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The Processing of Metonymy: Evidence From Eye Movements

Steven Frisson
University of Glasgow and University of Antwerp–Ufsia

Martin J. Pickering
University of Glasgow

The authors investigated the time course of the processing of metonymic expressions in comparison with literal ones in 2 eye-tracking experiments. Experiment 1 considered the processing of sentences containing place-for-institution metonymies such as *the convent* in *That blasphemous woman had to answer to the convent;* it was found that such expressions were of similar difficulty to sentences containing literal interpretations of the same expressions. In contrast, expressions without a relevant metonymic interpretation caused immediate difficulty. Experiment 2 found similar results for place-for-event metonymies such as *A lot of Americans protested during Vietnam,* except that the difficulty with expressions without a relevant metonymic interpretation was somewhat delayed. The authors argue that these findings are incompatible with models of figurative language processing in which either the literal sense is accessed first or the figurative sense is accessed first. Instead, they support an account in which both senses can be accessed immediately, perhaps through a single underspecified representation.

A great deal of psycholinguistic work has explored the processing of aspects of figurative language such as metaphor and idioms (e.g., Cacciari & Glucksberg, 1994; Gibbs, 1994). However, surprisingly little is actually known about the details of the time course of its processing. Many experiments rely on reaction times for entire sentences or large sentence fragments, which means that they may well miss early effects (e.g., Gerrig, 1989; Gibbs, 1990; Gibbs, Bogdanovich, Sykes, & Barr, 1997; Gibbs, Nayak, & Cutting, 1989; Glucksberg, McGlone, & Manfredi, 1997; Keysar, 1989; Onishi & Murphy, 1993; Ortony, Schallert, Reynolds, & Antos, 1978; Schraw, 1995; Shinjo & Myers, 1987). Other experiments use tasks that relate to on-line processing in an indirect manner at best, such as asking participants to determine whether a sentence is true or acceptable (e.g., Gildea & Glucksberg, 1983; Glucksberg, Gildea, & Bookin, 1982; Keysar, 1989; Swinney & Cutler, 1979) or simply to rate sentences off-line (e.g., Clark & Gerrig, 1983; Cronk, Lima, & Schweigert, 1993; Gibbs & O'Brien, 1990; Glucksberg et al., 1997; Nayak & Gibbs, 1990; Tourangeau & Rips, 1991). As Dascal (1989) put it: "more sensitive experiments should be designed to tap what kinds of meaning, in addition to the lexical ones, are activated *in the course of* the process of utterance interpretation, rather than immediately *after* its completion" (p. 255; see also Gibbs, 1992).

In contrast, a great deal is known about lexical ambiguity resolution (e.g., Rayner & Duffy, 1986; Swinney, 1979). In part, this is because the location of the lexical ambiguity is precisely specified and, in part, because the experiments have largely used the techniques of cross-modal priming and eye tracking, which are particularly sensitive to early stages in processing. In this article, we focus on eye tracking, because it provides evidence about processing during the first few hundred milliseconds after encountering a stimulus, and because it has been especially revealing about the resolution of words with more than one unrelated meaning (i.e., homonyms, Dopkins, Morris, & Rayner, 1992; Duffy, Morris, & Rayner, 1988; Rayner & Duffy, 1986; Rayner & Frazier, 1989; Rayner, Pacht, & Duffy, 1994; Sereno, 1995; Sereno, Pacht, & Rayner, 1992).

We use eye tracking to look at the processing of a type of figurative language that is localized to a single word. By doing this, we are able to explore the way that the processor accesses the appropriate figurative meaning for the word and to investigate whether the processor considers the literal meaning of the word as well. To do this, we consider the processing of *sense* ambiguities, in which words have more than one related meaning or sense (e.g., Frazier & Rayner, 1990). In particular, we consider the case in which one of these senses is figurative, specifically metonymic. In the General Discussion, we ask whether it is possible to generalize our conclusions from metonymy to other types of figurative language.

The Processing of Metonymy

In a metonymic construction, one salient aspect of an entity is used to refer to the entity as a whole or to some

Steven Frisson, Human Communication Research Centre (HCRC), Department of Psychology, University of Glasgow, Glasgow, Scotland, and Department of Linguistics, University of Antwerp–Ufsia, Antwerp, Belgium; Martin J. Pickering, HCRC, Department of Psychology, University of Glasgow, Glasgow, Scotland.

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Correspondence concerning this article should be addressed to Steven Frisson, Department of Linguistics, Room D 123, University of Antwerp–Ufsia, Prinsstraat 13, B-2000 Antwerp, Belgium. Electronic mail may be sent to steven.frisson@ufsia.ac.be.

other part of the entity. For instance, in *The ham sandwich is sitting at table 20,* the phrase *the ham sandwich* refers to the customer who ordered the ham sandwich (Nunberg, 1978). The precise relation between the literal and metonymic senses can vary (Preminger & Brogan, 1993), but it must be either well-understood or easy to perceive (Lakoff, 1987, p. 77). Unlike many metaphors, metonymies often seem extremely natural and need not carry an ornamental or literary overtone (Papafragou, 1996). From a linguistic point of view, metonymy is generally described as a kind of referential shorthand or *reference transfer* (Nunberg, 1978, 1979; but cf. Jackendoff, 1997; Papafragou, 1996).

Some types of metonymy are illustrated in (1)–(6):

1. *Shakespeare* is on the top shelf. (producer for product)
2. *The wings* took off from the runway. (part for whole or *synecdoche*)
3. *Hussein* invaded Iraq. (controller for controlled)
4. *The planes* are on strike. (object used for user)
5. That blasphemous woman had to answer to *the convent.* (place for institution)
6. A lot of Americans protested during *Vietnam.* (place for event)

We focus on (5) and (6), as such metonymies were used in the experiments reported below. In (5), *the convent* cannot refer to the building itself, as people do not answer to a building. Instead *the convent* refers to the institution that is housed in the convent building. The general principle underlying these place-for-institution metonymies is spelled out by Lakoff (1987, p. 78):

> Given an ICM [i.e., idealized cognitive model, the structural organization of knowledge according to Lakoff] with some background condition (e.g., institutions are located in places), there is a "stands for" relation that may hold between two elements *A* and *B*, such that one element of the ICM, *B*, may stand for another element *A*. In this case, *B* = the place and *A* = the institution.

(Note that the place need not be a building, as in *The customer congratulated the kitchen.*) In (6), *Vietnam* does not refer to the country itself, but rather to an event that happened there. In this case, the salient event is the Vietnam War.

Some researchers consider metonymy to be a type of metaphor (e.g., Levin, 1977; Searle, 1979; cf. Kövecses & Szabó, 1996), but most recent work treats them as distinct (e.g., Gibbs, 1990; Papafragou, 1996). Thus, in attributive metaphors like *Some jobs are jails* (Glucksberg et al., 1982), there is some kind of mapping between the conceptual domain of the topic (i.e., jobs) and the conceptual domain of the vehicle (i.e., jail; for details, see, e.g., Gentner & Clement, 1989; Gibbs, 1992, 1994; Glucksberg & Keysar, 1990; Lakoff & Turner, 1989; Ortony, 1979; Sweetser, 1991; Tourangeau & Sternberg, 1981, 1982). In metonymies, by contrast, the mapping occurs within rather than between domains (Lakoff, 1987, p. 288). Thus, Gibbs (1990) proposed that a nonliteral expression can be replaced by an "is like" statement (e.g., *This job is like a jail*) in metaphor but not metonymy. A metonymic expression can also be distinguished from an idiom, which is a compound expression that possesses a conventional meaning that is different from the literal interpretation of the combination of its parts. In contrast, the metonymic sense of a word is closely related to its literal meaning.

Finally, we distinguish familiar and unfamiliar metonymy. A reader (or listener) has an (appropriate) preexisting metonymic sense for a familiar metonymy but not for an unfamiliar one. To understand unfamiliar metonymies, the reader has to perform *sense creation* (Clark & Gerrig, 1983; Gerrig, 1989). Assuming that the expression also has a literal sense (which is familiar, because it is represented in the lexicon), the reader has to choose between selecting this sense and creating a metonymic sense. In contrast, the reader does have a metonymic sense for a familiar metonymy and so has to perform *sense selection.* This problem therefore parallels the problem of meaning selection in homonyms (e.g., Rayner & Duffy, 1986; Swinney, 1979).

Theories of Figurative Language Processing

In this article, we investigate two related questions: Can people rapidly access a familiar metonymic interpretation for a noun? and Is the processing of nouns that are ambiguous between a literal and a metonymic sense informative about figurative language processing? To address the latter question, we identify three accounts of figurative language processing, which we call *literal-first, figurative-first,* and *parallel.* We evaluate the results of our experiments against these models.

Literal-First Model

This model claims that people always obtain a literal interpretation first (Grice, 1975, 1989; Searle, 1979; cf. Récanati, 1995). If this interpretation is incompatible with the context, it is abandoned and a figurative interpretation can be obtained instead. (In the original model, figurative processing was delayed until the end of the sentence; we discuss an account more in keeping with evidence about incremental processing.) This model now has few supporters (though see Dascal, 1987, 1989), because numerous studies have found that metaphoric expressions, if preceded by enough relevant context, can be processed as fast as literal expressions (Gibbs & Gerrig, 1989; Harris, 1976; Hoffman & Kemper, 1987; Inhoff, Lima, & Carroll, 1984; Onishi & Murphy, 1993; Ortony et al., 1978; Shinjo & Myers, 1987; cf. Pynte, Besson, Robichon, & Poli, 1996).

