need not involve immediate resolution.

There are a number of reasons to suspect that ambiguities involving verbs behave differently than noun–noun ambiguities. For example, Frazier and Rayner (1987) studied noun–verb ambiguities, such as *trains* (in *The desert trains soldiers to be tough* vs. *The desert trains could resupply the camp*), and proposed a delay mechanism for this type of ambiguity in which both the noun and verb meaning are accessed in parallel but no selection is made until more information has been processed (though cf. MacDonald, 1993, for a different account). Additional evidence that noun–verb ambiguities are not immediately resolved comes from priming experiments by Seidenberg et al. (1982). Although the appropriate meaning of a noun–noun ambiguity was selected within 200 ms, multiple activation was still apparent at that stage for noun–verb ambiguities, such as *rose* (as in *He bought a rose* vs. *They all rose*). Hence, noun–verb ambiguities do not seem to be resolved as quickly as noun–noun ambiguities. Seidenberg et al. proposed that this delay in resolution is due to the cross-categorical nature of the ambiguity. However, an alternative possibility is that the delay is due to inherent properties of verbs.

In general, the interpretation of a verb is highly dependent on the arguments with which it combines in a particular sentence. For example, the verb *open* has different interpretations in the phrases *open the door*, *open the bottle*, and *open the file*. For transitive verbs, the verb's object or objects normally constitute the phrases that immediately follow the verb (at least in English), and these phrases generally disambiguate the verb. Hence, there is good reason that the processor might delay interpretation of a verb until most or all of its arguments are encountered (see Frazier & Rayner, 1987, for a similar argument). This situation contrasts with nouns: Their interpretations are not dependent on syntactic combinations to the same extent (perhaps because most nouns do not take arguments), and information that disambiguates a noun can be greatly delayed, occurring for example in a subsequent clause (as in, e.g., Frazier & Rayner, 1990).

A reason to expect this difference between nouns and verbs is that verb interpretations seem to be more malleable than noun interpretations (Gentner, 1981, 1982; Gentner & France, 1988; Maratsos, 1991). This malleability means that when semantic adjustments are necessary in order to interpret sentences, verbs get adjusted more than nouns. Gentner and France argued that this situation occurs because nouns have more internal cohesiveness than verbs and because verbs serve as operators over the referents established by the nouns, thereby making verbs the central element in achieving semantic coherence between the different parts of the sentence.

Another type of reason to expect delays with respect to the disambiguation of verbs (as compared with nouns) is a range of different sources of evidence that suggests that, in English, verbs are psychologically more complex and therefore more difficult to process than nouns. For instance, verbs are acquired later in development than nouns (Gentner, 1982; Landau & Gleitman, 1985; see Pinker, 1989, though some other languages are different: Choi & Gopnik, 1995; Tardiff, 1996). Also, young children use verbs less productively than nouns (Tomasello, Akhtar, Dodson, & Rekau, 1997). In addition, E. V. Clark (1993) argued that most innovative verbs (in English at least) appear to be derived from

nouns, whereas early innovative nouns are most often noun–noun compounds; this suggests that nouns are more basic than verbs. In memory tasks, nouns are better recalled than verbs (e.g., Engelkamp, 1989; Engelkamp, Zimmer, & Mohr, 1990; Helstrup, 1989; Reynolds & Flagg, 1976). Aphasic patients often have more difficulties in producing verbs than nouns (Bastiaanse & Jonkers, 1998; Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser & Berndt, 1990; see also Breedin, Saffran, & Schwartz, 1998) or tend to omit the verb component of verb–noun compounds (Semenza, Luzzatti, & Carabelli, 1997; see also Shelton & Caramazza, 1999, for discussion). Some more direct evidence is that verbs appear to take longer to process than nouns when frequency is controlled (Rayner, 1977). These considerations suggest that the delays found with noun–verb ambiguities may be at least partly due to the difficulty with verbs (and not entirely due to difficulties with cross-categorical ambiguity resolution). If this is the case, we expect delayed resolution of verb–verb ambiguities.

Such a delay would have a very interesting implication for the role of relative frequency in meaning selection. Recall that more-frequent meanings are activated faster than less-frequent meanings in neutral contexts. If immediate resolution holds, the more-frequent meaning is normally selected because it is the only one available (i.e., it is the only one reaching threshold level). But if resolution is delayed, the less-frequent meaning also has time to reach a high level of activation and be accessed. Thus, delayed resolution makes two predictions. First, competition between the meanings should occur later when resolution is delayed than when it is immediate. Second, fairly large differences in frequency will not play a major role in the process of ambiguity resolution, because both meanings will have been accessed. Thus, we can make two predictions about the resolution of verb–verb meaning ambiguities. Disambiguating context should facilitate processing in comparison with neutral context, but at a later stage than in the case of noun–noun meaning ambiguities. In addition, the behavior of biased verb–verb meaning ambiguities should be more similar to balanced meaning ambiguities during resolution.

Frequency of meanings, however, may play two rather different roles in processing. So far we have considered its impact on ambiguity resolution with respect to the time-course of meaning activation. However, it may also have a role in later stages of integration. For example, Rayner et al. (1994) and Binder and Rayner (1998) were unable to make context facilitate the processing of the subordinate meaning of a biased noun when the noun was initially fixated (see also Rayner, Binder, & Duffy, 1999). In other words, they found that the subordinate bias was robust (though cf. Martin, Vu, Kellas, & Metcalf, 1999; Kellas & Vu, 1999). In contrast, subsequent processing indicated that the contextually appropriate subordinate meaning could be facilitated later. These effects presumably reflect the process of integrating the meaning into the sentential interpretation rather than meaning selection. Likewise, when participants read texts containing the same ambiguous word used twice but with different meanings, they experienced no difficulty during initial processing but did experience difficulty later, in a manner that presumably reflects integration (Binder & Morris, 1995).

Hence, we might expect frequency effects to occur during later stages of processing, along with facilitation of processing of words in supporting versus neutral contexts. Such integrative effects would not be dependent on ambiguity resolution and should there-

fore also occur in cases where a word has two highly related senses, and the facilitatory effects of supporting context during integration should occur even when no ambiguity exists at all.

Disambiguating Verbs With Multiple Senses

Most research on lexical ambiguity resolution has considered words with two unrelated interpretations or meanings. However, this is only one source of semantic ambiguity within language. Another important case concerns words that have two related interpretations or senses. Sense ambiguity is utterly pervasive in language. Thus, it is perhaps surprising that studies of sense ambiguity are much rarer than studies of meaning ambiguity. For now, we assume that a reasonably clear distinction can be made between related and unrelated interpretations of a word. In the General Discussion section, we consider the possibility that this distinction is actually part of a continuum.

Much study of related interpretations forms part of figurative language research (e.g., Gibbs, 1994). The research suggests that the processor need not have great difficulty processing novel senses of words, so long as there is enough relevant context, and, in particular, that sense creation need not be delayed until after literal senses have been considered (H. H. Clark, 1983; H. H. Clark & Gerrig, 1983; Gerrig, 1989). In a similar manner, research on conventionalized metonymies and metaphors suggests that context may prevent there being any measurable difficulty with figurative interpretations (Frisson & Pickering, 1999; Inhoff, Lima, & Carroll, 1984; McElree & Nordlie, 1999; Onishi & Murphy, 1993; though cf. Gibbs, 1990).

Hence, the resolution of nouns with related senses may be straightforward in comparison with the resolution of nouns with unrelated meanings. Clearer support for this assumption comes from Frazier and Rayner (1990), who contrasted sense ambiguities due to concrete versus abstract distinctions (e.g., *Lying in the rain, the newspaper was destroyed* vs. *Managing advertising so badly, the newspaper was destroyed*) with meaning ambiguities. When disambiguating information followed the ambiguous word, fixation times for nouns with multiple meanings were lengthened compared with unambiguous control nouns, but fixation times for nouns with multiple senses were not. When disambiguating material occurred prior to a noun with multiple senses, there was some suggestion that readers had more difficulty with the subordinate than the dominant sense. In the absence of prior disambiguating context, Frazier and Rayner argued that readers initially use a single minimally specified meaning for words with multiple senses and do not have to perform immediate sense selection. However, when there is prior context, readers may immediately resolve sense ambiguities.

Frisson and Pickering (1999) investigated the processing of nouns in contexts that caused them to have either a literal interpretation (e.g., *walked to the school* or *hitchhiked around Vietnam*) or a metonymic one (e.g., *talked to the school* or *protested during Vietnam*). Readers experienced no difficulty with either interpretation, a finding that is difficult to reconcile with literal-first or figurative-first accounts of figurative-language processing. Frisson and Pickering suggested that a single underspecified meaning is initially accessed, and that this meaning is subsequently and incrementally refined in light of context until the appropriate sense

is obtained (though their data were also consistent with a simple parallel account).

These accounts suggest that alternative senses do not compete in the way that alternative meanings do. Even if two senses differ in frequency, there is no ordering of access of these senses. Instead, they are activated together as a single underspecified meaning. If this situation also holds for verbs with multiple senses, we would predict no early effects of context (because no immediate selection needs to be made) but instead would predict late integrative effects in such cases. To be specific, we predicted late effects of both context and frequency: facilitated processing for the dominant sense over the subordinate sense and facilitated processing for verbs that are preceded by disambiguating context over ones where the disambiguating context follows the verb (and no interaction).

Experiments

Our first goal in this experiment was to investigate the processing of verbs with multiple meanings and to determine whether it is related to the processing of nouns with multiple meanings. The above discussion suggests that resolution may be somewhat delayed for such verbs and that relative frequency should not be central to ambiguity resolution; the main impact of frequency should occur during integration. To investigate this hypothesis, we conducted an eye-tracking experiment using biased verbs, where one meaning was considerably more frequent than the other. We manipulated whether preceding context supported one or other interpretation of the verb (i.e., there was preceding disambiguating context) or was semantically neutral (in all conditions, subsequent context supported one interpretation) and whether context instantiated the dominant or the subordinate interpretation of the verb (see Table 1). As discussed above, we predicted that the effects of context would be somewhat delayed and that the two meanings should both have time to reach a high level of activation before the processor selected a particular meaning. Thus, even though the two

meanings differ greatly in frequency, they should both get activated to a high enough level for competition between the meanings to occur. In the neutral conditions, the processor should delay making a choice between the meanings and temporarily store both meanings; hence, competition should be considerable. In other words, biased verbs should behave like balanced nouns, except that the effects of competition should be somewhat delayed. During subsequent processing, the processor should find integration more straightforward in the supportive contexts, as these sentences contain additional information to discriminate the meanings. The processor may also favor the dominant meaning to some extent, as frequency is one factor that may help a decision to be made. Hence, we predicted difficulty with neutral sentences versus the supportive sentences and some signs of difficulty with the subordinate sentences versus the dominant sentences.

