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Obtaining a Figurative Interpretation of a Word: Support for Underspecification

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Based on the results from a number of eye-tracking experiments, Frisson and Pickering (1999) and Pickering and Frisson (2001) proposed a model for the on-line processing of words with semantically related senses. According to this model, only the underspecified, schematic meaning of a word with multiple senses is activated initially. This underspecified meaning encompasses all related senses that are established in someone's lexicon. Once this underspecified meaning has been used to assign a semantic value, it can be followed by a homing-in stage in which context is used to arrive at the contextually appropriate sense. This article discusses the implications of the underspecification model with respect to the processing of figurative language and asserts that this model gives a better account of how incremental semantic processing can proceed smoothly and flexibly. In conclusion, the model is related to the linguistic distinctions of polysemy and monosemy, and it is argued that, at this moment in time, there is no compelling evidence to postulate more than one underspecified meaning.

This article aims to explicate the way in which people obtain a figurative interpretation for a word. Most literature on figurative language is concerned with whole ex-

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pressions or sentences, but the processing of individual words is extremely well researched in other areas of psycholinguistics. We argue understanding lexical ambiguity and its resolution allows us to understand the time-course of figurative language processing. The first part of the article considers the nature of lexical ambiguity resolution and how it can be applied to figurative language by considering the way that the processor decides whether to interpret a word literally or figuratively. It then relates current figurative language processing models to such lexical ambiguities. For example, the processor might always access a literal interpretation before a figurative one, might access all interpretations in parallel, or might use context to determine which interpretation to access. However, we present arguments in favor of a rather different kind of account, the underspecification model, whereby the processor initially accesses an interpretation that can be compatible with both figurative and literal interpretations. We outline recent eye-tracking evidence that provides support for this account. The final section proposes more details about the underspecification model and briefly addresses such issues as how the processor is eventually able to "home in" on a fully specified interpretation.

SENSE AMBIGUITY AND FIGURATIVE LANGUAGE

This article is primarily concerned with figurative interpretations of individual words. We focus on probably the best-known example of this—namely, metonymy. The italicized word has a metonymic interpretation in 1 and 2:

1. That blasphemous woman had to answer to the *convent*.
2. A lot of Americans protested during *Vietnam*.

In 1, *the convent* does not refer literally to a building. Instead, it refers to the institution that is associated with that building. In 2, *Vietnam* refers not to the country itself, but rather to the highly salient war. In these cases, as in other metonymic expressions, one salient aspect of an entity is used to refer to the entity as a whole or some other aspect of the entity. However, we note that not all single-word figurative expressions are metonymic. In *"The car flew down the road,"* for instance, the verb *flew* means (roughly) "traveled very fast," which is presumably metaphorical rather than metonymic. For our purposes, it is not important whether a figurative interpretation of a word should be classed as metonymic or metaphorical.

Much more critically, we assume that the distinction between a figurative and a literal interpretation of a word is one of *sense* rather than *meaning*. Meanings are unrelated, whereas senses are related. Words with multiple meanings are often known as *homonyms*. Examples are *bank*, meaning a "river" bank or "money" bank, and *ruled* (as in ruled a country or ruled a line). Obviously, the critical point is that people regard the meanings as unrelated; it is irrelevant whether they are

etymologically related. In contrast, words with multiple senses have two related interpretations. For instance, *the novel* can refer to a particular object (e.g., in *The novel was soaked by coffee*) or to an abstract interpretation (e.g., *The novel got great reviews*), and the verb *paint* can refer to merely applying paint on a surface (e.g., *paint the wall*) or to doing this in an artistic way (e.g., *paint a portrait*). It is important to stress that neither sense need be figurative. When a word does have both a literal and a figurative interpretation, however, these interpretations are generally related. Hence, literal–figurative ambiguities like *convent* and *Vietnam* are sense ambiguities. We also assume that words with figurative interpretations also always have literal interpretations. Hence, it is not surprising that accounts of sense-ambiguity resolution (Frazier & Rayner, 1990) and accounts of the resolution of literal–figurative ambiguities that are localized to an individual word (Frisson & Pickering, 1999) have much in common.

Notice that we have not addressed the difficult question of when two different uses of a word involve different senses and when they involve the same sense (Tuggy, 1993). This is probably a much harder distinction to make than the distinction between different senses and different meanings. When one use of a word is figurative and another is literal, however, it is fairly uncontroversial that two different senses are implicated. Hence, this issue is not too important for our purposes.