However, relevant context does not always eliminate processing difficulty (Gerrig & Healy, 1983; Gibbs, 1990; Inhoff et al., 1984; Onishi & Murphy, 1993; Schraw, 1995; Shinjo & Myers, 1987). It may simply be that processing difficulty is removed with a strong context but not with a weaker context. A possible explanation in keeping with this model is that the processor accesses the literal interpretation first, but a context strongly supporting a metaphorical interpretation allows for extremely rapid revision (see Frazier, 1995, for similar arguments about parsing). Just as in research into parsing (e.g., Ferreira & Clifton, 1986; Trueswell, Tanenhaus, & Garnsey, 1994), distinguishing initial processing from revision is probably impossible without on-line techniques.

The literal-first model makes clear predictions for the processing of expressions that have both a literal and a familiar metonymic interpretation: The processor accesses the literal interpretation first, irrespective of context. The metonymic interpretation is obtained only after the literal interpretation has been judged infelicitous.

Figurative-First Model

This model claims that people initially seek a figurative interpretation. If no interpretation is found, or if the interpretation is contextually inappropriate, the processor then considers the literal interpretation. It is not clear that a general figurative-first account has ever been proposed, but figurative-first accounts for particular kinds of figurative language do exist. Thus, Gibbs (1980) proposed an account of the processing of idioms in which "subjects understanding unconventional uses of idioms [i.e., literal interpretations of idioms] tend to analyze the idiomatic meaning of these expressions before deriving the literal, unconventional interpretation" (p. 149). Evidence comes from findings that the figurative interpretation of idioms can be processed more rapidly than the literal interpretation (Gibbs, 1980, 1986; Gibbs & Gonzales, 1985; though cf. Colombo, 1993; Estill & Kemper, 1982). In one version of this account, the figurative interpretation is only obtained first if the literal interpretation has to be derived (by combining the interpretations of different words). This version makes no predictions for the processing of metonymy. But another version of this account assumes that the processor adopts the conventional (i.e., figurative) interpretation of idioms first, simply because this interpretation is figurative. This appears to be the implication of Gibbs (1990), who suggested that people may process some particularly appropriate metonymies (slang expressions) "as quickly as literal descriptions, if not more quickly" (p. 65). This version of the account therefore amounts to a general figurative-first model. For expressions that have both a literal and a familiar metonymic interpretation, it predicts that the processor accesses the metonymic interpretation before the literal interpretation.

Parallel Model

On this account, people simultaneously access literal and figurative interpretations. A parallel account has been proposed for the processing of metaphors (Cacciari & Glucksberg, 1994; Glucksberg, 1991). It claims that neither literal nor metaphorical interpretation has priority if both are appropriate and if the metaphor is easily interpretable. The literal reading of a metaphor is accessed even in extremely metaphor-favoring conditions, because it serves to guide and constrain the inferential comprehension process (Glucksberg, 1991; cf. Dascal, 1989; Paivio, 1979). The *concurrent processing model* (Gerrig, 1989), in which sense selection and sense creation operate simultaneously, is another parallel model.

The experiments that show little difference in difficulty for figurative and literal interpretations are obviously compatible with the parallel model. Clearer support comes from studies showing that participants automatically apprehend both interpretations, even when one is anomalous (Gildea & Glucksberg, 1983; Glucksberg et al., 1982; Keysar, 1989). In a Stroop-like paradigm, these studies found that participants were slow to classify sentences like *Some jobs are jails* as literally false if they can be true metaphorically. However, this interference might reflect a late checking or delayed interpretation stage rather than initial processing.

The lexical representation model (Swinney & Cutler, 1979) is a parallel model for the processing of idioms. But it also assumes that idioms have a unitized interpretation, whereas literal interpretations have to be constructed compositionally, and hence that the processor always obtains the idiomatic interpretation first. Hence, there is also a sense in which this model is a figurative-first account as well. The problem is that the locus of ambiguity is not clearly specified: At the beginning of the expression, both interpretations are activated, but the idiomatic interpretation is completed first.

For expressions with both a literal and a familiar metonymic interpretation, the model predicts that the processor simultaneously accesses both interpretations. In the General Discussion, we contrast versions of the parallel account that can be distinguished in terms of their sensitivities to the relative frequencies of different senses.

Processing Metonymy and Sense Ambiguity

Unlike metaphors and idioms, experimental work on metonymy has been sparse. Some studies have looked at the disambiguation of closely related senses but were not explicitly concerned with metonymy. In other studies, it is unclear whether the metonymic interpretations were familiar or not.

Some experiments investigated the process of assigning a novel interpretation to an expression; many, but not all, of the novel interpretations were metonymic (Clark, 1983; Clark & Gerrig, 1983; Gerrig, 1989; cf. Gibbs, 1990). For example, Gerrig measured sentence reading time for sentences like *There are 20,000 uniforms in this city.* Preceding context highlighted either the familiar sense of *uniform* or the unfamiliar sense (i.e., people in uniforms). Participants took longer reading the unfamiliar sense, but detailed analyses suggested that sense selection and sense creation operated simultaneously and that it is not the case that sense creation only occurred if sense selection failed. However, the results did not replicate using self-paced reading. These data therefore "support the notion that meaning creation goes on alongside meaning selection, but say little about the time course at a more refined level" (Gerrig, 1989, p. 205).

Other studies do not clearly distinguish between sense creation and sense selection. Gibbs (1990) found that readers spent more time processing metonymic referring expressions (e.g., *scalpel* to refer to a surgeon) and metaphorical ones (e.g., *butcher*) than literal ones (e.g., *doctor*) when they were at the beginning of a target sentence. Metonymic expressions were in fact harder to process than metaphoric ones. These findings may suggest that readers initially adopt a literal interpretation for such expressions. However, the literal expressions were judged to be the most plausible, which may also explain the results (see also Blasko & Connine, 1993). Onishi and Murphy (1993) replicated Gibbs's results using new items (though without metonymies) but found that the reading-time difference disappeared when the metaphorical expressions appeared after relevant sentence-initial context. Hence there is only weak evidence that metonymies are hard to process in comparison with literal controls.

Two studies have used eye tracking to investigate sense ambiguities. Frazier and Rayner (1990) contrasted the processing of sense ambiguities with homonyms. The sense ambiguities concerned concrete versus abstract senses of words (e.g., *newspaper* in *Lying in the rain, the newspaper was destroyed* vs. *Managing advertising so poorly, the newspaper was destroyed*), but some did not involve metonymy (e.g., *poem* referring to the written-down vs. spoken version). When disambiguating information was delayed, reading times for homonyms were longer than unambiguous control words, but sense ambiguities did not differ from their controls. Frazier and Rayner argued for an underspecification account: When not enough material is available to distinguish between the concrete and abstract readings of a word with multiple senses, readers do not need to determine the appropriate sense and therefore "minimally commit." When the disambiguating information appeared prior to a word with multiple senses, there was some suggestion that readers experienced more difficulty with the less frequent sense. However, the experiment did not investigate whether the concrete or the abstract sense was easier to process.

Finally, Pickering and Traxler (1998) investigated the processing of metonymies in an eye-tracking study concerned with syntactic ambiguity resolution. For example, participants read a context sentence mentioning either an actual professor or a statue of a professor, and then a syntactically ambiguous target sentence that was about a janitor polishing the professor on one syntactic analysis. The results indicated that readers adopted the plausible metonymic interpretation when it was available and that this affected the process of syntactic ambiguity resolution. The processor must have rapidly adopted this analysis, though no effects occurred at the point at which *professor* was first encountered.

This research suggests that the processor may access metonymic interpretations rapidly under appropriate circumstances. However, we do not know which effects occur with familiar and which with unfamiliar metonymies, and we often cannot be sure that effects specifically relate to metonymy. Most importantly, little is known about the time course of the processing of metonymies, in clear contrast to the processing of homonyms (e.g., Rayner & Duffy, 1986).

We have contrasted three accounts of figurative language processing and have related them to the specific issue of the resolution of ambiguities between literal and metonymic senses. The literal-first model states that the processor initially adopts a literal interpretation and can only adopt a figurative interpretation on revision. The figurative-first model claims the opposite. The parallel model claims that both senses are activated. Previous work fails to discriminate these models for reasons already discussed: Most idioms and metaphors are poorly localized; irrelevant difficulty may be incurred by sense creation over sense selection; plausibility has been poorly controlled; and techniques have not been adequate for investigating initial processing. To avoid these problems, we conducted two eye-tracking experiments using sentences containing carefully normed familiar metonymies and expressions without a familiar metonymic interpretation, in contexts that supported either a literal or a metonymic interpretation.

Experiment 1

Experiment 1 investigated the time course of the comprehension of place-for-institution metonymies and used sentences such as (7a–d):

> 7a. These two businessmen tried to purchase the convent at the end of last April, which upset quite a lot of people. (literal context–familiar metonymic; LC-FM)
> 7b. That blasphemous woman had to answer to the convent at the end of last March, but did not get a lot of support. (metonymic context–familiar metonymic; MC-FM)
> 7c. These two businessmen tried to purchase the stadium at the end of last April, which upset quite a lot of people. (literal context–no familiar metonymic; LC-NM)
> 7d. That blasphemous woman had to answer to the stadium at the end of last March, but did not get a lot of support. (metonymic context–no familiar metonymic; MC-NM)

Sentences (7a) and (7b) use the expression *the convent.* In (7a), prior context indicates that it should receive a literal interpretation (convent building). In (7b), prior context indicates that it should receive a metonymic interpretation based on the place-for-institution metonymic principle discussed earlier (roughly, the committee of people that run the convent). Pretests (see below) indicated that this metonymic interpretation is familiar (i.e., people are familiar with this metonymic sense). Sentences (7c) and (7d) replace *the convent* with *the stadium,* which has a literal interpretation but no (contextually relevant) familiar metonymic interpretation. In (7c), the context indicates that *the stadium* should receive the literal interpretation (stadium as an edifice). But in (7d), the literal interpretation is incongruous, and there is no appropriate familiar metonymic interpretation. In this case, readers might interpret *the stadium* metonymically (e.g., answering to the people in the stadium) or literally (e.g., answering to a speaking stadium).