Our second goal was to investigate the processing of verbs with multiple senses (but one meaning). Experiment 2 used such verbs but was otherwise comparable to Experiment 1 (see Table 1). Here, our predictions were that the processor does not select between alternative senses of the verb but, rather, initially activates an underspecified meaning and subsequently homes in on the precise contextually appropriate sense for the verb. If this is correct, there should be no early effects of context. Instead, context effects and any effects of frequency should occur during integration, toward the end of the sentence and during rereading. In this experiment, the dominant sense was literal, whereas the subordinate sense was an established metaphorical sense (though we do not focus on this issue in the article; see Frisson & Pickering, *in press*). Experiment 3 simply manipulated whether preceding context was supporting or neutral for unambiguous verbs where only one sense appears to be in common use (see Table 1). We assumed that it may be possible to slightly refine the interpretation of such verbs in a context but not to alter it significantly (e.g., Geeraerts, 1993). Previous research has tended to use unambiguous words as

Table 1
Examples for Experiments 1–3

Item #	Example	Condition
Experiment 1: Verbs with multiple meanings		
1a	As he had all the power, that sultan <i>ruled</i> this very nice country as he thought best.	Supportive–dominant
1b	By using a fine artist's pencil, Max <i>ruled</i> this very nice line on all his papers.	Supportive–subordinate
1c	As there was no one to ask, Mr. Jones <i>ruled</i> this very nice country as he thought best.	Neutral–dominant
1d	As there was no one to ask, Mr. Jones <i>ruled</i> this very nice line on all his papers.	Neutral–subordinate
Experiment 2: Verbs with multiple senses		
2a	After the capture of the village, we <i>disarmed</i> almost every rebel and sent them to prison for a very long time.	Supportive–dominant
2b	With his wit and humour, the speaker <i>disarmed</i> almost every critic who was opposed to spending more money on art.	Supportive–subordinate
2c	Mr. Graham is quite certain that they <i>disarmed</i> almost every rebel and sent them to prison for a very long time.	Neutral–dominant
2d	Mr. Graham is quite certain that they <i>disarmed</i> almost every critic who was opposed to spending more money on art.	Neutral–subordinate
Experiment 3: Unambiguous verbs		
3a	When he was a police officer, Philip <i>fined</i> almost every driver on the spot until he got a ticket himself.	Supportive
3b	As everybody will remember, that man <i>fined</i> almost every driver on the spot until he got a ticket himself.	Neutral

Note. The critical verb is in italics. dominant = the sentence used the dominant interpretation of the verb; subordinate = the sentence used the subordinate interpretation of the verb; Supportive = preceding context supported this interpretation; Neutral = preceding context did not support either interpretation.

control items against which the processing of ambiguous words can be compared. However, some of these words have actually involved multiple common senses. For example, the word *tail*, which has been used as an unambiguous control item (Duffy et al., 1988), clearly has different senses, including "the tail of a plane" and "someone who watches and follows a person." The unambiguous verbs should show context effects during integration as well, and an important prediction was that context effects for unambiguous verbs should be similar to context effects for verbs with multiple senses (but delayed in comparison with verbs with multiple meanings).

Because the distinction between the different types of verbs is critical, we begin by describing the methods used to select the items (see Table 2). Three pretests examined meaning preference (to determine the dominant and subordinate interpretation of a verb), relatedness of the two interpretations (to contrast the two

types of ambiguous verbs), and strength of preceding context. The items are discussed in Experiments 1–3 below.

Pretests

Interpretation Preference

We first selected 42 verbs with multiple meanings, 42 verbs with multiple senses, and 39 unambiguous verbs on the basis of dictionary definitions (*Collins Cobuild English Language Dictionary*, 1987). We chose a particular form for each verb (present or past tense) and then divided the verbs into three lists, each with four different random orders. Seventy-two participants (with a minimum of 20 participants per verb) wrote down the first sentence that came to mind, using each verb. We determined whether each sentence used the verb on the dominant or subordinate

Table 2
Item Specifics for Experiments 1–3

Measure	Condition							
	Supp-dom		Supp-sub		Neut-dom		Neut-sub	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Clozure (%)								
MM	1.9	2.7	0.9	2.5	0.0	0.0	0.0	0.0
MS	2.7	4.3	1.3	2.8	0.0	0.0	0.0	0.0
Unambiguous	2.9	3.7	2.9	3.7	0.0	0.0	0.0	0.0
Frequency (in words per million) of verb (region 2)								
MM	2.6	3.6	2.6	3.6	2.6	3.6	2.6	3.6
MS	2.7	3.2	2.7	3.2	2.7	3.2	2.7	3.2
Unambiguous	1.3	1.5	1.3	1.5	1.3	1.5	1.3	1.5
Length (in characters) of verb (region 2)								
MM	6.1	1.4	6.1	1.4	6.1	1.4	6.1	1.4
MS	6.75	1.0	6.75	1.0	6.75	1.0	6.75	1.0
Unambiguous	6.75	1.5	6.75	1.5	6.75	1.5	6.75	1.5
Length (in characters) of intervening region (region 3)								
MM	12.5	1.8	12.5	1.8	12.5	1.8	12.5	1.8
MS	12.7	2.0	12.7	2.0	12.7	2.0	12.7	2.0
Unambiguous	12.7	2.2	12.7	2.2	12.7	2.2	12.7	2.2
Frequency (in words per million) of noun (region 4)								
MM	85.5	122.0	78.9	81.6	85.5	122.0	78.9	81.6
MS	74.8	123.0	80.1	101.8	74.8	123.0	80.1	101.8
Unambiguous	80.6	98.8	80.6	98.8	80.6	98.8	80.6	98.8
Length (in characters) of noun (region 4)								
MM	6.1	1.4	5.9	1.6	6.1	1.4	5.9	1.6
MS	5.9	1.4	6.3	1.3	5.9	1.4	6.3	1.3
Unambiguous	6.3	1.6	6.3	1.6	6.3	1.6	6.3	1.6
Length of end-of-line region (region 5)								
MM	12.4	3.3	12.2	3.6	12.4	3.3	12.2	3.6
MS	12.4	2.3	12.4	3.6	12.4	2.3	12.4	3.6
Unambiguous	12.3	2.5	12.3	2.5	12.3	2.5	12.3	2.5
Length of word preceding verb								
MM	4.5	2.4	4.4	2.1	4.4	1.7	4.4	1.7
MS	4.5	2.4	4.6	2.5	4.5	2.1	4.5	2.1
Unambiguous	4.5	2.1	4.5	2.1	4.8	3.0	4.8	3.0
Length of sentence								
MM	98.6	8.5	98.7	8.7	98.6	8.5	98.7	8.7
MS	98.4	9.3	98.2	8.9	98.4	9.3	98.2	8.9
Unambiguous	98.9	9.6	98.9	9.6	98.9	9.6	98.9	9.6

Note. dom = the sentence used the dominant interpretation of the verb; sub = the sentence used the subordinate interpretation of the verb; Supp = preceding context supported this interpretation; Neut = preceding context did not support either interpretation. MM = verbs with multiple meanings; MS = verbs with multiple senses. In some cases, the same pretest data are included in more than one column (e.g., the dominant-subordinate distinction is not relevant to unambiguous verbs, so the values in the dominant and subordinate columns are the same).

interpretation (and ignored ambiguous responses or responses that used yet another interpretation). On this basis, we selected 28 verbs with multiple meanings and 28 verbs with multiple senses that showed a clear preference for one of their meanings or senses. We reduced these to 20 verbs with multiple meanings and 20 verbs with multiple senses following the relatedness pretest described below. The dominant meaning of the verbs with multiple meanings was used 86.9% of the time ($SD = 9.8$; range = 72.7%–100%; 17.0% of the answers were discarded either because they were unclassifiable [11.8%] or used another meaning [5.2%]), and the dominant sense of the verbs with multiple senses was used 88.4% of the time ($SD = 9.1$; range = 68.2%–100%; with 7.0% of the answers discarded, of which 2.5% were unclassifiable and 5.5% used another meaning; see Appendix for each individual preference score). Note that these preferences were as large as the preferences in studies using biased ambiguous nouns (e.g., Rayner et al., 1994). In addition, we selected 20 unambiguous verbs for which the pretest demonstrated that only one interpretation was given.

Relatedness

We constructed a short sentence for the dominant and subordinate interpretations of each ambiguous verb, containing a preceding disambiguating context, a subject, the verb, and a direct object. The sentences were printed on two lines—with the dominant and subordinate interpretations occurring first equally often—and were presented in four different random orders. Twenty further participants were paid to indicate how related in meaning the two verbs were as expressed in the two sentences, using a scale ranging from 0 (*totally unrelated*) to 7 (*highly related*; see Appendix for each individual rating). The 20 verbs with multiple meanings that we selected had a mean relatedness ratio of 0.63 ($SD = .27$; range = 0.15–1.30); the 20 verbs with multiple senses that we selected had a ratio of 4.17 ($SD = .95$; range = 2.85–6.45), $t(19) = 15.96$, $p < .0001$. Thus, raters' judgments of degree of relatedness for verbs with multiple senses was much greater than for verbs with multiple meanings.

Clozure

For each verb, we wrote preceding contexts that were neutral or that supported either the dominant or subordinate interpretation. Our aim was for supportive contexts to be supportive but not predictive of the verb. Hence, we examined whether the preceding context predicted the verb. An off-line cloze task (Bloom & Fischler, 1980) was constructed in which participants had to complete sentence fragments consisting of the context up to but not including the critical verb. This task provided a cloze probability on the verb of the sentence fragments. In a first stage, each sentence fragment was completed by 10 participants (total number of participants = 30). If the completion used any form of the same verb, then 1 point was scored; if it used a verb with very similar meaning, then 0.5 of a point was scored. We rewrote any fragments with a score of more than 1.5 (out of a maximum of 10; i.e., 15%). We iterated this procedure until all fragments had a score of less than 11% (using 83 participants in total). The neutral contexts always had a cloze of 0%; the supportive contexts had cloze probabilities of less than 3% in all conditions. Thus, supportive

contexts were not predictive. With reference to the Birkbeck word association norms (Moss & Older, 1996) as well as our intuitions, we made sure that the preceding context contained no words that were strongly associated with the verb.