A final important distinction is between familiar, or *established*, and unfamiliar, or *novel*, figurative interpretations for a word. In this article we are not concerned with the way that people adopt novel interpretations for words, but restrict ourselves to the discussion of the way that they select between pre-existing interpretations. In other words, we are only concerned with established senses. We assume that established senses have been conventionalized in the language and are thus part of a person's lexical knowledge. For example, the *wing* of an airplane is an established interpretation of the word *wing*. Hence, in this article we restrict ourselves to the issue of *sense selection* and do not consider *sense creation* (see Brisard, Frisson, & Sandra, in press; Clark & Gerrig, 1983; Gerrig, 1989)

INCREMENTAL INTERPRETATION AND FIGURATIVE LANGUAGE

A great deal of evidence indicates that both spoken and written language comprehension is essentially incremental, with the interpretation of each new word being incorporated into the unfolding meaning of the utterance pretty much as soon as it is encountered (e.g., Just & Carpenter, 1980; Tyler & Marslen-Wilson, 1977; see articles in Garrod & Pickering, 1999). For example, a striking finding is that semantic anomalies can lead to increased processing difficulty as soon as a word is read. In Traxler and Pickering (1996), people read sentences like 3 below:

3. That's the very small pistol in which the heartless killer shot the hapless man yesterday afternoon.

Not surprisingly, they found this semantically anomalous sentence harder to read than plausible control sentences (e.g., replacing *in* with *with*). What was striking was that, as soon as readers first encountered the anomalous word *shot*, eye fixation times increased. The point is that the sentence becomes implausible at *shot* but not before. Hence, people must have interpreted *shot* with respect to the prior context immediately when they encountered the word.

This incrementality means that the processor could in principle use context to have very rapid effects on the process of ambiguity resolution. In many cases, prior context makes it clear (or very likely) which meaning or sense of a word is appropriate. The evidence suggests that context plays this very rapid role in the resolution of words with multiple meanings (i.e., homonyms). We might therefore predict that it also plays a rapid role in the resolution of words with literal and figurative senses. In the following, we consider this suggestion.

We must first outline the way in which the processor disambiguates homonyms in context. Aspects of this process are highly controversial, but there are helpful areas of agreement. Most researchers agree that both meanings of a homonym are initially activated (e.g., Swinney, 1979; Tanenhaus, Leiman, & Seidenberg, 1979), except perhaps when the most frequent meaning has strong contextual support (Tabossi, 1988) or when one meaning is immediately preceded by an associatively related word that can prime one interpretation (Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982). Context has a rapid effect on ambiguity resolution, with contextually inappropriate interpretations being rapidly suppressed (e.g., Swinney, 1979). The process by which the processor adopts the appropriate meaning is affected by both the context and the relative frequencies of the meanings (see, e.g., Binder & Rayner, 1998; Rayner, Binder, & Duffy, 1999; Rayner & Duffy, 1986; Rayner, Pacht, & Duffy, 1994; Sereno, Pacht, & Rayner, 1992). In isolation or neutral contexts, most theories agree that meanings are accessed in order of frequency, with less frequent meanings being accessed later. In context, the situation becomes rather less clear. According to some accounts, context cannot affect the order of access but merely affects the way in which a meaning is integrated with the context (e.g., Rayner & Frazier, 1989). Other theories assume that context can facilitate the access of an infrequent meaning but cannot inhibit the access of a frequent meaning (Dopkins, Morris, & Rayner, 1992; Duffy, Morris, & Rayner, 1988). More interactive accounts assume that context can override frequency and cause an infrequent meaning to be accessed first if the context is strong enough (Kellas & Vu, 1999). Even in such accounts, however, frequency is a major determinant of order of access, all other things being equal. Hence, the resolution of homonyms is either frequency based or more generally interactive, but with frequency constituting a major factor.