The sentences in (7a–d) vary on two orthogonal dimensions: whether the critical expression has a familiar metonymic sense or not (*Sense*) and whether the context supports a literal or a metonymic interpretation for the expression (*Context*). In (7a), *the convent* has both a literal and a familiar metonymic sense, and the context supports an interpretation of the sentence in which the literal sense is used. We therefore call it LC-FM: LC for literal context and FM for familiar metonymic sense of the expression (i.e., because *the convent* has a familiar metonymic sense, even though that sense is not used in the actual sentence). In (7b), *the convent* still has both senses (of course), so it is FM; but the context supports an interpretation of the sentence in which the place-for-institution metonymic sense is used. We therefore call it MC-FM, where MC stands for metonymic context. In (7c), *the stadium* has a literal sense but no familiar metonymic sense; and the context supports an interpretation in which the literal sense is used. We therefore call it LC-NM, where NM stands for no familiar metonymic sense. In (7d), *the stadium* still has the literal sense only; and the context supports an interpretation of the sentence that would use a place-for-institution metonymic sense, if one existed. Hence we call it MC-NM. In other words, the first part of this abbreviation indicates whether the context supports an interpretation in which the expression requires a literal or a place-for-institution metonymic sense, and the second part indicates whether the expression has an (appropriate) familiar metonymic sense on its own.

The processing of these sentences should help us distinguish between the three models discussed above (see Table 1 for summary). According to the literal-first model, (7a) and (7c) should present no difficulty, because the literal interpretation is correct. In contrast, (7b) and (7d) should cause rapid difficulty, because people should initially interpret *the convent* or *the stadium* literally and then realize that this interpretation is incongruous. Numerous studies have shown that the processor rapidly detects semantic incongruity or implausibility during reading (e.g., Garrod, Freudenthal, & Boyle, 1993; Traxler & Pickering, 1996). Additionally, people should eventually access the correct metonymic interpretation for (7b), but no such interpretation is available for (7d). Hence, the full predictions of the literal-first model are initial difficulty with (7b) and (7d) in comparison with (7a) and (7c) and, later, (additional) difficulty with (7d) in comparison with (7b).

According to the figurative-first model, readers should experience no difficulty with (7b), because they would access the metonymic interpretation initially. In contrast, they should experience difficulty with (7a), because the metonymic interpretation is incongruous; they would then be forced to reanalyze. In (7c), they should initially seek a metonymic interpretation. They might encounter no difficulty with this sentence, because there is no relevant interpretation. However, it is perhaps more likely that they might still try to create a novel metonymic interpretation. Finally, readers should initially seek a metonymic interpretation for (7d). Assuming rapid detection of incongruity, readers should attempt to seek a literal interpretation but should fail there as well. Hence, (7d) should cause rapid processing difficulty and additional difficulty in comparison with (7a), and perhaps (7c). The critical prediction of the figurative-first model, however, is that (7b) should be easier to process than (7a).

Finally, the parallel model predicts that readers access both the literal and the figurative interpretation together. There should be no difficulty so long as one or the other interpretation is plausible. This is the case in (7a) and (7c), where the literal interpretation is plausible, and (7b), where the figurative interpretation is plausible. But (7d) has no plausible interpretation. Hence, the model predicts rapid difficulty with (7d) in comparison with (7a–c).

Method

Participants. Twenty-eight native British English speaking students from the University of Glasgow (Glasgow, Scotland) were paid to participate in the eye-tracking experiment. All had normal or corrected-to-normal vision. None took part in the pretests (see below).

Items. We constructed 16-item quartets similar to (7a–d; see the Appendix). The literal sentences (e.g., [7a & c]) and the metonymic sentences (e.g., [7b & d]) were identical except for the critical noun (e.g., *convent* or *stadium*). The literal interpretation of this noun was as an edifice; the metonymic interpretation was as an institution associated with that edifice. In the experiment, they were presented on two lines (double spaced). All versions of an item were identical for some words after the target noun (e.g., *at the end of;* range = 11–18 characters). These words were semantically unconstraining. The rest of the line was the same length across conditions. The items were assigned to one of two experimental lists, so that each target word appeared exactly once in each list, and each list contained one literal and one metonymic sentence from each quartet. Hence, there was no repetition of either context or target within a list. For example, one list contained (7a) and (7d), and the other list contained (7b) and (7c). The critical items were mixed with 64 filler items (including the stimuli of Experiment 2). Each list consisted of two halves, with each half containing exactly one sentence from each quartet. The two halves were assigned a fixed random order. Half of the participants received the two half

Table 1
Experiments 1 and 2: Predictions of the Models

	Condition and example			
Model	LC-FM *purchase the convent* *around Vietnam*	MC-FM *answer to the convent* *during Vietnam*	LC-NM *purchase the stadium* *around Finland*	MC-NM *answer to the stadium* *during Finland*
Literal first	No difficulty	Rapid difficulty	No difficulty	Rapid difficulty Additional difficulty
Figurative first	Rapid difficulty	No difficulty	No or rapid difficulty	Rapid difficulty Additional difficulty
Parallel	No difficulty	No difficulty	No difficulty	Rapid difficulty

Note. "Additional difficulty" should be interpreted in relation to the other condition(s) in which rapid difficulty occurs. LC-FM = literal context–familiar metonymic; MC-FM = metonymic context–familiar metonymic; LC-NM = literal context–no familiar metonymic; and MC-NM = metonymic context–no familiar metonymic. The examples on the first line (e.g., *purchase the convent*) refer to Experiment 1; the examples on the second line (e.g., *around Vietnam*) refer to Experiment 2.

lists in one order, and half of the participants saw them in the reverse order. Two versions of an item were at least one experimental break and 41 sentences apart.

The critical nouns were controlled for length and frequency, using the Celex English Database (Baayen, Piepenbrock, & Van Rijn, 1993). Plausibility, sense frequency, and predictability were assessed in three pretests (see Table 2).

Plausibility norming. We first constructed 20 item sets. The sentence fragments up to and including the target word were divided into two lists just as in the eye-tracking experiment and were mixed with 40 distractors. Each list was randomized and appeared in one of two orderings (one the reverse of the other). A total of 40 participants (20 per list) assigned a number from 0 (*very implausible*) to 7 (*very plausible*) that reflected how much sense the sentence made. We selected 16 items for which the literal conditions and the metonymic condition with the familiar metonymic sense for the expression (MC-FM) were judged highly plausible, but the metonymic condition without the familiar metonymic sense for the expression (MC-NM) was judged highly implausible. The plausibility rating for the MC-FM condition was somewhat lower than both literal conditions (indeed all pairs of conditions differed significantly, $ps < .01$, except the two literal conditions), but its standard deviation was low and all three ratings were situated at the highly plausible end of the scale (see also Footnote 2 below).

Sense frequency. Frequency of the literal and metonymic senses was assessed on the basis of a corpus search (see Table 2). Using the CORSET search engine (Corley, Corley, & Crocker, 1997), we randomly selected 55 occurrences of each item from the British National Corpus (BNC), which contains approximately 100 million words. On the basis of preceding and following context, we classified each occurrence as literal or metonymic and ignored irrelevant metonymic uses and ambiguous cases. All nouns that were hypothesized to exhibit a familiar metonymic reading (e.g., *convent*) appeared with that sense in the sample.[1] For nine items, the literal sense was more frequent; for seven items, the most frequent sense was the metonymic one. The frequencies of the literal and metonymic senses did not differ ($F < 1$). Note that many individual words were not balanced (e.g., the dominant sense often occurred well above 70% of the time). Our goal was not to consider balanced sense ambiguities but rather to make sure that any processing differences between literal and metonymic uses could not be explained by frequency differences. This pretest also allowed us to explore any relationship between relative frequency and reading times (see below).

Predictability. It has been shown that strong predictability can affect reading times (e.g., Rayner & Well, 1996). Fifty-one participants completed sentence fragments that stopped immediately before the critical noun (e.g., *These two businessmen tried to purchase the . . .*). The sentence fragments were arranged in three files with two different orderings (one the reverse of the other). Predictability was extremely low (see Table 2) and was never above 8% for any version of any item.

Procedure. Participants' eye movements were recorded with a SRI Dual Purkinje generation 5.5 eye tracker. The tracker had an angular resolution of 10 min arc. It monitored only the right eye's movements. A PC displayed the materials on a VGA color screen 77 cm from the participants' eyes. The screen displayed 3.8 characters per degree of visual angle. 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.