Strength of Context

In order to determine that our supportive and neutral contexts had the appropriate effects on the interpretation of the verb, we asked 53 further participants (a minimum of 15 per condition) to complete fragments of the experimental sentences, stopping just before the direct object (e.g., *As he had all the power, that sultan ruled this very nice . . .*). We judged whether they used the verb (here, *ruled*) on the dominant or the subordinate interpretation (or whether their responses were unclassifiable). For the verbs with multiple meanings, context supporting the dominant meaning caused the dominant meaning to be used 91.2% of the time and the subordinate meaning 2.3% of the time; context supporting the subordinate meaning caused the dominant meaning to be used 16.8% of the time and the subordinate meaning 68.1% of the time. Thus, the supporting contexts were highly effective. The neutral contexts caused the dominant meaning to be used 63.6% of the time and the subordinate meaning 11.7% of the time. This bias (81.7%) corresponded very closely to the bias found in the interpretation preference pretest (86.9%) and therefore indicated that our neutral contexts were truly neutral.

For the verbs with multiple senses, context supporting the dominant sense caused the dominant sense to be used 89.9% of the time and the subordinate sense 4.8% of the time; context supporting the subordinate sense caused the dominant sense to be used 20.8% of the time and the subordinate sense 68.7% of the time. Again, the supporting contexts were highly effective. The neutral contexts caused the dominant sense to be used 74.9% of the time and the subordinate sense 14.7% of the time. This bias (80.4%) corresponded closely to the bias found in the interpretation preference pretest (88.4%) and again indicated that our neutral contexts were truly neutral.

Experiment 1: Verbs With Multiple Meanings

Method

Participants. Forty members of the University of Glasgow community were paid to participate in the experiments. All were native English speakers, had normal uncorrected vision, and were naïve with respect to the purpose of the experiment. They had not participated in any of the pretests.

Items. Experiment 1 used 20 sets of items like 1a–1d in Table 1 (also see the Appendix). In 1a and 1c, the verb was disambiguated to the dominant meaning; in 1b and 1d, it was disambiguated to the subordinate meaning. In the supportive conditions (1a & 1b), the disambiguating context occurred both before and after the verb; in the neutral conditions (1c & 1d), it occurred only after the verb. Except for the preceding context, sentences were exactly the same in the conditions that expressed the same verb meaning. The neutral context was identical for both the dominant and subordinate meanings of the verb. Disambiguating information following the verb was contained in the head noun of the direct object (here, *country* or *line*). The words between the critical verb and the head noun were the same in all four conditions. The words in this intervening region were semantically neutral (e.g., *a number of, this very nice*) and did not disambiguate between the two meanings of a verb. We included this region to clearly distinguish effects related to the verb and effects related to the head

noun and to allow any delayed effects relating to the verb to occur before the head noun was encountered.

The head noun of the direct object was matched for length (number of letters) and frequency across conditions (Celex English Database; Baayen, Piepenbrock, & Van Rijn, 1993). Length and frequency of the head noun of the direct object, length of the intervening region and of the grammatical subject, and total sentence length were also controlled. As a further control, the character position at which the verb appeared was the same across conditions and experiments. In general, we attempted to keep the characteristics of the items as similar as possible between experiments (see Table 2), but some differences were inevitable.

Procedure. The experimental sentences were randomly assigned to four lists, with five sentences from each condition per list. Each verb appeared exactly once in each list. Each list also contained 20 items from Experiments 2 and 20 items from Experiment 3 as well as 75 further filler sentences of various types. Sentences were presented on two lines, with a maximum of 80 characters per line. The second line contained a few words only. Participants were randomly assigned to a list, and each list was read by 10 participants.

Eye movements were recorded with a Fourward Technologies Dual Purkinje Generation 5.5 Eye-Tracker. The tracker had an angular resolution of 10' arc. Viewing was binocular, but viewing position was monitored only from the right eye. A personal computer displayed the materials on a video graphics array color screen 70 cm from the participants' eyes. The tracker monitored participants' gaze location every millisecond, and the software sampled the tracker's output to establish the sequence of eye fixations and their start and finish times. Sentences were displayed in lowercase letters, except when capitals were appropriate.

Each participant was run individually. Before the experiment started, participants read a general explanation of the eye-tracking method and a set of instructions. The experimenter explained the instructions again and emphasized that sentences should be read carefully for comprehension at a normal rate. Bite bars and head restraints were used to minimize head movements. Next, the participant had to complete a calibration procedure. Before each sentence in the experiment, a calibration check was performed on five positions located on the axis of the first line of the following sentence. If the calibration check was unsatisfactory, the participant was recalibrated. Once the participant was looking at the box on the left, which coincided with the first character of the following sentence, the experimenter pressed a button and the sentence appeared. After reading the sentence, the participant pressed a button. On 50% of the trials, balanced across conditions, a comprehension question appeared (e.g., *Was the sultan restricted in his power?*). Questions made reference to various aspects of the sentences. Half of the questions required a "yes" response and half of them a "no" response (again balanced across conditions). The button for the "yes" answer was in the participant's preferred hand. No feedback was given. The experiment then proceeded to the next trial. The entire experiment lasted approximately 50 min, including two breaks of 2 min.

Analyses. An automatic procedure pooled short contiguous fixations. Fixations of less than 80 ms were incorporated into larger fixations that were within one character. Fixations less than 80 ms and not within one character space of another fixation were deleted as, presumably, readers do not extract any vital information during these short fixations (see Rayner & Pollatsek, 1989). Fixations over 1,000 ms were also excluded because these were most probably due to tracker loss. Prior to all analyses, trials with major tracker losses were excluded (0.9%) as were sentences for which the first region or two consecutive regions were skipped (1.1%). We assumed that in these cases, readers were unable to process the sentence adequately.

Regions. For the purposes of analysis, each sentence was divided into six regions, as in the following example:

2a. As he had all the power, that sultan/ruled/this very nice/country/as he thought/best.

Region 1 consisted of the preceding context, Region 2 was the critical verb itself, Region 3 was the intervening region, Region 4 consisted of the head noun of the direct object, and Region 5 consisted of the other words that were presented on the first line. Region 6 consisted of the words presented on the second line, and was omitted from the analyses.

Measures. We used four standard measures in our analyses (e.g., Rayner, Sereno, Morris, Schmauder, & Clifton, 1989). Two of these measures, first-pass time and first-pass regressions, reflect early stages of processing of a particular word or region, because they are concerned with aspects of processing that occur when the eye first fixates on a word or region. First-pass time is the sum of all fixations occurring within a region before the first fixation outside the region. If the eye fixates a point beyond the end of a region before fixating in the region for the first time, then first-pass time is 0 ms. For single-word regions, first-pass time corresponds to gaze duration (Rayner & Duffy, 1986). For this measure, following Rayner and Pollatsek (1987), we replaced 0-ms reading times by the time of the nearest fixation that fell within three character spaces to the left before the region was skipped. If there was no such fixation, but the fixation after the skip was on the first character to the right of the region, we counted that fixation instead. We assumed that such fixations were used to encode the information in the skipped region. If no fixation occurred just before or after the region, the duration remained 0. First-pass regressions are leftward eye movements that cross the region's left boundary and which immediately follow a first-pass fixation.

The other two measures are not purely concerned with the earliest stages of processing, because they pay attention to the processing of a particular word or region that occurs during rereading. Total time is the sum of all fixations within a region. It therefore reflects both initial processing time and rereading time. Second-pass time, a measure of rereading, is the sum of all fixations in a region after the eye has fixated on any region to the right of the region. The reported means and analyses of variance (ANOVAs) for first-pass and total times were based on reading times excluding 0-ms fixations. Analyses including 0-ms fixations produced almost identical results. Second-pass times included 0-ms fixations.

Results

For each measure and for each region, we subjected the data to separate 2 (context: supportive vs. neutral) \times 2 (preference: dominant vs. subordinate) ANOVAs, treating participants (F_1) and items (F_2) as random effects. For all three experiments, we report effects that approached significance by both participants and items. Mean first-pass times, first-pass regressions, second-pass times, and total times (using participant means) are shown in Table 3.

We report the measures of initial processing first (i.e., first-pass time and first-pass regressions). In general, these findings showed effects of context starting in Region 3 but much less clear effects of preference. No significant effects emerged in Region 2 (the verb). In Region 3 (the intervening region), first-pass time for sentences with a supporting context was less than for sentences with a neutral context, $F_1(1, 39) = 4.36, p < .05, MSE = 54,035$; $F_2(1, 19) = 6.78, p < .05, MSE = 28,470$. There was also a strong suggestion that participants made fewer regressions from this region in the supporting context conditions than the neutral context conditions, $F_1(1, 39) = 5.15, p < .05, MSE = 1,594$; $F_2(1, 19) = 3.65, p < .08, MSE = 758$. There were similar suggestions that first-pass times for Region 4 (the noun region) and Region 5 (the end-of-line region) were shorter in the supporting context conditions: Region 4, $F_1(1, 39) = 7.21, p < .05, MSE = 12,814$; $F_2(1, 19) = 3.12, p < .1, MSE = 6,831$, and Region 5, $F_1(1, 39) = 3.09, p < .09, MSE = 24,879$; $F_2(1, 19) = 4.75, p < .05, MSE = 15,748$.