Each participant was run individually. The experimenter told the participant to read the sentences carefully in order to understand them, but to read at her or his normal rate. The experimenter then used bite bars and head restraints to minimize the participant's head movements. Next, the participant completed a calibration procedure. Before each item or filler, a calibration check was performed. If the calibration check was unsatisfactory, the participant was recalibrated. The participant then looked at a box presented at the same point as the first letter of the item. The experimenter pressed a button and the sentence appeared. After reading the sentence, the participant pressed a button. On 50% of trials (balanced across conditions), a comprehension question appeared (e.g., *Did the woman get much support?*). 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 40 min, including a break of 3 min in the middle.

Analyses. We report analyses on four critical regions. Region 1 consisted of the sentence before the determiner *the* of the target word. Region 2, the noun region, comprised *the* plus the critical noun (and excluded any punctuation). Region 3, the postnoun region, contained the words that remained constant across conditions. Region 4, the end-of-line region, continued until the line break. We did not analyze the part of the sentence on the next line. The character space between regions was included in the following region. In (8), regions breaks are indicated by slashes:

8. These two businessmen tried to purchase/ the convent/ at the end of/ last April,/ which upset quite a lot of people.

After the experimenter determined which line of the text was fixated, an automatic procedure pooled short contiguous fixations. This procedure assimilated all fixations shorter than 80 ms and within one character space of another fixation to that fixation. Fixations shorter than 80 ms and not within one character space to another fixation were excluded because we presume that readers hardly extract any information during such a short fixation (see Rayner & Pollatsek, 1989). Fixations longer than 1,500 ms were also excluded because these were most probably due to tracker loss.

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, this corresponds to gaze duration (Rayner & Duffy, 1986). *First-pass regressions* are leftward eye movements that cross the region's left boundary and that immediately follow a first-pass fixation. These two measures are thought to reflect early sentence processing. *Total time* is the sum of all fixations within a region. *Second-pass time* is total time minus first-pass time: It is intended to measure rereading. The reported means and analyses of variance (ANOVAs) for first-pass and total time are based on reading times excluding trials on which readers skipped a region on first pass. Analyses for which these skips were substituted by zeroes produced nearly identical results. Second-pass times included zeroes.

Results

Prior to all analyses, sentences were excluded on which the eye tracker lost track of the participant's gaze location, caused, for example, by a major head movement (4% of the trials). Trials for which participants skipped the first region or two consecutive regions were also excluded (5% of the trials). We assume that in these cases readers were unable to

[1] Except for *palace*. However, the plausibility of the MC-FM condition using *palace* was within the normal range (5.5).

Table 2
Experiments 1 and 2: Item Specifics

Measure	Condition			
	LC-FM	MC-FM	LC-NM	MC-NM
Plausibility pretest (out of 7)				
Exp. 1	6.4 (.46)	5.8 (.68)	6.3 (.39)	0.8 (.48)
Exp. 2	6.4 (.48)	6.3 (.49)	6.4 (.39)	3.2 (.86)
Literal usage (%)				
Exp. 1	55.0 (36.0)	45.0 (36.0)		
Exp. 2	73.9 (20.1)	26.1 (20.1)		
Predictability (%)				
Exp. 1	1.2	0.2	0.0	0.0
Exp. 2	0.0	2.4	0.0	0.0
Length/frequency target word (characters/per million)				
Exp. 1	7.4 (1.9)/74.1 (98.9)	7.4 (1.9)/74.1 (98.9)	7.4 (1.9)/27.3 (31.8)	7.4 (1.9)/27.3 (31.8)
Exp. 2	7.8 (1.9)/1.8 (6.7)	7.8 (1.9)/1.8 (6.7)	7.8 (1.9)/3.1 (7.8)	0.8 (1.9)/3.1 (7.8)
Length/frequency preceding word (characters/per million)				
Exp. 1	4.1 (2.6)/5,176.5 (7,290.8)	4.6 (2.55)/4,292.4 (3,154.6)	4.1 (2.6)/5,176.5 (7,290.8)	4.6 (2.55)/4,292.4 (3,154.6)
Exp. 2	4.5 (2.1)/6,180.8 (9,610.4)	4.75 (1.9)/7,956.3 (13,209.3)	4.5 (2.1)/6,180.8 (9,610.4)	4.75 (1.9)/7,956.3 (13,209.3)
Length of spillover region (characters)				
Exp. 1 (all conditions)	13.8 (2.0)			
Exp. 2 (all conditions)	13.8 (2.3)			
Length of end-of-line region (characters)				
Exp. 1	15 (2.8)	14.8 (2.4)	15 (2.8)	14.8 (2.4)
Exp. 2	13.25 (2.5)	13.4 (2.3)	13.25 (2.5)	13.4 (2.3)
Total length (characters)				
Exp. 1	89.1 (9.8)	88.4 (8.6)	89.1 (9.8)	88.4 (8.6)
Exp. 2	100.6 (6.3)	101.1 (6.1)	100.6 (6.3)	101.1 (6.1)

Note. Standard deviations are presented in parentheses. Literal usage is expressed in percentages obtained by calculating the number of classifiable occurrences within the sample drawn from the BNC database. Overall frequency is the number of occurrences per million of the word form in the CELEX (Centre for Lexical Information) database (based on a corpus of 17.9 million words). LC-FM = literal context–familiar metonymic; MC-FM = metonymic context–familiar metonymic; LC-NM = literal context–no familiar metonymic; MC-NM = metonymic context–no familiar metonymic. Exp. = experiment; BNC = British National Corpus.

process the sentence adequately. Overall, questions were answered correctly on 90% of trials.

Table 3 presents mean first-pass times, first-pass regressions, second-pass times, and total times (using participant means). Table 4 presents statistical analyses for these data.[2]

For each measure and for each region, we subjected the data to separate Context (literal context vs. metonymic context) × Sense (familiar metonymic sense vs. no familiar metonymic sense) ANOVAs, treating participants and items as random effects. Because we were interested in how processing differs between conditions and because the main effects were largely driven by the reading times for MC-NM (see Table 3), we concentrated on those cases in which a significant interaction was found. When an interaction was found, we performed simple effects analyses to determine its origin. (Throughout, F_1 represents participant analysis and F_2 represents item analysis.)

As can be seen in Table 4, interactions were found in the noun region (only reliable on the participants analysis) and postnoun regions for the first-pass times measure. These interactions were caused by lengthened reading times for MC-NM in comparison with the other conditions, which did not statistically differ from each other. An interaction was also found for the first-pass regressions in the participants analysis of the postnoun region. Simple effects analyses showed that this was due to the higher number of regressions for the MC-NM condition. However, there was also a weak effect in the participants analysis only for the comparison between LC-FM and MC-FM, caused by a higher number of regressions for MC-FM.[3] Second-pass analyses showed a similar pattern to the early processing measures: interactions in Region 1 and 2 (the noun region) because of higher reading times for MC-NM than any of the other conditions. For the noun region, the participants analysis suggests that MC-FM may be harder than LC-FM. Total time analyses mirror this pattern with interactions caused by higher reading times for MC-NM in Regions 1–3. For Regions 2 and 3, the participants analyses again suggest that MC-FM may differ from LC-FM.

The relative frequencies, as established by a classification of random examples from the BNC database (see above), were correlated with the reading times and regressions for LC-FM minus MC-FM sentences for the noun and postnoun regions. This allowed us to explore whether different frequencies of metonymic usage are reflected in the reading pattern. Because none of the correlations approached significance (all $ps > .1$),[4] there is no evidence that the more frequent a word is used in its literal or metonymic sense, the faster that sense is processed.

Discussion

The results demonstrate that familiar place-for-institution metonymy can be resolved very rapidly whereas unfamiliar place-for-institution metonymy requires more effort from the semantic processor. This effect was found as soon as the critical word was encountered and was evident both in immediate and later processing. Hence, it seems that figurative language processing need not be delayed when the figurative expression is familiar. These results also help us distinguish the three general models discussed earlier.

The literal-first model predicted initial difficulty processing the critical expression when context supports a place-for-institution metonymic sense for the expression (i.e., MC-FM and MC-NM). Later, additional difficulty should ensue if the expression does not have a relevant metonymic sense; that is, in the MC-NM condition. In contrast to this, only MC-NM nouns rapidly became much harder to process than the other nouns. There was weak evidence that MC-FM nouns were harder than LC-FM nouns, but even these weak effects were delayed. Hence, the results provide little support for the literal-first model.

The figurative-first model fares even worse. This model predicts that MC-FM nouns should be easier than LC-FM nouns. In fact, there was no evidence to support this prediction.

In contrast, the parallel model correctly predicts rapid difficulty with MC-NM nouns in comparison with MC-FM and literal nouns. Readers appear to consider literal and familiar metonymic senses at the same time.

Basic versus derived senses. Our assumption is that the place sense is literal and the institutional sense is metonymic. This follows from the standard assumption that place-for-institution is the guiding metonymic principle (e.g., Lakoff, 1987). It might be argued that there is another way to capture the relationship between the two senses, which we can call *basic sense* and *derived sense.* People may have the intuition that one sense is basic. If so, readers might initially access the basic sense and only subsequently obtain the derived sense. We call this the *basic-sense-first account.* The basic sense may coincide with the literal sense, but it need not. To consider this possibility, we operationally defined the basic sense as the sense listed first in dictionary definitions (here, the *Collins Cobuild English Dictionary,* 1995). The familiar metonymic sense was basic for five nouns (*academy, university, embassy, institute,* and *college*). To consider whether the processor might access the basic sense initially, we reordered the items in such a way that the 16 basic senses appeared in one condition and the 16 derived senses in another. Then we computed the same ANOVAs as

[2] Correlations were performed on the difference in reading times between LC-FM and MC-FM with the difference in plausibility for these two conditions. The hypothesis is that if the difference in plausibility is reflected in reading times, a positive correlation between the two measures should be found. For first-pass reading times, all $rs < .1$, all $ps > .7$; for first-pass regressions, all $rs < .1$, all $ps > .2$; for second-pass, all $rs < .42$, all $ps > .1$; and for total time, all $rs < .12$, all $ps > .28$. Hence, we did not find any evidence for the hypothesis that the slight difference in plausibility between LC-FM and MC-FM had an effect on reading times and regressions.

[3] This comparison has to be treated cautiously given the low number of regressions (see Tabachnick & Fidell, 1989).

[4] First-pass: Region 2, $r = .292$, Region 3, $r = -.376$; first-pass regressions: Region 2, $r = -.236$, Region 3, $r = -.327$, Region 4, $r = -.287$; second-pass: Region 2, $r = -.105$, Region 3, $r = -.174$; total time: Region 2, $r = .08$; Region 3, $r = -.418$.

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

Variable	LC-FM/NM = MC-FM/NM =	Region 1 (beginning) *These two businessmen tried to purchase* *That blasphemous woman had to answer to*	Region 2 (noun) *the convent/stadium* *the convent/stadium*	Region 3 (postnoun) *at the end of* *at the end of*	Region 4 (end-of-line) *last April* *last March*
First pass (ms)					
LC-FM		1,141 (350)	363 (74)	345 (134)	460 (135)
MC-FM		1,096 (407)	377 (119)	350 (137)	487 (165)
LC-NM		1,130 (360)	362 (103)	326 (101)	457 (128)
MC-NM		1,093 (369)	446 (122)	407 (152)	479 (122)
First-pass regressions (%)					
LC-FM		0	16.5 (16.1)	1.8 (4.5)	16.3 (16.5)
MC-FM		0	18.0 (15.7)	6.6 (8.9)	15.8 (16.6)
LC-NM		0	11.5 (11.3)	4.1 (6.9)	16.2 (13.7)
MC-NM		0	17.5 (13.7)	15.8 (15.5)	21.4 (16.3)
Second pass (ms)					
LC-FM		274 (281)	50 (50)	64 (66)	38 (73)
MC-FM		298 (235)	99 (136)	78 (90)	44 (86)
LC-NM		260 (247)	52 (81)	103 (123)	49 (93)
MC-NM		500 (386)	280 (278)	133 (159)	74 (108)
Total time (ms)					
LC-FM		1,415 (526)	430 (131)	411 (140)	532 (152)
MC-FM		1,395 (472)	514 (213)	445 (165)	585 (233)
LC-NM		1,380 (476)	437 (146)	432 (174)	560 (185)
MC-NM		1,593 (573)	776 (336)	604 (236)	640 (212)

Note. LC-FM = literal context–familiar metonymic; MC-FM = metonymic context–familiar metonymic; LC-NM = literal context–no familiar metonymic; and MC-NM = metonymic context–no familiar metonymic. Standard deviations are presented in parentheses.

Table 4
Experiment 1: Analysis of Variance and Mean Square Errors (in Parentheses) for First-Pass Times, First-Pass Regressions, Second-Pass Times, and Total Times

Variable	Region 1 (beginning) F_1	Region 1 (beginning) F_2	Region 2 (noun) F_1	Region 2 (noun) F_2	Region 3 (postnoun) F_1	Region 3 (postnoun) F_2	Region 4 (end-of-line) F_1	Region 4 (end-of-line) F_2
First pass								
Context	2.46 (46,674)	1.08 (38,380)	15.8*** (67,184)	14.85** (38,351)	13.36** (51,817)	12.36** (19,426)	3.32(*) (16,599)	<1 (5,823)
Sense	<1 (1,417)	<1 (265)	9.64** (32,812)	9.08** (21,628)	8.72** (10,288)	3.23(*) (5,712)	<1 (748)	<1 (75)
Interaction	<1 (458)	<1 (2,094)	6.96* (34,502)	1.81 (15,234)	10.7* (41,295)	6.35* (24,729)	<1 (201)	<1 (56)
LC-FM vs. MC-FM			<1 (2,698)	<1 (2,621)	<1 (298)	<1 (160)		
LC-NM vs. MC-NM			19.97*** (98,988)	6.05* (50,964)	24.04*** (92,814)	11.29** (43,995)		
LC-FM vs. LC-NM			<1 (11)	<1 (279)	1.34 (5,180)	<1 (3,336)		
MC-FM vs. MC-NM			13.58*** (67,303)	4.34(*) (36,583)	12.02** (46,403)	6.96* (27,105)		
First-pass regressions								
Context			2.67 (403)	1.84 (239)	20.12*** (1,905)	15.34** (1,033)	<1 (156)	<1 (71)
Sense			2.04 (216)	1.35 (130)	9.17** (916)	12.64** (552)	1.82 (211)	2.07 (132)
Interaction			<1 (136)	<1 (78)	6.63* (328)	1.86 (196)	1.55 (231)	1.51 (173)
LC-FM vs. MC-FM					6.59* (326)	1.56 (164)		
LC-NM vs. MC-NM					38.56*** (1,907)	10.08** (1,065)		
LC-FM vs. LC-NM					1.49 (74)	<1 (43)		
MC-FM vs. MC-NM					23.06*** (1,170)	6.66* (703)		
Second pass								
Context	14.27*** (487,947)	10.19** (268,837)	23.44*** (540,670)	66.03*** (294,111)	2.7 (12,865)	2.35 (5,242)	2.44 (6,595)	4.17(*) (3,617)
Sense	10.55** (247,073)	7.51* (149,423)	19.13*** (235,637)	23.76*** (143,436)	10.94** (61,421)	19.19*** (36.779)	4.9* (12,224)	7.06* (7,591)
Interaction	8.79** (327,973)	18.44*** (199,335)	28*** (222,357)	21.92*** (135,689)	<1 (1,916)	<1 (1,909)	<1 (2,492)	<1 (1,504)
LC-FM vs. MC-FM	<1 (7,918)	<1 (2,594)	4.38* (34,783)	2.44 (15,131)				
LC-NM vs. MC-NM	21.66*** (808,002)	43.07*** (465,579)	91.7*** (728,243)	66.98*** (414,669)				
LC-FM vs. LC-NM	<1 (2,860)	<1 (1,795)	<1 (96)	<1 (54)				
MC-FM vs. MC-NM	25.34*** (572,186)	32.1*** (346,963)	57.66*** (457,898)	45.08*** (279,072)				
Total time								
Context	4.2(*) (258,836)	1.61 (119,841)	38.7*** (1,139,684)	121.96*** (631,274)	25.71*** (296,546)	30.09*** (131,992)	10.49** (122,640)	4.98* (57,372)
Sense	7.81** (187,626)	3.36(*) (120,197)	24.3*** (432,083)	24.42*** (273,597)	20.48*** (226,205)	25.79*** (128,720)	9.86** (47,596)	5.31* (33,420)
Interaction	9.15** (380,820)	7.28* (263,442)	31.76*** (528,593)	25.32*** (305,027)	24.41*** (133,641)	17.85*** (77,845)	<1 (5,037)	<1 (4,194)
LC-FM vs. MC-FM	<1 (5,870)	<1 (13,959)	3.48(*) (57,975)	2.44 (29,339)	2.93(*) (16,019)	<1 (3,553)		
LC-NM vs. MC-NM	15.23** (633,787)	10.21** (369,325)	96.75*** (1,610,301)	75.3*** (906,962)	75.66*** (414,169)	47.29*** (206,284)		
LC-FM vs. LC-NM	<1 (16,918)	<1 (13,873)	<1 (2,430)	<1 (427)	1.11 (6,054)	<1 (3,181)		
MC-FM vs. MC-NM	13.25** (551,528)	10.22** (369,766)	57.57*** (958,246)	48*** (578,197)	64.63*** (353,793)	46.63*** (203,383)		

Note. F_1 = participant analyses; F_2 = item analyses. Degrees of freedom for F_1 are 1 and 27; degrees of freedom for F_2 are 1 and 15. LC-FM = literal context–familiar metonymic; MC-FM = metonymic context–familiar metonymic; LC-NM = literal context–no familiar metonymic; MC-NM = metonymic context–no familiar metonymic.
*$p < .05$. **$p < .01$. ***$p < .001$. (*) = approached significance (between the .1 and .05 level).

in the main analyses above. The results almost exactly replicated the main analyses. The only difference was that the tendency for the literal sense to be easier to process than the familiar metonymic sense on some measures (simple effects between LC-FM and MC-FM; see above) was reduced when the literal sense was replaced with the basic sense and the metonymic sense was replaced with the derived sense: first-pass regressions, Region 3, $F_1(1, 27) = 3.76$, $p < .1$, $MSE = 282$ and $F_2(1, 15) = 1.56$, $p > .1$, $MSE = 164$; second-pass, Region 2 (both Fs < 1); total time, Region 2 (both Fs < 1); total time, Region 3, $F_1(1, 27) = 6.67$, $p < .05$, $MSE = 46{,}821$ and $F_2(1, 15) = 5.25$, $p < .05$, $MSE = 25{,}625$. Hence, the basic-sense-first account is not supported.