Table 3
 Experiment 1: Mean First-Pass Times, First-Pass Regressions, Second-Pass Times, and Total Times

Variable	Condition							
	Supp-dom		Supp-sub		Neut-dom		Neut-sub	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Region 1 (preceding context)								
First-pass time (ms)	1,377.8	456.7	1,377.2	383.2	1,365.5	348.5	1,330.6	376.8
First-pass regressions (%)	—	—	—	—	—	—	—	—
Second-pass time (ms)	383.8	307.5	377.5	375.7	379.9	354.6	500.6	377.6
Total time (ms)	1,761.6	650.4	1,754.8	643.8	1,745.5	619.1	1,831.1	633.4
Region 2 (verb)								
First-pass time (ms)	316.0	83.5	328.9	100.0	302.5	63.6	314.4	82.3
First-pass regressions (%)	14.8	15.8	15.3	17.5	12.4	13.7	15.4	18.0
Second-pass time (ms)	123.0	110.3	144.1	107.5	155.7	139.1	212.0	135.9
Total time (ms)	464.9	166.2	506.2	189.1	465.3	180.8	525.3	205.4
Region 3 (intervening region)								
First-pass time (ms)	401.9	106.1	421.8	123.3	446.8	123.9	450.4	142.9
First-pass regressions (%)	19.5	18.4	19.9	22.4	23.6	19.8	28.4	19.3
Second-pass time (ms)	140.3	129.7	157.5	142.3	164.8	187.5	228.6	197.3
Total time (ms)	625.2	217.0	652.4	235.0	693.7	280.4	773.2	266.2
Region 4 (noun)								
First-pass time (ms)	288.1	61.5	259.1	58.1	299.8	63.4	283.1	67.1
First-pass regressions (%)	18.6	19.4	16.5	17.3	16.8	15.7	16.8	20.8
Second-pass time (ms)	34.4	38.3	37.1	44.9	64.9	80.2	92.9	107.2
Total time (ms)	337.7	80.9	321.0	108.5	385.3	124.6	374.5	151.6
Region 5 (end of line)								
First-pass time (ms)	402.7	140.7	421.1	144.5	425.9	155.4	447.8	156.2
First-pass regressions (%)	13.3	15.3	11.0	15.0	14.1	15.2	23.0	19.7
Second-pass time (ms)	45.3	75.1	66.5	108.1	69.3	97.2	74.6	113.9
Total time (ms)	485.3	176.0	517.0	215.2	532.2	219.7	601.4	201.6

Note. Dashes indicate that no data were available. dom = the sentence used the dominant interpretation of the verb; sub = the sentence used the subordinate interpretation of the verb; Supp = preceding context supported this interpretation; Neut = preceding context did not support either interpretation.

There were also suggestions that preference may have had some effects in these later regions. In Region 4, the subordinate meaning may have actually been read faster than the dominant meaning, $F_1(1, 39) = 5.70, p < .05, MSE = 20,939; F_2(1, 19) = 3.17, p < .1, MSE = 6,831$. In Region 5, there was an interaction, on first-pass regressions, between context and preference that was easier to interpret but that was marginal by items, $F_1(1, 39) = 5.71, p < .05, MSE = 1,238; F_2(1, 19) = 3.50, p < .08, MSE = 535$. Tests of simple effects indicated that more regressions were made in the neutral subordinate condition than each of the other conditions (all $ps < .05$), which did not differ from each other (all $F_s < 1$).

The total time and second-pass time measures demonstrated broadly distributed effects of context, with shorter reading times when there was supportive versus neutral context, and some more localized effects of preference, with shorter reading times when the verb used the dominant versus the subordinate sense immediately after the verb. For Region 2, context effects emerged on the second-pass measure, $F_1(1, 39) = 11.79, p < .01, MSE = 101,070; F_2(1, 19) = 5.62, p < .05, MSE = 48,521$. Region 3 showed a context effect on the total time measure of total time, $F_1(1, 39) = 12.64, p < .01, MSE = 358,506; F_2(1, 19) = 6.32, p < .05, MSE = 181,685$, and evidence of a preference effect on both total time, $F_1(1, 39) = 6.82, p < .05, MSE = 113,748; F_2(1, 19) = 4.23, p < .06, MSE = 53,678$, and second-pass time, $F_1(1, 39) = 3.65, p < .07, MSE = 65,468; F_2(1, 19) = 8.41, p < .01,$

$MSE = 33,621$. For Region 4, context effects emerged on both total time, $F_1(1, 39) = 8.51, p < .01, MSE = 102,187; F_2(1, 19) = 6.02, p < .05, MSE = 57,568$, and second-pass time, $F_1(1, 39) = 16.60, p < .001, MSE = 74,246; F_2(1, 19) = 7.82, p < .05, MSE = 37,270$. A similar effect occurred on total time for Region 5, $F_1(1, 39) = 11.31, p < .01, MSE = 172,377; F_2(1, 19) = 8.16, p < .05, MSE = 92,549$.

Discussion

We found context effects from first-pass time in Region 3, the region immediately following the verb, onwards. There was also some evidence for preference effects, most notably during later processing of Region 3. These results are compatible with the suggestion that the resolution of verbs with multiple meanings is delayed in comparison with the resolution of nouns with multiple meanings. We proposed that this delay in resolution would have two effects: (a) context effects that emerged slightly after the ambiguous verb and (b) little or no sign of preference affecting the process of ambiguity resolution. The context effects in Region 3 emerged as a result of a selection process between two meanings, both of which had time to reach high levels of activation before any choice between them was made. We argued that preference might affect integration, on the assumption that frequency is relevant to the ease of integrating an interpretation into the sentence

context. The late appearance of the preference effect (and the fact that it was comparatively small and localized) is compatible with this proposal. Taken together, it appears that context also has a later effect on processing: Readers make use of context to determine the exact interpretation of the sentence, and this determination is easier when the verb is used in its dominant interpretation.

Hence, the results suggest that the resolution of verb meaning ambiguity is delayed. If resolution had been immediate, we would have expected a subordinate bias effect, with increased difficulty on the verb in the supportive-subordinate condition compared with the other conditions. This pattern clearly did not emerge in our data. The results therefore provide support for the intuition that, when people encounter a fragment like *The man ruled . . .*, they do not immediately select an interpretation for *ruled* but, rather, ask a question like "What did he rule?" and await the disambiguating information that is likely to be found in the verb's argument.¹

Experiment 2: Verbs With Multiple Senses

In Experiment 2, we investigated the processing of verbs with multiple senses in order to determine whether they are processed differently than verbs with multiple meanings. In particular, we wished to investigate the claim that ambiguity resolution does not involve selecting between alternative senses. The experiment was comparable to Experiment 1 in that it used biased verbs and four conditions that manipulated whether context disambiguated the verb to the dominant or subordinate sense and whether disambiguation preceded or followed the verb.

Method

Participants and procedure. Experiment 2 was run with Experiment 1; hence, we used the same 40 participants and the same procedure.

Items. Experiment 2 used 20 sets of items like 2a–2d in Table 1 (also see the Appendix). As described earlier, verbs with multiple senses have two senses that our raters considered semantically closely related, in contrast to the two meanings of the verbs with multiple meanings of Experiment 1. (In fact, the dominant sense of the verb with multiple senses always expressed a metaphorical relationship involving a mapping from a more concrete domain [e.g., *disarming a rebel*] onto a more abstract domain [*disarming a critic*]. The metaphorical expressions used in the experiment were taken from the pretests or the dictionary.)

Results

Trials with major tracker losses were excluded (1.9%) as were sentences for which the first region or two consecutive regions were skipped (0.9%). For each measure and for each region, we subjected the data to separate 2 (context: supportive vs. neutral) \times 2 (preference: dominant vs. subordinate) ANOVAs. Mean first-pass times, first-pass regressions, second-pass times, and total times are shown in Table 4.

In this experiment, context effects were delayed as were preference effects. The measures of initial processing did not demonstrate any early effects of preference, and effects of context only emerged in Region 5. Readers produced more first-pass regressions from Region 5 when the verb was preceded by a neutral context than a supportive context, $F_1(1, 39) = 7.19, p < .05, MSE = 1,400; F_2(1, 19) = 4.91, p < .05, MSE = 894$. There was also evidence that first-pass time was longer in this region when

the context was neutral, $F_1(1, 39) = 5.07, p < .05, MSE = 41,307; F_2(1, 19) = 3.57, p < .08, MSE = 21,777$.

The measures of subsequent processing displayed both context and preference effects, with supportive contexts making processing easier than neutral contexts and dominant senses making processing easier than subordinate senses. On the second-pass time measure, effects of context emerged in Region 2, $F_1(1, 39) = 5.96, p < .05, MSE = 75,147; F_2(1, 19) = 3.20, p < .09, MSE = 43,584$; Region 3, $F_1(1, 39) = 20.89, p < .0001, MSE = 250,470; F_2(1, 19) = 32.51, p < .0001, MSE = 127,748$; and Region 4, $F_1(1, 39) = 4.80, p < .05, MSE = 17,943; F_2(1, 19) = 5.25, p < .05, MSE = 10,525$. On the total-time measure, they emerged on Region 3, $F_1(1, 39) = 8.89, p < .01, MSE = 153,121; F_2(1, 19) = 7.79, p < .05, MSE = 80,760$; Region 4, $F_1(1, 39) = 4.14, p < .05, MSE = 42,232; F_2(1, 19) = 5.21, p < .05, MSE = 28,605$; and Region 5, $F_1(1, 39) = 5.76, p < .05, MSE = 109,758, F_2(1, 19) = 5.28, p < .05, MSE = 80,438$. The second-pass time measure showed effects of preference in Region 2, $F_1(1, 39) = 7.51, p < .01, MSE = 176,998; F_2(1, 19) = 4.48, p < .05, MSE = 87,198$; Region 3, $F_1(1, 39) = 8.97, p < .01, MSE = 92,237; F_2(1, 19) = 8.36, p < .01, MSE = 47,293$; Region 4, $F_1(1, 39) = 7.07, p < .05, MSE = 34,232; F_2(1, 19) = 6.80, p < .05, MSE = 17,721$; and Region 5, $F_1(1, 39) = 4.69, p < .05, MSE = 25,814; F_2(1, 19) = 4.68, p < .05, MSE = 12,421$. On the total-time measure, the preference effect was limited to Region 2, $F_1(1, 39) = 9.03, p < .01, MSE = 365,970; F_2(1, 19) = 4.95, p < .05, MSE = 153,769$.

Discussion

Unlike verbs with multiple meanings, for which context is used quickly in order to help the selection process, verbs with multiple senses do not show rapid context effects. Instead, context effects emerged on Region 5 (the end-of-line region) during initial processing and more broadly on measures of later processing. Preference effects also did not emerge during initial processing but did occur during later processing. These two effects did not interact, indicating that the pattern of results is unrelated to a subordinate bias effect.

We explain these results in terms of the underspecification model introduced by Frisson and Pickering (1999) in relation to metonymy. On this account, the processor activates a single underspecified meaning for a verb with multiple senses and then uses evidence from context to home in on the appropriate sense. Context is not used for selecting between senses, but a constraining context is advantageous to the processor in that it helps specify a precise interpretation for the verb. The effect of preference may be

¹ The tendencies toward effects of preference during measures of initial processing, though not fully significant, may require some explanation. The tendency toward a first-pass effect on Region 4 (the head noun) in which the dominant meaning actually took longer than the subordinate meaning may well be due to differences in predictability: In the cloze task, participants completed the the supportive-dominant sentences less often with the noun used in the actual experiment (15.8%) than the supportive-subordinate sentence (21.9%). We suspect that the tendency toward an interaction in Region 5 may be of more theoretical interest, but it would be dangerous to draw strong conclusions in light of the earlier effect in Region 4.