High-frequent versus low-frequent senses. Another way to capture basic versus derived senses is by looking at the frequency of the literal and metonymic senses rather than the ranking in dictionary definitions. As mentioned earlier, for seven items, the metonymic sense was the most frequent sense in the corpus. Not surprisingly, four out of the five items for which the basic sense was metonymic according to the dictionary also had this sense as the most frequent one (*embassy* being the exception). We reordered the items so that the 16 high-frequent senses, be they literal or metonymic, appeared in one condition and the 16 low-frequent senses in another. The same ANOVAs were computed, and the results, again, replicated the main analyses, with the exception that the tendency for the literal (now most frequent) sense to be easier to process than the familiar metonymic (now less frequent) sense on some measures (simple effects between LC-FM and MC-FM, see above) disappeared altogether: first-pass regressions, Region 3, $F_1(1, 27) = 1.11$, $p > .1$, $MSE = 109$ and $F_2(1, 15) < 1$; second-pass, Region 2 (both Fs < 1); total time, Region 2, $F_1(1, 27) < 1$ and $F_2(1, 15) = 3.01$, $p > .1$, $MSE = 29{,}330$; total time, Region 3, $F_1(1, 27) = 1.11$, $p > .1$, $MSE = 8{,}457$ and $F_2(1, 15) = 2.41$, $p > .1$, $MSE = 13{,}250$. These results, together with the results of the correlations (see above), provide no support for the hypothesis that the frequency of the senses influences reading times.

Experiment 2

Experiment 2 investigated the comprehension of place-for-event metonymies. We used four conditions equivalent to those in Experiment 1:

9a. During my trip, I hitchhiked around Vietnam, but in the end I decided to rent a car for a couple of days. (LC-FM)
9b. A lot of Americans protested during Vietnam, but in the end this did not alter the president's decision. (MC-FM)
9c. During my trip, I hitchhiked around Finland, but in the end I decided to rent a car for a couple of days. (LC-NM)
9d. A lot of Americans protested during Finland, but in the end this did not alter the president's decision. (MC-NM)

The context preceding the noun that literally refers to the place determines whether the noun has to be taken in a literal or a metonymic sense. Much of this is due to the preposition before the noun. In (9a), the preposition *around* indicates that *Vietnam* is to be interpreted literally (as one can go around a place), but the preposition *during* indicates that it must be interpreted metonymically (as something happening during a place is incongruous, whereas something happening during an event is possible). Both *Vietnam* and *Finland* literally refer to places. In addition, *Vietnam* has a (relevant) familiar metonymic interpretation (the Vietnam War), whereas *Finland* does not (see below). Hence, (9a) and (9c) have literal interpretations, and (9b) has a familiar metonymic interpretation; whereas (9d) has neither a literal nor a familiar metonymic interpretation. However, it may be straightforward to construct, on the fly, a metonymic interpretation for this condition (here, 9d). Novel place-for-event metonymies clearly occur regularly (e.g., after Princess Diana's death, it immediately became acceptable to say *The whole nation mourned after Paris*). Hence, although people may not immediately recall an event happening somewhere (e.g., in Finland), they may initially assume that some event did happen there. Later, they may realize that no salient event actually occurred at that place. This contrasts with sentences such as (7d) above (containing *answer to the stadium*) for which it may be less straightforward to infer a relevant institutional sense. Moreover, place-for-institution metonymies seem less productive than place-for-event metonymies given the limited number of edifices that can house an institution (in contrast to the unlimited number of places that can have events associated with them). Support for these observations comes from the pretests below.

In general, the predictions are similar to those for Experiment 1. The literal-first model predicts that (9a) and (9c) will be easier than (9b) and (9d), whereas the figurative-first model predicts that (9b) will be easier than (9a). The parallel model predicts no difficulty with (9a–c) but difficulty with (9d). But this difficulty might be reduced in comparison with the difficulty associated with (7d) in Experiment 1.

Method

Participants. This experiment was run together with Experiment 1 and therefore used the same 28 participants.

Items. The item specifics are given in Table 2. We conducted a plausibility test as in Experiment 1, and thereby selected 16 sets of four sentences such as (9a–d) above (see the Appendix). Additionally, we determined whether participants would be likely to associate particular events with given place names. Ten participants were read a list of place names one by one and were given 30 s per place name to come up with an associated event (or events). The relevant event was associated with expressions with familiar metonymic senses (e.g., *Vietnam*) 98% of the time (minimum of 80%); whereas an event was associated with expressions without familiar metonymic senses (e.g., Finland) only 4% of the time (maximum of 10%).

Other pretests were as Experiment 1. The LC-FM, LC-NM, and MC-FM conditions did not differ in plausibility (all Fs < 1), whereas the MC-NM condition differed from each of the other conditions (all ps $< .01$). Note that the plausibility of the MC-NM sentences (e.g., 9d) was considerably higher than the MC-NM sentences from Experiment 1 (3.2 vs. 0.8), whereas the plausibility of the other sentences was comparable. Because almost no one associated the place names in the MC-NM condition with an event, these differences reflect genuine differences in type of metonymy rather than item selection. Predictability was very low overall but somewhat higher for two items in the MC-FM condition (Vietnam = 16% and Chernobyl = 23%). This is still very low, and data analyses with those two items taken out produced comparable results.

In contrast to Experiment 1, the literal sense was considerably more frequent than the metonymic sense. Note, however, that new place-for-event metonymies develop regularly, and hence the corpus may have been out of date in some respects. For two expressions, the associated events happened too recently to be reflected in the database (the Olympic Games in Atlanta, Georgia, and the shootings in Dunblane, Scotland). These two items were therefore excluded from the correlations (see below).

Procedure and analyses. Procedure was identical to Experiment 1. The only difference in analysis was that the noun region

Table 5
Experiment 2: Means for First-Pass Times, First-Pass Regressions, Second-Pass Times, and Total Times

Variable	LC-FM/NM = / MC-FM/NM =	Region 1 (beginning)	Region 2 (noun)	Region 3 (postnoun)	Region 4 (end-of-line)
	LC-FM/NM =	*During my trip, I hitchhiked around*	*Vietnam/Finland*	*, but in the end*	*I decided to*
	MC-FM/NM =	*A lot of Americans protested during*	*Vietnam/Finland*	*, but in the end*	*this did not*
First pass (ms)					
LC-FM		1,293 (395)	349 (86)	330 (111)	431 (137)
MC-FM		1,390 (487)	353 (74)	322 (119)	405 (112)
LC-NM		1,315 (463)	332 (75)	352 (130)	390 (126)
MC-NM		1,383 (425)	342 (94)	354 (130)	442 (153)
First-pass regressions (%)					
LC-FM		0	18.2 (15.2)	4.0 (7.7)	12.3 (12.5)
MC-FM		0	17.9 (19.4)	6.0 (9.4)	9.6 (10.7)
LC-NM		0	17.4 (17.5)	1.3 (5.2)	9.8 (9.2)
MC-NM		0	22.7 (17.5)	6.3 (8.0)	17.2 (18.6)
Second pass (ms)					
LC-FM		219 (251)	36 (45)	48 (49)	43 (60)
MC-FM		227 (334)	35 (59)	44 (69)	49 (131)
LC-NM		241 (318)	31 (58)	68 (171)	45 (97)
MC-NM		396 (360)	67 (80)	90 (133)	54 (106)
Total time (ms)					
LC-FM		1,512 (444)	413 (115)	385 (134)	505 (171)
MC-FM		1,616 (682)	398 (108)	375 (146)	472 (197)
LC-NM		1,557 (618)	382 (101)	418 (194)	477 (227)
MC-NM		1,772 (635)	450 (174)	461 (207)	535 (207)

Note. Standard deviations are presented in parentheses. LC-FM = literal context–familiar metonymic; MC-FM = metonymic context–familiar metonymic; LC-NM = literal context–no familiar metonymic; MC-NM = metonymic context–no familiar metonymic.

consisted of the critical noun alone, as illustrated in (10):

10. A lot of Americans protested during/ Vietnam/, but in the end/ this did not/ alter the president's decision.

Results

Prior to all analyses, we excluded sentences with major tracker losses (9% of trials) and trials for which participants skipped the first region or two consecutive regions (7% of trials). Overall, questions were answered correctly on 94% of trials. Table 5 presents mean first-pass times, first-pass regressions, second-pass times, and total times. Table 6 presents statistical analyses for these data.

Exactly as in Experiment 1, we subjected the data to separate Context (literal context vs. metonymic context) × Sense (familiar metonymic sense vs. no familiar metonymic sense) ANOVAs for each measure and for each region. We again restrict ourselves to a discussion of those regions and measures for which an interaction effect was observed. As can be seen from Table 6, the earliest effect found was the first-pass regression effect in Region 4, the region following the postnoun region. Simple effects analyses showed that this was caused by a significant increase in the number of regressions for MC-NM, whereas the other conditions did not differ from each other. The second-pass times showed a comparable interaction effect in Regions 1 and 2, due to lengthened reading times for the MC-NM condition. The total reading times showed similar patterns, but the interactions were mainly restricted to Region 2.

Correlations of the relative frequencies with the differences in reading times and percentages of regressions for LC-FM minus MC-FM did not show any significant effect (all $ps > .1$).[5]

Discussion

Experiment 2 found that readers encountered difficulty with nouns without a familiar place-for-event metonymic sense when prior context required such an interpretation. This mirrored the findings of Experiment 1 and suggests similarities between place-for-institution and place-for-event metonymies. However, the processing difficulty was considerably delayed, appearing well downstream of the critical noun and on measures of reanalysis.

As in Experiment 1, the literal-first model predicted immediate difficulty with both metonymic context conditions. However, there was no difficulty with the MC-FM condition and delayed difficulty with the MC-NM condition. There was no hint of difficulty for the MC-FM condition compared with the LC-FM condition; in other words, the familiar metonymic sense was every bit as straightforward to process as its literal control. Hence, the results provide no support for the figurative-first model either. In contrast, the results fit with the parallel model, just as in Experiment 1.

[5] First-pass: Region 2, $r = .164$, Region 3, $r = .035$; first-pass regressions: Region 2, $r = -.013$, Region 3, $r = -.195$, Region 4, $r = -.14$; second-pass: Region 2, $r = .225$, Region 3, $r = -.126$; total time: Region 2, $r = .386$; Region 3, $r = -.049$.

Table 6
Experiment 2: Analysis of Variance and Mean Square Errors (in Parentheses) for First-Pass Times, First-Pass Regressions, Second-Pass Times, and Total Times

Variable	Region 1 (beginning)		Region 2 (noun)		Region 3 (postnoun)		Region 4 (end-of-line)	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
First pass								
Context	6.94* (191,303)	4.43(*) (107,923)	<1 (1,373)	1.69 (1,302)	<1 (245)	<1 (162)	1.18 (4,662)	<1 (2,989)
Sense	<1 (1,485)	<1 (<1)	2.42 (5,478)	3.14(*) (4,434)	8.37** (20,215)	18.39*** (12,663)	<1 (70)	<1 (10)
Interaction	<1 (6,040)	<1 (2,505)	<1 (372)	<1 (158)	<1 (718)	<1 (1,589)	3.04(*) (41,541)	6.49* (21,289)
LC-FM vs. MC-FM							<1 (9,185)	1.27 (4,162)
LC-NM vs. MC-NM							2.71 (37,018)	6.13* (20,116)
LC-FM vs. LC-NM							1.65 (22,513)	3.1(*) (10,180)
MC-FM vs. MC-NM							1.4 (19,098)	3.39(*) (11,120)
First-pass regressions								
Context			1.37 (175)	<1 (103)	6.97* (334)	5.26* (185)	2.06 (156)	<1 (87)
Sense			1.49 (118)	<1 (62)	<1 (38)	<1 (25)	1.19 (182)	<1 (81)
Interaction			<1 (222)	<1 (138)	1.63 (65)	<1 (38)	5.21* (711)	6.14* (442)
LC-FM vs. MC-FM							<1 (100)	<1 (68)
LC-NM vs. MC-NM							5.62* (766)	6.4* (460)
LC-FM vs. LC-NM							<1 (87)	1 (72)
MC-FM vs. MC-NM							5.91* (806)	6.27* (451)
Second pass								
Context	5.36* (182,415)	4.03(*) (117,497)	4.32* (8,303)	2.38 (4,814)	<1 (1,887)	<1 (1,762)	<1 (1,716)	<1 (1,059)
Sense	10.88** (255,924)	13.27** (150,935)	2.24 (4,755)	2.42 (2,897)	2.55 (30,484)	4.23(*) (17,018)	<1 (296)	<1 (358)
Interaction	3.52(*) (43,182)	5.95* (15,266)	6.73* (9,124)	4.2(*) (5,262)	1.56 (4,701)	1.18 (3,778)	<1 (28)	<1 (80)
LC-FM vs. MC-FM	<1 (702)	<1 (861)	<1 (10)	<1 (5)				
LC-NM vs. MC-NM	7.73** (333,527)	13.59** (207,402)	12.85** (17,417)	8.04* (10,071)				
LC-FM vs. LC-NM	<1 (6,758)	<1 (3,805)	<1 (353)	<1 (175)				
MC-FM vs. MC-NM	9.29** (400,980)	15.58** (237,897)	9.98** (13,526)	6.37* (7,984)				
Total time								
Context	9.27** (715,872)	8.93** (43,938)	3.82(*) (20,512)	2.83 (10,772)	1.59 (8,686)	1.15 (7,983)	<1 (4,289)	<1 (4,362)
Sense	6.63* (280,358)	8.18* (142,563)	<1 (3,009)	<1 (1,349)	6.54* (100,719)	9.55** (58,332)	<1 (8,451)	1.53 (7,935)
Interaction	<1 (86,160)	1.46 (56,238)	8.97** (47,651)	2.77 (26,368)	1.99 (18,958)	3.13(*) (11,682)	2.07 (58,371)	3.34(*) (28,931)
LC-FM vs. MC-FM			<1 (2,818)	<1 (1,717)				
LC-NM vs. MC-NM			12.3** (65,345)	3.73(*) (35,424)				
LC-FM vs. LC-NM			2.52 (13,356)	<1 (7,895)				
MC-FM vs. MC-NM			7.02** (37,304)	2.09 (19,822)				

Note. F_1 = participant analyses; F_2 = item analyses. Degrees of freedom for F_1 are 1 and 27; degrees of freedom for F_2 are 1 and 15. LC-FM = literal context–familiar metonymic; MC-FM = metonymic context–familiar metonymic; LC-NM = literal context–no familiar metonymic; MC-NM = metonymic context–no familiar metonymic.
*$p < .05$. **$p < .01$. ***$p < .001$. (*) = approached significance (between the .1 and .05 level).

General Discussion

Experiment 1 showed that the processor is able to rapidly adopt a familiar place-for-institution metonymic interpretation for an expression. The results are hard to reconcile with both literal-first and figurative-first accounts of figurative language processing but are compatible with the parallel model, in which the processor accesses literal and metonymic interpretations together. Experiment 2 showed that the processor can also rapidly adopt a familiar place-for-event metonymic interpretation for an expression. These results were also most compatible with the parallel model. Additionally, they suggested that people may initially attempt to provide an interpretation for novel place-for-event metonymies.

We believe that these results shed light on conflicting data concerning the processing of figurative language. Some previous experiments have supported the literal-first model, whereas others have supported the figurative-first model, for various kinds of figurative language. However, as we discussed earlier, most previous experiments have failed to use an appropriate on-line technique, and most have not identified a sufficiently restricted region so that initial stages of analysis can be investigated. Experiments 1 and 2 avoided these problems by using eye tracking to look at short regions during early stages of analysis, in a similar manner to work on lexical ambiguity resolution (e.g., Rayner & Duffy, 1986) and parsing (e.g., Frazier & Rayner, 1982). Our results therefore support the parallel model for the processing of familiar metonymy. We now explore the nature of this account in more detail and then relate it to the processing of figurative language in general.

Fully Specified or Underspecified?

We can distinguish two versions of the parallel model. A *fully specified account* assumes that representations of all senses are activated separately (as in homonyms); an *underspecified account* assumes that a single representation is activated initially, and the processor subsequently "homes in" on the appropriate (literal or metonymic) sense. (We class this as a kind of parallel model for ease of exposition, although there is a sense in which an underspecified account is different from a parallel one.)

We can make a further distinction within the fully specified account. According to the *ranked version,* the different senses of a word are activated according to their relative frequency of occurrence; according to the *unranked version,* all senses are equally activated (see Mitchell, 1994, for similar distinctions in syntactic ambiguity).

In Experiments 1 and 2, we found no correlations between the frequency of literal versus metonymic senses for the expressions with a familiar metonymic sense (e.g., *the convent*) and the difference between the reading times for the LC-FM (e.g., *purchase the convent*) and MC-FM (e.g., *answer to the convent*) conditions (even though relative frequencies varied greatly across items). The additional analyses, in which basic senses were contrasted with derived senses and more frequent senses were contrasted with less frequent senses, also showed no immediate difference between LC-FM and MC-FM.

Furthermore, in Experiment 2, we found no overall preference for the LC-FM condition over the MC-FM condition, even though the literal sense was almost three times as frequent as the familiar metonymic sense (74% vs. 26%). Although these data show essentially null effects, their contrast with frequency effects in homonym resolution is striking (Duffy et al., 1988; Rayner & Duffy, 1986; Rayner & Frazier, 1989). Hence, the results disfavor the ranked version of the fully specified account.

We now argue that there are several reasons to favor the underspecified account over the unranked version of the fully specified account. First, the underspecified account is compatible, on the one hand, with Frazier and Rayner's (1990) data and their minimal commitment account (see also Gildea & Glucksberg, 1983, p. 585) and, on the other, with recent proposals in linguistics (e.g., Bezuidenhout, 1997; Langacker, 1987) and computational semantics (e.g., Poesio, 1991; Van Deemter & Peters, 1996). Second, any fully specified account faces the problem that there can be very large numbers of familiar metonymic interpretations for an expression (e.g., *the professor* can refer to a statue of the professor, a picture of the professor, an article by the professor, and so on; see Pickering & Traxler, 1998). Even if the processor only activates some senses, it is unclear why the appropriate sense should turn out to be one of those adopted. But our experiments found no problem with familiar metonymic senses in general. Third, the lack of a relationship between frequency and difficulty suggests a very different process from that found in the resolution of homonyms, which obviously require separate representations, as they have unrelated meanings.

In the underspecified account, one abstract, underspecified meaning of a word with a familiar metonymic sense and a literal sense is initially activated. This meaning is, of course, the same for both senses. Hence, no extra processing is predicted for either sense initially (see Gildea & Glucksberg, 1983). Likewise, no correlation is expected between initial reading times and the relative frequency of the senses. Both of these predictions are supported by our results. Once readers have used this underspecified meaning to assign a (rather abstract) semantic value to an expression, they can home in on the intended sense by instantiating any underspecified features. We exclude homonyms from this account, because the two meanings of a homonym are unrelated.