Table 4
 Experiment 2: Mean First-Pass Times, First-Pass Regressions, Second-Pass Times, and Total Times

Variable	Condition							
	Supp-dom		Supp-sub		Neut-dom		Neut-sub	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Region 1 (preceding context)								
First-pass time (ms)	1,388.3	466.0	1,409.4	420.9	1,338.3	368.8	1,367.1	384.9
First-pass regressions (%)	—	—	—	—	—	—	—	—
Second-pass time (ms)	279.3	267.8	399.1	420.2	393.8	320.6	429.7	321.2
Total time (ms)	1,667.6	631.0	1,808.5	676.1	1,732.1	568.6	1,796.9	565.7
Region 2 (verb)								
First-pass time (ms)	323.5	80.3	336.4	113.9	315.7	77.3	349.2	109.8
First-pass regressions (%)	15.4	19.0	11.5	16.1	18.1	20.2	15.3	15.6
Second-pass time (ms)	87.6	102.4	170.6	235.8	147.4	117.2	197.4	166.1
Total time (ms)	435.2	133.1	522.4	296.9	471.1	159.9	575.2	229.6
Region 3 (intervening region)								
First-pass time (ms)	412.3	132.7	399.2	127.2	402.9	128.6	413.6	121.2
First-pass regressions (%)	18.0	17.5	18.4	19.0	22.5	16.4	14.4	17.3
Second-pass time (ms)	94.2	106.0	122.0	130.1	153.1	156.9	221.4	192.3
Total time (ms)	577.8	174.1	610.6	228.2	633.9	216.5	678.3	244.4
Region 4 (noun)								
First-pass time (ms)	286.1	51.9	290.7	62.5	298.2	67.2	293.0	74.0
First-pass regressions (%)	11.3	15.6	11.6	17.6	11.6	14.3	13.3	14.2
Second-pass time (ms)	40.5	85.7	77.8	105.8	69.8	68.0	90.9	92.5
Total time (ms)	333.2	118.8	368.8	142.7	375.6	134.9	391.4	142.8
Region 5 (end of line)								
First-pass time (ms)	410.7	141.0	413.1	165.0	437.2	152.7	450.9	173.1
First-pass regressions (%)	13.3	19.4	13.3	14.2	17.6	20.3	20.8	17.3
Second-pass time (ms)	47.6	78.9	71.8	107.4	55.4	86.3	82.1	122.1
Total time (ms)	494.9	201.2	543.2	248.8	544.5	187.9	598.2	293.3

Note. Dashes indicate that no data were available. dom = the sentence used the dominant interpretation of the verb; sub = the sentence used the subordinate interpretation of the verb; Supp = preceding context supported this interpretation; Neut = preceding context did not support either interpretation.

because the dominant sense is more frequent and because it is easier to construct a sentence interpretation using a more frequent than a less frequent sense. (It is also possible that the processor has more difficulty integrating a metaphorical sense than a literal sense, so the late effect of preference may be due to frequency, figurativeness, or a combination of the two.) However, it is very important to stress that these effects were not relevant to the initial stages of processing.

Comparisons Between Experiments 1 and 2

The items used in Experiments 1 and 2 were fairly similar in many respects (see Table 2), so we decided to conduct analyses that directly compared the results of the two experiments. However, Table 2 also shows that there were some important differences that were not completely controlled in this respect. For example, the critical verbs were 6.1 characters long in Experiment 1 versus 6.75 characters in Experiment 2. Because of this, we conducted a combined set of analyses using millisecond-per-character (ms/char) transforms on the data (except on the first-pass regressions analyses). We also conducted untransformed combined analyses and report these as well where relevant. Thus, we conducted separate 2 (experiment: verbs with multiple meanings vs. multiple senses) \times 2 (context: supportive vs. neutral) \times 2 (preference: dominant vs. subordinate) ANOVAs. Experiment was a within-participants but between-items factor. For the sake of brev-

ity, we only report effects involving the Experiment factor, though we report effects that approached significance as well as fully significant ones.

Our basic predictions were that sentences containing verbs with multiple senses should be easier than verbs with multiple meanings, and that this effect should be mainly concentrated in the neutral context conditions. Transformed first-pass times were longer for the multiple-meaning than multiple-sense conditions in Region 3: multiple meaning = 34.62 ms/char, multiple sense = 31.75 ms/char; $F_1(1, 39) = 4.94, p < .001, MSE = 658$; $F_2(1, 38) = 3.40, p < .08, MSE = 321$, and were longer by participants only in Region 2, multiple meaning = 54.19 ms/char, multiple sense = 49.90 ms/char; $F_1(1, 39) = 14.84, p < .001, MSE = 1,466$; $F_2(1, 38) = 2.32, p > .1, MSE = 779$, and Region 5, multiple meaning = 37.24 ms/char, multiple sense = 34.86 ms/char; $F_1(1, 39) = 8.48, p < .01, MSE = 453$; $F_2(1, 38) < 1$. However, the effect in Region 2 is probably spurious, as the untransformed analyses revealed the opposite pattern by participants: multiple meaning = 315.4 ms, multiple sense = 331.2 ms, $F_1(1, 39) = 4.69, p < .05, MSE = 19,868$; $F_2(1, 38) = 1.89, p > .1, MSE = 10,622$ (see Tables 3 & 4 for means). Perhaps more interesting, a marginal Type \times Context interaction in Region 3, $F_1(1, 39) = 2.90, p < .1, MSE = 179$; $F_2(1, 38) = 4.06, p < .06, MSE = 95$, supported the conclusion that supportive context specifically assisted the processing of verbs

with multiple meanings: For verbs with multiple meanings, the neutral context conditions were significantly slower, $F_1(1, 39) = 6.37, p < .05, MSE = 393$; $F_2(1, 19) = 6.99, p < .05, MSE = 202$, but no differences were found between the supporting and neutral context conditions for verbs with multiple senses, both $F_s < 1$. First-pass regressions analyses also revealed a marginal Type \times Context interaction in Region 3, $F_1(1, 39) = 3.52, p < .07, MSE = 740$; $F_2(1, 38) = 2.97, p < .1, MSE = 526$, that supported the same conclusion (with a context effect for multiple-meaning conditions that was marginal by items: $F_1[1, 39] = 7.57, p < .01, MSE = 1,594$; $F_2[1, 19] = 3.65, p < .08, MSE = 758$, but no context effect for multiple-sense conditions: both $F_s < 1$; see Tables 3 & 4 for means). Second-pass times revealed an effect of experiment on Region 2 in the transformed analyses, significant by participants only: multiple meaning = 26.99 ms/char, multiple sense = 21.70 ms/char; $F_1(1, 39) = 5.03, p < .05, MSE = 2,242$; $F_2(1, 38) = 2.04, p < .1, MSE = 1,120$; however, the effect did not occur in the untransformed analyses (multiple meaning = 158.7 ms, multiple sense = 150.8 ms; both $F_s < 1$). Total times revealed an effect of Experiment in Region 3, again significant by participants only: multiple meaning = 55.00 ms/char, multiple sense = 51.39 ms/char, $F_1(1, 39) = 6.15, p < .05, MSE = 1046$; $F_2(1, 38) < 1$ (though this pattern also occurred in the untransformed analyses). Planned comparisons between the neutral conditions in Region 3 revealed significantly longer first-pass reading times and a higher number of first-pass regressions when the verb had multiple meanings than when it had multiple senses: first pass, multiple-meaning neutral = 36.18 ms/char, multiple-sense neutral = 31.82 ms/char; $F_1(1, 39) = 12.35, p < .01, MSE = 762$; $F_2(1, 38) = 5.71, p < .05, MSE = 382$; first-pass regressions, $F_1(1, 39) = 10.93, p < .01, MSE = 2,300$; $F_2(1, 38) = 4.74, p < .05, MSE = 1,377$. The comparisons between verbs with multiple meanings and verbs with multiple senses for the supporting contexts did not reveal significant effects: first pass, multiple-meaning supporting context = 33.05 ms/char; multiple-sense supporting context = 31.68 ms/char; $F_1(1, 39) = 1.22, p > .2, MSE = 75$; $F_2(1, 38) < 1$; first-pass regressions, both $F_s < 1$. In conclusion, there is some evidence that sentences containing verbs with multiple meanings are harder to process than sentences containing verbs with multiple senses, and there is some evidence that during early processing, the effect is mainly driven by sentences with neutral contexts. The comparison of the experiments provides additional support for the distinctions between the processing of verbs with multiple meanings and verbs with multiple senses that we have drawn on the basis of the separate analyses of Experiments 1 and 2.

Experiment 3: Unambiguous Verbs

Experiment 3 simply manipulated whether preceding context was supporting or neutral for unambiguous verbs where only one sense appears to be in common use. We predicted context effects during integration, in a manner similar to that found in Experiment 2 for verbs with multiple senses.

Method

Participants and procedure. Experiment 3 was run with Experiment 1; hence, we used the same 40 participants and the same procedure.

Items. Experiment 3 used 20 pairs of items like 3a and 3b in Table 1 (also see the Appendix).

Results

Trials with major tracker losses (1.0%) and sentences for which the first region or two consecutive regions were skipped (0.6%) were excluded from the analyses. One-way ANOVAs comparing supportive and neutral contexts were run for each measure and each region. Mean first-pass times, first-pass regressions, second-pass times, and total times are shown in Table 5.

This experiment showed late effects of context only. No significant effects emerged on first-pass times or first-pass regressions. However, measures of later processing demonstrated that supportive contexts aided processing over neutral contexts. Context effects emerged in Region 2 on both second-pass time, $F_1(1, 39) = 11.29, p < .01, MSE = 136,425$; $F_2(1, 19) = 8.68, p < .01, MSE = 70,918$, and total time, $F_1(1, 39) = 18.08, p < .0001, MSE = 191,295$; $F_2(1, 19) = 4.61, p < .05, MSE = 87,528$. There was also evidence of a context effect in Region 4 on the total-time measure, $F_1(1, 39) = 3.94, p < .06, MSE = 18,215$; $F_2(1, 19) = 4.69, p < .05, MSE = 11,806$.