However, it may not be obligatory to determine the exact sense if the context is vague with respect to the appropriate interpretation. As long as some semantic value can be assigned to an expression, without making the sentence semantically incongruous at that point (and as long as it is not a homonym), readers may not have to choose between the different senses of that word (see Frazier & Rayner, 1990). Our experiments, of course, do not directly address this issue.

Implications of the Underspecified Account

We developed this account in relation to the processing of metonymic expressions. However, the contrast between accounts (literal-first vs. figurative-first vs. parallel and fully specified vs. underspecified) might apply much more generally. It is clear that many of the advantages of the underspecified account would hold for other kinds of figurative language. For instance, by using an underspecified meaning during initial processing, the processor will never assign the wrong sense. Furthermore, semantic processing can proceed rapidly without having to rely on context acting as a judge.

As noted earlier, not all cases of related meanings for words are metonymic. For example, Frazier and Rayner (1990) also used concrete versus abstract senses of words that are not metonymically related (e.g., *poem* referring to the written-down vs. spoken version). We hypothesize that the underspecified account extends to such examples and is therefore not restricted to metonymies.

The account may also extend to metaphors. Although many metaphors are clausal or sentential, the distinction between metaphor and metonymy is not based on the length of the expression but rather on the kind of mapping between literal and figurative interpretations. In one-word metaphors such as *flew* in *The man flew down the road,* the literal and metaphorical interpretations share many features (such as speed), and therefore it may be possible to set up an underspecified meaning that is compatible with both senses of *flew* (so long, of course, as the reader appreciates the relationship between the senses). However, it may that the two senses are sufficiently distinct that separate representations are needed.

It is unclear whether to propose an underspecified account of the processing of clausal or sentential metaphors and idioms (in part because of the difficulties of determining localization and equating for predictability, as discussed earlier). Such an account may hold for multiword metaphors, because there may be no good reason to differentiate them from single-word metaphors. But an underspecified account of the processing of literal versus idiomatic interpretations of expressions is less likely, because there need be no semantic relationship between these interpretations.

Conclusion

Our results suggest that the processor can access a relevant familiar metonymic sense immediately and can therefore obtain these metonymic interpretations without appreciable difficulty. Our two experiments showed that readers could obtain place-for-event and place-for-institution metonymic interpretations as soon as the critical word was encountered; in contrast, words with no relevant metonymic interpretation caused disruption in the eye-movement record. The results are incompatible with both literal-first and figurative-first models of figurative language processing. Instead, they provide support for accounts in which the processor initially accesses a representation that is compatible with both literal and metonymic senses.

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Appendix

Experimental Items

For each item, the literal context versions of the item appear first, followed by the metonymic context versions. The words with familiar metonymic interpretations come before the "|" symbol; the words without familiar metonymic interpretations come after the "|" symbol. The "/" symbols delimit the regions of analysis. The final "/" symbol also indicates the line break.

Experiment 1: Place for Institution

We were told that the dean walked into/ the academy | bedroom/, exactly as/ everyone had/ expected him to do.
Ron heard that the professor addressed/ the academy | bedroom/, exactly as/ I had wished/ that he would do.

Those angry protesters surrounded/ the embassy | cottage/, but not much/ was achieved/ by it.
The minister had an argument with/ the embassy | cottage/, but not much/ more could be/ done.

Some of those workmen painted/ the store | sheds/, which really/ made everything look/ prettier.
The grateful old lady thanked/ the store | sheds/, which really/ was a nice gesture/ by her.

This morning, terrorists blew up/ the prison | statue/ in order to/ gain publicity for/ their cause.
These solicitors negotiated with/ the prison | statue/ in order to/ make their point/ a bit clearer.

The young children strolled to/ the school | bridge/ quite early on/ a sunny Wednesday/ morning.
The concerned father talked to/ the school | bridge/ quite early on/ a rainy Monday/ afternoon.

The agitated senator rushed into/ the headquarters | conservatory/, which was/ something none/ of us had been waiting for.
The guards got instructions from/ the headquarters | conservatory/, which was/ something nobody/ could have prevented.

The petty thief was thrown out of/ the court | tower/, just as his/ accomplice before/ him.
The famous drug smuggler provoked/ the court | tower/, just as his/ partner instructed/ him.

These two businessmen tried to purchase/ the convent | stadium/ at the end of/ last April,/ which upset quite a lot of people.
That blasphemous woman had to answer to/ the convent | stadium/ at the end of/ last March,/ but did not get a lot of support.

A lot of sight-seers stopped at/ the university | lighthouse/, although it was/ an official/ holiday.
These applicants consulted with/ the university | lighthouse/, although it was/ late in the/ afternoon.

That gentleman was taken to/ the palace | cellar/, according to the/ newspapers this/ morning.
The TV presenter displeased/ the palace | cellar/, according to the/ latest gossip in/ the tabloids.

Two days ago, a criminal set fire to/ the consulate | apartment/, but then he/ got arrested/ the same day.
Last Tuesday, the traveller spoke to/ the consulate | apartment/, and then he/ ran away in a/ great hurry.

The strikers gathered around/ the institute | roadblock/, which was not/ something that I/ advised them to do.
The teacher took advice from/ the institute | roadblock/, which was not/ a very sensible/ idea after all.

The cab driver dropped us off at/ the treasury | building/, which was not/ what we had/ anticipated.
The businessmen were grateful to/ the treasury | building/, which was not/ exactly what/ we wanted.

The worried young husband ran to/ the hospital | platform/ as soon as/ he had been/ informed about the accident.
That angry man threatened to sue/ the hospital | platform/ as soon as/ he had heard/ about the mistake that was made.

The photographer stepped inside/ the college | pyramid/ after he had/ received an official/ invitation.
That bright boy was rejected by/ the college | pyramid/ after he had/ bribed some crooked/ officials.

Those American visitors drove to/ the gallery | highway/, and did not/ encounter any/ major problems.
The young expert cooperated with/ the gallery | highway/, but did not/ exactly enjoy/ the experience.

Experiment 2: Place for Event

The landowner finally settled somewhere in/ Normandy | Colorado/ but did not/ want to sell/ his two houses in Yorkshire.
The German troops started retreating after/ Normandy | Colorado/ but did not/ accept defeat/ until several months later.

A guide gave us an excellent tour around/ Monaco | Dundee/, and then he/ recommended us/ a delightful restaurant.
This driver became a living legend after/ Monaco | Dundee/, and then he/ went on to win/ many more major events.

During my trip, I hitchhiked around/ Vietnam | Finland/, but in the end/ I decided to/ rent a car for a couple of days.
A lot of Americans protested during/ Vietnam | Finland/, but in the end/ this did not/ alter the president's decision.

During my holiday, I made an excursion to/ Auschwitz | Rotterdam/, and a lot of/ people did/ the same thing.
Many were accused of war atrocities after/ Auschwitz | Rotterdam/, and a lot of/ them were/ thrown in jail.

My wife used to live in a place near/ Hillsborough | Peterborough/, which explains/ why most of/ her friends are English.
New safety measures were taken after/ Hillsborough | Peterborough/, which explains/ why so many/ cameras had to be installed.

A lot of hikers used to camp just outside/ Woodstock | Leicester/, no matter/ what kind of/ weather it was.
Many music bands became famous because of/ Woodstock | Leicester/, no matter/ whether they/ played well or not.

The old surgeon volunteered to go to/ Chernobyl | Baltimore/, but nobody/ that he knew was/ willing to follow him.
Many deformed babies were born after/ Chernobyl | Baltimore/, but nobody/ has been able to/ accurately explain why.

It is difficult to find a good job near/ Atlanta | Chicago/, but it was not/ like that ten/ years ago.
A new record was set in swimming during/ Atlanta | Chicago/, but it was not/ by a British/ competitor.

The company had a new plant built outside/ Hiroshima | Vancouver/, which was/ in fact what/ the board had voted for.
The enemy was forced to resign because of/ Hiroshima | Vancouver/, which was/ in fact the/ only option open to them.

There are a lot of green fields around/ Ascot | Luton/, which is why/ you can find a lot/ of cattle there.
The bookmaker lost millions because of/ Ascot | Luton/, which is why/ he tried to commit/ suicide yesterday.

There are some very beautiful houses in/ Wimbledon | Stockholm/ but unfortunately/ many are/ not well taken care of at all.
Princess Anne is usually present during/ Wimbledon | Stockholm/ but unfortunately/ she could/ not attend the last day.

In summertime, it can become very warm in/ Cannes | Lisbon/, but that does/ not make the/ place any less enjoyable.
A new movie contract was signed following/ Cannes | Lisbon/, but that does/ not mean that/ all problems are solved now.

After retiring, the diplomat visited/ Maastricht | Portsmouth/, which allowed/ him to stop by/ some of his friends there.
Politics within Europe changed after/ Maastricht | Portsmouth/, which allowed/ everybody to/ work much closer together.

When he got in trouble, the gangster fled/ Kuwait | Canada/ although nobody/ knew for sure/ where his hiding place was.
Some allied soldiers got really ill after/ Kuwait | Canada/ although nobody/ wants to take/ any responsibility for this.

This alleged arms smuggler was evicted from/ Bosnia | Sweden/, and a lot/ of weapons/ were later found at his brother's.
A number of major cities were bombed during/ Bosnia | Sweden/, and a lot/ of civilians/ died or sustained heavy injuries.

Last weekend, the reporter drove through/ Dunblane | Basildon/, and a lot/ of people/ were looking very suspiciously at him.
The whole country was shocked because of/ Dunblane | Basildon/, and a lot/ of different/ groups called for immediate action.

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