Table 5
Experiment 3: Mean First-Pass Times, First-Pass Regressions, Second-Pass Times, and Total Times

Variable	Condition			
	Supportive context		Neutral context	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Region 1 (preceding context)				
First-pass time (ms)	1,355.5	403.4	1,347.4	376.0
First-pass regressions (%)	—	—	—	—
Second-pass time (ms)	339.0	262.1	413.5	305.1
Total time (ms)	1,694.6	560.6	1,760.9	576.4
Region 2 (verb)				
First-pass time (ms)	330.3	84.9	331.4	78.7
First-pass regressions (%)	13.8	10.5	15.8	13.1
Second-pass time (ms)	110.6	71.9	193.2	169.7
Total time (ms)	453.8	127.6	551.6	206.9
Region 3 (intervening region)				
First-pass time (ms)	442.5	114.5	432.0	126.2
First-pass regressions (%)	20.5	13.0	26.5	16.7
Second-pass time (ms)	106.5	124.6	126.4	120.4
Total time (ms)	632.8	178.6	678.4	243.5
Region 4 (noun)				
First-pass time (ms)	273.1	46.5	286.9	55.7
First-pass regressions (%)	14.1	14.0	12.4	11.5
Second-pass time (ms)	35.9	49.9	49.8	57.6
Total time (ms)	316.7	76.5	346.9	99.4
Region 5 (end of line)				
First-pass time (ms)	414.7	141.2	418.6	130.7
First-pass regressions (%)	9.1	11.8	11.8	11.5
Second-pass time (ms)	52.5	76.0	42.1	63.8
Total time (ms)	489.1	166.4	492.9	180.3

Note. Dashes indicate that no data were available. Supportive = preceding context supported this interpretation; Neutral = preceding context did not support either interpretation.

Discussion

The results of Experiment 3 are comparable with those of Experiment 2: Context does not have an immediate effect on the interpretation of the verb, but it does play a role in later processing. In this experiment, its role must be integrative, on the assumption that the verb has only one salient interpretation. Hence, the results lend support to our claims that context is used in integration and is only used in early selection processes when the choice is between (incompatible) meanings. In this experiment, the context effects may be more restricted than in Experiment 2 (i.e., they only occur on the verb and the head noun). If this finding reflects a real difference between the experiments, it may be because the interpretation of the context was critical to determining which sense should be adopted in Experiment 2, whereas in Experiment 3, there was no need to use context to determine the appropriate sense for the verb.

General Discussion

To summarize, Experiment 1, using verbs with multiple meanings, found evidence of context effects emerging on measures of initial processing from the region immediately following the critical verb onwards. In contrast, Experiments 2 and 3 found more delayed context effects for verbs with multiple senses and unambiguous verbs, principally emerging during measures of later processing. For both types of ambiguous verbs, effects of preference emerged during later processing. These findings suggest that the resolution of ambiguous verbs is very different from the resolution of ambiguous nouns. However, they also suggest that verbs and nouns are similar in one respect—namely, that they make a fairly similar distinction between meaning and sense ambiguity.

In the introduction, we proposed that the resolution of meaning ambiguity in verbs may be delayed in comparison to nouns in English. Empirical reasons to suspect this may be the case are the evidence that verbs are harder to process, acquire, and remember than nouns and that the delays in the resolution of noun–verb ambiguities (Frazier & Rayner, 1987; Seidenberg et al., 1982) may be due to the presence of a verb interpretation. However, it would also be advantageous to delay resolution of verb ambiguities because their interpretation is so often dependent on the interpretation of their arguments (e.g., Gentner & France, 1988), and these arguments are almost always adjacent to the verb (as was the case in our experiment).

The evidence from Experiment 1 supports the conclusion that participants delayed the resolution of verbs with multiple meanings. The contrast between our findings and those for nouns is very striking. Notice that the degree of bias in our verbs is considerable, and the contexts were acceptably strong (indeed, the presence of context effects demonstrates this to be the case). If verbs with multiple meanings behaved like nouns, we would have found a quite different pattern of results, corresponding to the subordinate bias effect discussed by Duffy et al. (1988): immediate difficulty with the supportive–subordinate condition versus the other three conditions. According to Duffy et al.'s reordered access model, the dominant meaning is straightforwardly adopted in the other three conditions, because it is activated first and there is no appreciable competition from the subordinate meaning. But in the supportive–subordinate condition, both meanings are activated at approxi-

mately the same time and rate, thereby leading to competition. For verbs, however, we argue that ambiguity resolution is delayed, so that both meanings have time to reach a high level of activation. When this happens, context helps the process of ambiguity resolution. This explains the presence of the context effect, the fact that it is delayed, and the lack of an early preference effect. The late preference effect is, we argue, due to integrative processing rather than ambiguity resolution. Integrative effects also occur in the resolution of ambiguous nouns (Binder & Morris, 1995; Rayner et al., 1994), but they are not of central importance to the reordered access account.

In contrast, Experiment 2 suggests that the processing of verbs with multiple senses is broadly similar to the processing of nouns with multiple senses. Context effects emerge much later than with verbs with multiple meanings and are similar to those found with unambiguous verbs in Experiment 3; preference effects also emerge late. The comparison between Experiments 1 and 2 lends support to these conclusions.

Frisson and Pickering (1999) proposed that the processor initially uses a meaning for a noun that is underspecified with respect to whether it has a literal or a metonymic sense. On their account, the processor uses underspecified representations for at least one type of sense ambiguity. However, their results could not straightforwardly distinguish between this account and a fully specified parallel account in which both senses (as well as any other conventionalized senses) were proposed together and context selected between them. The current results provide some evidence for an underspecified account in that the parallel account would predict that competition would emerge in verbs with multiple senses just as in verbs with multiple meanings. This competition should have been realized as (fairly) early context effects, with the verbs in the neutral context being harder to process than in the supportive contexts, just as in Experiment 1. In fact, this was not the case; hence, it appears that there is no early process of sense resolution for verbs. This finding provides some evidence for the conclusion that the processor does not propose multiple separate senses in parallel but, rather, proposes one underspecified meaning. As Frisson and Pickering (1999) pointed out, there is a very good theoretical reason to believe this to be the case: The number of different senses for a word, unlike the number of meanings, is potentially infinite, and therefore it would be impossible to propose them in parallel.

We chose verbs with related meanings and verbs with related senses by selecting two discrete sets of verbs: ones where the raters claimed that the two interpretations were very closely related and ones where the raters claimed that the two senses were very distantly related. We have assumed that these two sets of verbs form examples of two distinct categories. However, it is also possible that our sets actually involve verbs from two ends of a continuum, with interpretations being more or less closely related to each other. If so, the division between meanings and senses is not an absolute one. On this account, we would predict that selecting between interpretations is graded, with more of a process of selection occurring for distantly related verbs and less occurring for more closely related verbs. For example, the processor would need to select only between features that are not shared between the interpretations. When the verbs are as closely related as in Experiment 2, the amount of selection is minimal and cannot be detected experimentally. If this account is correct, we would

predict that the size of any effects of context (in particular) would grow as the distance between interpretations increased. Such an approach is more compatible with approaches to disambiguation found in parallel distributed processing approaches (e.g., McClelland, St. John, & Taraban, 1989).

In conclusion, our results suggest that people resolve verbs with multiple meanings in a very different way from nouns. Instead of immediately adopting a meaning on the basis of context and frequency information, people are prepared to delay the interpretation of verbs and resolve them in light of subsequent as well as preceding context. We suggest that different meanings are given time to reach a high level of activation before selection need occur, thereby reducing or eliminating early effects of frequency. In contrast, the processor does not appear to select between different senses of a verb but, rather, proposes a single underspecified meaning and then uses context and frequency information to home in on the contextually appropriate sense.

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Appendix

Experimental Items

For each item, the dominant meaning or sense of the verb preceded by a supportive context comes first, followed by the subordinate meaning or sense preceded by a supportive context, followed by the dominant meaning or sense in a neutral context, followed by the subordinate meaning or sense in a neutral context. For Experiment 3, each item appears in two conditions: preceded by a supportive or a neutral context, respectively. The “/” marks delimit the regions of analysis. The final “/” mark also indicates the line break. After the first version of each item, the percentage of responses using the dominant meaning or sense of the verb (of the classifiable answers) is given before the semicolon; the degree of relatedness is given after the semicolon, using a scale ranging from 0 (*totally unrelated*) to 7 (*highly related*).

Experiment 1: Verbs With Multiple Meanings

As he had all the power, that sultan/ ruled/ this very nice/ country/ as he thought/ best. (90.9%; 0.8)

By using a fine artist's pencil, Max/ ruled/ this very nice/ line/ on all his papers.

As there was no one to ask, Mr Jones/ ruled/ this very nice/ country/ as he thought/ best.

As there was no one to ask, Mr Jones/ ruled/ this very nice/ line/ on all his papers.

Because he waffled all the time, Sam/ bored/ a couple of/ guests/ enormously at the/ reception last Thursday. (83.3%; 0.35)

(Appendix continues)

In order to hang up the speakers, we/ bored/ a couple of/ holes/ in the wall of the/ living room last night. It was indeed Fiona who said that Al/ bored/ a couple of/ guests/ enormously at the/ reception last Thursday. It was indeed Fiona who said that Al/ bored/ a couple of/ holes/ in the wall of the/ living room last night.

Because he is always depressed, Gary/ affects/ a number of/ friends/ and makes them/ feel bad themselves. (100%; 0.9)

Whenever he imitates a character, Al/ affects/ a number of/ voices/ but never/ gets the exact right accent.

Someone explained to me once that Al/ affects/ a number of/ friends/ and makes/ them feel bad themselves.

Someone explained to me once that Al/ affects/ a number of/ voices/ but never/ gets the exact right accent.

As it hadn't drunk anything, the dog/ lapped/ most of the/ water/ in a few seconds/ without paying attention to anybody. (89.5%; 0.15)

Because he ran so fast, that athlete/ lapped/ most of the/ runners/ in the race/ that was held at the university track.

While they were all watching him, he/ lapped/ most of the/ water/ in a few seconds/ without paying attention to anybody.

While they were all watching him, he/ lapped/ most of the/ runners/ in the race/ that was held at the university track.

After finding his notebook, Mr Young/ penned/ a number of/ letters/ to his children/ who live in Australia. (72.7%; 0.3)

To stop them escaping, those farmers/ penned/ a number of/ sheep/ into the old barn/ somewhere up that hill.

My neighbours told me that Mr MacKay/ penned/ a number of/ letters/ to his children/ who live in Australia.

My neighbours told me that Mr MacKay/ penned/ a number of/ sheep/ into the old barn/ somewhere up that hill.

Before we put them on, the shoemaker/ laces/ the majority of the/ boots/ that were/ our size. (87.5%; 0.45)

When she makes Irish coffee, Mrs Lee/ laces/ the majority of the/ drinks/ with too/ much whiskey.

First he clears the table, then Gary/ laces/ the majority of the/ boots/ that were/ our size.

First he clears the table, then Gary/ laces/ the majority of the/ drinks/ with too/ much whiskey.

Out in the open sea, those fishermen/ cast/ plenty of/ nets/ in the deep blue/ waters and caught a lot of tuna. (72.7%; 0.9)

Before making the film, the producer/ cast/ plenty of/ actors/ for both the/ supporting and the leading roles.

It was a beautiful morning when Mark/ cast/ plenty of/ nets/ in the deep blue/ waters and caught a lot of tuna.

It was a beautiful morning when Mark/ cast/ plenty of/ actors/ for both the/ supporting and the leading roles.

When he had to pay, that stingy boss/ billed/ his very own/ company/ for all the/ expenses he had made. (89.5%; 0.6)

In this advertisement, that magician/ billed/ his very own/ performance/ as the/ greatest in the world.

You can believe it or not, but Keith/ billed/ his very own/ company/ for all the/ expenses he had made.

You can believe it or not, but Keith/ billed/ his very own/ performance/ as the/ greatest in the world.

Whenever she goes to an auction, Eve/ bids/ quite a lot of/ cash/ for every old/ porcelain doll. (72.2%; 0.5)

Every time she goes abroad, Mrs Gray/ bids/ quite a lot of/ friends/ farewell at/ the airport.

Everybody must know by now that Jill/ bids/ quite a lot of/ cash/ for every old/ porcelain doll.

Everybody must know by now that Jill/ bids/ quite a lot of/ friends/ farewell at/ the airport.

Because it was very dark, the artist/ plugged/ over half of his/ lamps/ into their/ sockets. (88.2%; 0.9)

On the famous TV chat show, Mr Bloom/ plugged/ over half of his/ books/ as often as/ he could.

After he had lit his cigar, Jonathan/ plugged/ over half of his/ lamps/ into their/ sockets.

After he had lit his cigar, Jonathan/ plugged/ over half of his/ books/ as often as/ he could.

Being a scrupulous secretary, Claire/ files/ not only the/ documents/ but even/ every handwritten note. (100%; 0.5)

Being a well-trained manicurist, she/ files/ not only the/ nails/ of women but also/ of men and children.

Being one of the best employees, Ann/ files/ not only the/ documents/ but even/ every handwritten note.

Being one of the best employees, Ann/ files/ not only the/ nails/ of women but also/ of men and children.

These really self-satisfied teachers/ patronise/ at least some/ students/ of the/ first and second year. (95.5%; 0.8)

Whenever we go for a pint, we always/ patronise/ at least some/ bars/ near to the/ University of Glasgow.

I know a couple of people who always/ patronise/ at least some/ students/ of the/ first and second year.

I know a couple of people who always/ patronise/ at least some/ bars/ near to the/ University of Glasgow.

To know more about eating habits, we/ conducted/ a part of the/ survey/ for the/ Scottish Health board. (84.2%; 0.5)

When Ed was repairing the pylons, he/ conducted/ a part of the/ energy/ along these/ very fine red wires.

I was watching him closely when Will/ conducted/ a part of the/ survey/ for the/ Scottish Health board.

I was watching him closely when Will/ conducted/ a part of the/ energy/ along these/ very fine red wires.

At the latest rehearsal, the drummer/ tapped/ almost all the/ rhythms/ while the/ trumpet players were watching. (78.3%; 0.6)

During the Watergate affair, FBI men/ tapped/ almost all the/ phones/ of those/ journalists who were too critical.

First they smoked a cigar, then they/ tapped/ almost all the/ rhythms/ while the/ trumpet players were watching.

First they smoked a cigar, then they/ tapped/ almost all the/ phones/ of those/ journalists who were too critical.

Because none of them had an alibi, I/ charged/ the troublesome/ gang/ with murder/ in the first degree. (92.3%; 0.4)

Because his Jaguar didn't start, Joe/ charged/ the troublesome/ battery/ with this/ electrical gadget.

While Mr Craig was watching, someone/ charged/ the troublesome/ gang/ with murder/ in the first degree.

While Mr Craig was watching, someone/ charged/ the troublesome/ battery/ with this/ electrical gadget.

Being faced with the witnesses, they/ admit/ not only the/ theft/ at the diamond/ store but also a kidnapping. (96.2%; 0.9)

Being the doorkeepers of the bar, we/ admit/ not only the/ students/ but almost/ anyone who gives us money.

Maybe I haven't told you yet, but we/ admit/ not only the/ theft/ at the diamond/ store but also a kidnapping.

Maybe I haven't told you yet, but we/ admit/ not only the/ students/ but almost/ anyone who gives us money.

Andy's hand trembles so much that he/ dribbles/ most of his/ drinks/ over the/ kitchen floor. (77.3%; 0.8)

As he is a great footballer, Raymond/ dribbles/ most of the/ balls/ past the/ opposing defence.

I hope you can see now how Mr Turner/ dribbles/ most of his/ drinks/ over

the/ kitchen floor.

I hope you can see now how Mr Turner/ dribbles/ most of the/ balls/ past the/ opposing defence.

When Andy was searching for gold, he/ mined/ a part of this/ coal-pit/ from top to/ bottom. (95.8%; 1.3)

Booby-traps injured many as the army/ mined/ a part of this/ road/ heavily in the/ last war.

If this report is correct, then they/ mined/ a part of this/ coal-pit/ from top to/ bottom.

If this report is correct, then they/ mined/ a part of this/ road/ heavily in the/ last war.

As Christianity was suppressed, they/ stoned/ most of the/ priests/ to death in/ ancient Rome. (100%; 0.7)

You can eat the cherries now as Kate/ stoned/ most of the/ fruit/ and washed them/ as well.

It was on a warm afternoon when they/ stoned/ most of the/ priests/ to death in/ ancient Rome.

It was on a warm afternoon when they/ stoned/ most of the/ fruit/ and washed them/ as well.

Once safe inside the harbour, Mr Lee/ docked/ the enormous/ yacht/ against one of/ the piers. (72.7%; 0.4)

Due to economic recession, that boss/ docked/ the enormous/ wages/ of some of his/ salesmen.

As everybody had expected, Mr Gibson/ docked/ the enormous/ yacht/ against one of/ the piers.

As everybody had expected, Mr Gibson/ docked/ the enormous/ wages/ of some of his/ salesmen.

Experiment 2: Verbs With Multiple Senses

Too many of those physical exercises/ weaken/ most of your/ body/ rather than/ strengthen it. (68.2%; 4.8)

I told you that my counter-arguments/ weaken/ most of your/ points/ to a very large/ extent.

As she told Mrs Duncan, these things/ weaken/ most of your/ body/ rather than/ strengthen it.

As she told Mrs Duncan, these things/ weaken/ most of your/ points/ to a very large/ extent.

In order to spy on the enemy, Russia/ launched/ a couple of/ satellites/ into the/ sky. (90.9%; 4.4)

In order to sell more, the companies/ launched/ a couple of/ goods/ on the food/ market.

Over six days have passed since they/ launched/ a couple of/ satellites/ into the/ sky.

Over six days have passed since they/ launched/ a couple of/ goods/ on the food/ market.

When the queen arrived, this officer/ paraded/ some of his/ troops/ in front of an/ invited audience. (84.0%; 3.6)

Because Jim was extremely bright, he/ paraded/ some of his/ wisdom/ on quite a few/ different occasions.

After Ed was given the promotion, he/ paraded/ some of his/ troops/ in front of an/ invited audience.

After Ed was given the promotion, he/ paraded/ some of his/ wisdom/ on quite a few/ different occasions.

When he worked in a circus, that man/ tamed/ his very nasty/ lions/ with

a whole/ lot of patience and skill. (95.7%; 5.9)

Although he was very angry, that man/ tamed/ his very nasty/ temper/ and remained/ remarkably calm to the end.

When he was working in Italy, Robert/ tamed/ his very nasty/ lions/ with a whole/ lot of patience and skill.

When he was working in Italy, Robert/ tamed/ his very nasty/ temper/ and remained/ remarkably calm to the end.

When she was laying the table, Karen/ wiped/ those very nice/ plates/ that were/ still a bit damp. (85.7%; 4.0)

Because Jo wanted to forget him, she/ wiped/ those very nice/ memories/ of Jack/ out of her mind.

Somebody told me yesterday that Mary/ wiped/ those very nice/ plates/ that were/ still a bit damp.

Somebody told me yesterday that Mary/ wiped/ those very nice/ memories/ of Jack/ out of her mind.

After the terrible car accident, Amy/ buried/ all of her/ family/ in the communal/ graveyard. (92.3%; 3.8)

Being too ashamed to admit it, Jenny/ buried/ all of her/ face/ very quickly in her/ hands.

Having noticed what had happened, Jo/ buried/ all of her/ family/ in the communal/ graveyard.

Having noticed what had happened, Jo/ buried/ all of her/ face/ very quickly in her/ hands.

When Mrs Pitt worked in Safeway, she/ labelled/ many of the/ bottles/ for days on/ end until she quit her job. (68.2%; 4.5)

Everyone says Sue is a Tory, but Ian/ labelled/ many of her/ ideas/ about tax cuts/ as rather progressive.

I know you won't believe it, but Sue/ labelled/ many of the/ bottles/ for days on/ end until she quit her job.

I know you won't believe it, but Ian/ labelled/ many of her/ ideas/ about tax cuts/ as rather progressive.

After the capture of the village, we/ disarmed/ almost every/ rebel/ and sent them/ to prison for a very long time. (87.5%; 3.7)

With his wit and humour, the speaker/ disarmed/ almost every/ critic/ who was/ opposed to spending more money on art.

Mr Graham is quite certain that they/ disarmed/ almost every/ rebel/ and sent them/ to prison for a very long time.

Mr Graham is quite certain that they/ disarmed/ almost every/ critic/ who was/ opposed to spending more money on art.

Because she has a loom herself, Gail/ weaves/ some remarkable/ rugs/ every other/ weekend and gives them to her brother. (94.1%; 3.0)

Being a talented crime writer, Tracy/ weaves/ some remarkable/ plots/ in all her/ books and makes good money that way.

Malcolm praised her once because she/ weaves/ some remarkable/ rugs/ every other/ weekend and gives them to her brother.

Malcolm praised her once because she/ weaves/ some remarkable/ plots/ in all her/ books and makes good money that way.

Last Saturday, Claire ironed while I/ cleaned/ the whole of the/ kitchen/ from top/ to bottom. (95.7%; 4.6)

Because Joseph had obscene lusts, he/ cleaned/ the whole of his/ thoughts/ with a/ lot of prayers.

While his wife was reading, Alastair/ cleaned/ the whole of the/ kitchen/ from top/ to bottom.

While his wife was reading, Alastair/ cleaned/ the whole of his/ thoughts/ with a/ lot of prayers.

(Appendix continues)

To protect them from going bad, they/ conserve/ plenty of the/ onions/ by pickling/ them thoroughly. (87.0%; 4.3)

By adopting this restrictive law, we/ conserve/ plenty of the/ rights/ of the upper/ class once again.

Mrs Haig has often told us that they/ conserve/ plenty of the/ onions/ by pickling/ them thoroughly.

Mrs Haig has often told us that they/ conserve/ plenty of the/ rights/ of the upper/ class once again.

As the man had become impotent, they/ adopted/ that charming/ child/ from Brazil/ and also a girl from Bangladesh. (78.3%; 3.5)

She always spoke so well because she/ adopted/ that charming/ accent/ of the Queen/ and also the use of long words.

When she was living in Bristol, Kate/ adopted/ that charming/ child/ from Brazil/ and also a girl from Bangladesh.

When she was living in Bristol, Kate/ adopted/ that charming/ accent/ of the Queen/ and also the use of long words.

When she worked at the farm, Theresa/ milked/ almost all/ goats/ every morning/ before seven o'clock. (90.9%; 3.0)

The senator was so pragmatic that he/ milked/ almost all/ events/ to the full and/ became very rich.

When he was living in Yorkshire, Don/ milked/ almost all/ goats/ every morning/ before seven o'clock.

When he was living in Yorkshire, Don/ milked/ almost all/ events/ to the full and/ became very rich.

It smells so nice here because Sally/ scented/ all possible/ rooms/ with some rose/ oil. (100%; 2.9)

As she was easily frightened, Janice/ scented/ all possible/ dangers/ wherever she/ looked.

As her husband was telling us, Dolly/ scented/ all possible/ rooms/ with some rose/ oil.

As her husband was telling us, Dolly/ scented/ all possible/ dangers/ everywhere/ she looked.

Because he is of Austrian origin, Al/ climbs/ the well-known/ ridge/ like a real/ mountaineer. (95.8%; 4.8)

By marrying the next king, Lady Jane/ climbs/ the well-known/ hierarchy/ of Great/ Britain.

It has been noted before that George/ climbs/ the well-known/ ridge/ like a real/ mountaineer.

It has been noted before that George/ climbs/ the well-known/ hierarchy/ of Great/ Britain.

In Japan, the very severe earthquake/ ruined/ over half of the/ suburbs/ of the/ city in less than a minute. (94.7%; 5.1)

They know that the Wall Street Crash/ ruined/ over half of the/ brokers/ who placed/ their money in shares.

Dominic told me that the catastrophe/ ruined/ over half of the/ suburbs/ of the/ city in less than a minute.

Dominic told me that the catastrophe/ ruined/ over half of the/ brokers/ who placed/ their money in shares.

Having missed the last lecture, Eric/ copied/ a number of/ sheets/ from a junior/ honours student in psychology. (90.5%; 6.5)

As Eric liked her way of dancing, he/ copied/ a number of/ steps/ that Amy usually/ makes when she dances.

As he had been away for a week, Eric/ copied/ a number of/ sheets/ from a junior/ honours student in psychology.

As he had been away for a week, Eric/ copied/ a number of/ steps/ that Amy usually/ makes when she dances.

To get ready for an exhibition, Dali/ sketched/ the rest of the/ model/ with a few/ quick lines. (96.2%; 3.2)

In the second chapter, Graham Greene/ sketched/ the rest of the/ history/ of the/ hero in the book.

Having made herself comfortable, Ann/ sketched/ the rest of the/ model/ with a few/ quick lines.

Having made herself comfortable, Ann/ sketched/ the rest of the/ history/ of the/ hero in the book.

As they are all still young, Mrs Kay/ dresses/ all of the/ infants/ while she is at/ the nursery. (95.5%; 4.4)

Because Harry has been shot, a nurse/ dresses/ all of the/ wounds/ and only then/ calls a doctor.

They informed my wife that Miss Hall/ dresses/ all of the/ infants/ while she is at/ the nursery.

They informed my wife that Miss Hall/ dresses/ all of the/ wounds/ and only then/ calls a doctor.

As he is interested in insects, Dick/ captures/ every single/ beetle/ that he/ notices flying around. (77.3%; 3.6)

The film *The Commitments* correctly/ captures/ every single/ problem/ of a rock/ band in Ireland.

It is remarkable to see how that man/ captures/ every single/ beetle/ that he/ notices flying around.

It is remarkable to see how that man/ captures/ every single/ problem/ of a rock/ band in Ireland.

Experiment 3: Unambiguous Verbs

When he was a police officer, Philip/ fined/ almost every/ driver/ on the spot/ until he got a ticket himself.

As everybody will remember, that man/ fined/ almost every/ driver/ on the spot/ until he got a ticket himself.

For some documentaries, Attenborough/ filmed/ some remarkable/ tribes/ in the South/ American forest.

After he had left Canada, Mr Davison/ filmed/ some remarkable/ tribes/ in the South/ American forest.

When they turn up far too late, they/ enrage/ almost all/ teachers/ with their very/ childish behaviour.

Some of them find it funny when they/ enrage/ almost all/ teachers/ with their very/ childish behaviour.

Because of the riots, that policeman/ patrols/ this very large/ area/ every night/ of the week.

Because it is part of his work, Hugh/ patrols/ this very large/ area/ every night/ of the week.

When he was playing in the park, Ted/ dirtied/ almost all of his/ clothes/ and was/ afraid to go back home.

As his mother told us yesterday, Ted/ dirtied/ almost all of his/ clothes/ and was/ afraid to go back home.

Being very well trained, my labrador/ obeyed/ most of the/ commands/ that I gave/ him.

I do not want to boast but he really/ obeyed/ most of the/ commands/ that I gave/ him.

By being so eloquent and witty, Kate/ fascinated/ an entire/ audience/ of well over/ 300 people.

We had not expected it, but Geoffrey/ fascinated/ an entire/ audience/ of well over/ 300 people.

To get the ban lifted, Great Britain/ vetoed/ every single/ proposal/ that was/ discussed in the European Parliament.

Eve read in the newspapers that they/ vetoed/ every single/ proposal/ that was/ discussed in the European Parliament.

By being so arrogant and haughty, Al/ angers/ a whole lot of/ customers/ who come/ to him for advice.

I don't know him, but apparently, Al/ angers/ a whole lot of/ customers/ who come/ to him for advice.

The Scandinavian fishermen illegally/ harpooned/ a couple of/ whales/ just off the/ Japanese coast.

As we heard on television, those men/ harpooned/ a couple of/ whales/ just off the/ Japanese coast.

By pressing that red button, the man/ activated/ the well-designed/ timer/ that was/ connected to the bomb.

When nobody was looking at him, Ewan/ activated/ the well-designed/ timer/ that was/ connected to the bomb.

After preparing it himself, the cook/ ladled/ a lot of the/ pudding/ into our large/ bowls.

We were all waiting for it when Glen/ ladled/ a lot of the/ pudding/ into our large/ bowls.

Because of the constant fighting, we/ fled/ that beautiful/ country/ to another/ state.

It is really sad that lots of people/ fled/ that beautiful/ country/ to another/ state.

After he picked up the receiver, Greg/ phoned/ some of his/ friends/ to make a new/ arrangement for Monday.

We thought it was normal that Steven/ phoned/ some of his/ friends/ to make a new/ arrangement for Monday.

Three options were given, and Gloria/ selected/ not only the/ answer/ that was/ wrong, but also crossed out the others.

I felt pity when I heard that Gloria/ selected/ not only the/ answer/ that was/ wrong, but also crossed out the others.

Whenever she bakes a cake, Mrs Clark/ greases/ a part of the/ bowl/ with far too/ much butter.

Because she is told to do so, Claire/ greases/ a part of the/ bowl/ with far too/ much butter.

Jim went to the post office where he/ mailed/ quite a few/ parcels/ to his mother/ for her birthday.

After he had gone shopping, Alastair/ mailed/ quite a few/ parcels/ to his mother/ for her birthday.

Because it didn't fit her anymore, I/ altered/ the expensive/ robe/ and nobody was/ allowed to know it.

Do not tell anyone else this, but he/ altered/ the expensive/ robe/ and nobody was/ allowed to know it.

Because Liz failed her exams, Mr Lee/ tutors/ this very lazy/ girl/ every other day/ of the week.

It was no surprise to hear that Ewan/ tutors/ this very lazy/ girl/ every other day/ of the week.

As he hadn't worked during summer, I/ financed/ over half of his/ trip/ to Ireland/ but he'll pay me back.

Mr Forster must have told you that I/ financed/ over half of his/ trip/ to Ireland/ but he'll pay me back.

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If you are interested in reviewing manuscripts for APA journals, the APA Publications and Communications Board would like to invite your participation. Manuscript reviewers are vital to the publications process. As a reviewer, you would gain valuable experience in publishing. The P&C Board is particularly interested in encouraging members of underrepresented groups to participate more in this process.

If you are interested in reviewing manuscripts, please write to Demarie Jackson at the address below. Please note the following important points:

- To be selected as a reviewer, you must have published articles in peer-reviewed journals. The experience of publishing provides a reviewer with the basis for preparing a thorough, objective review.
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- Reviewing a manuscript takes time (1–4 hours per manuscript reviewed). If you are selected to review a manuscript, be prepared to invest the necessary time to evaluate the manuscript thoroughly.

Write to Demarie Jackson, Journals Office, American Psychological Association, 750 First Street, NE, Washington, DC 20002-4242.