There has been much less work on the processing of sense ambiguities. One important exception is Frazier and Rayner (1990), who used eye tracking to investigate the processing of nouns with multiple senses (e.g., *novel*) and multiple meanings (e.g., *ball*) and compared them to unambiguous nouns like *door*. Their results showed that homonyms were processed differently from words with multiple senses, which behaved much more like unambiguous words. For example, when disambiguating information followed the ambiguous noun, nouns disambiguated to the subordinate meaning caused difficulty compared with nouns disambiguated to the dominant meaning. Apparently people generally adopted the dominant meaning soon after they encountered the word. However, a comparable difference did not emerge for nouns with multiple senses. Thus, they concluded that people did not perform immediate sense disambiguation in the absence of prior disambiguating context. In fact, it appears that senses did not get accessed in order of frequency. Frazier and Rayner proposed a "minimal semantic commitment" model in which a single semantic value is only assigned immediately when two interpretations are incompatible.

Hence, a large body of research has attempted to understand the stages involved in the resolution of meaning ambiguities, though there has been much less work on sense ambiguities. Notice that these experiments have carefully localized effects to the word under investigation and have employed techniques that are sensitive to the earliest stages of processing. Studies of figurative language processing have similarly attempted to provide accounts of the initial stages of processing. Unfortunately they have paid much less attention to the accurate localization of effects and have often not employed techniques that are sensitive to early processing.

First, a number of expressions derive their figurative interpretation not on the basis of the activation of a figurative sense of a word, but rather through the combination with other lexical elements in the sentence. Hence, it is possible to have figurative expressions consisting of words that in themselves do not have figurative senses. This is, for example, the case for attributive metaphors like *"Some jobs are jails."* Although there are many theories of how such figurative expressions are interpreted (for an overview, see Cacciari & Glucksberg, 1994), it is often hard to determine the exact point at which the expression clearly becomes a metaphor. (The same argument can be made concerning idioms like *"crying over spilled milk."*) In contrast, literal–figurative sense ambiguities (i.e., words that have both a literal and a figurative sense) can be appropriately localized, just like homonyms. In these cases, lexical access is the important topic. Figurative language processing models, as we will see, differ exactly at the lexical access stage. However, they do not always seem to make a distinction between these different types of figurative expressions.

Second, although a lot of attention has gone to appropriate measuring techniques in the meaning ambiguity literature (see, e.g., Simpson, 1994), the methodologies used in the figurative language research are in general too insensitive to derive anything with respect to the earliest processing stages (though see Blasko & Connine,

1993, and McElree & Nordlie, 1999). Many experiments in the literature only considered reading times for entire sentences or large sentence fragments (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). Although such experiments can tell us how much time is needed to achieve a complete or specific interpretation for a certain figurative expression, they say little about *how* this interpretation has developed over time, nor are they able to localize effects to particular words. The only eye-tracking experiments dealing with metaphors that have been reported (Inhoff, Lima, & Carroll, 1984) also suffered from a lack of sensitivity. Although they had the advantage of investigating shorter regions, only total reading times (i.e., the total viewing time on a word or region) were examined, and, as we shall see, these do not necessarily coincide with the reading pattern observed in the earliest stages of processing. Pickering and Traxler (1998) used eye tracking to examine the processing of metonymic expressions in syntactically ambiguous "garden-path" sentences. Although the presence of a plausible metonymic interpretation of the expression affected ease of recovery from an initial syntactic misanalysis, the results were not informative about the initial stages of figurative language processing.

A number of experiments made use of indirect techniques and measured, for example, how quickly an interpretable figurative expression could be rejected as being literally false (e.g., Gildea & Glucksberg, 1983; Glucksberg, Gildea, & Bookin, 1982; Keysar, 1989; Swinney & Cutler, 1979). Other experiments looked at reactions to a stimulus that was either related or unrelated to a figurative or literal expression (e.g., Giora & Fein, 1999), and yet others simply had participants 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). Although all these experiments are interesting in their own right, they do not allow us to deduce what happens during the earliest stages of processing because reactions or reading times are only measured *after* the expression has been processed to a large extent. We therefore agree with Gibbs (1992; see also Dascal, 1989) when he pointed out that "most theories of metaphor draw unjustified conclusions about the entire time-course of interpretation" (p. 575). Indeed, we would extend the criticism to theories of other aspects of figurative language processing.

There have been many other problems with studies of the initial stages of figurative language processing. For example, frequency has hardly ever been taken into account. Likewise, plausibility of an expression and predictability of upcoming words has not been controlled for (e.g., the likelihood of the idiomatic *milk* after *"crying over spilled"* is surely much greater than any given nonidiomatic word), and there has been little attempt to control for lexical priming by individual words in the context. In addition, most studies have not determined whether a particular figurative sense is conventionalized or novel. It is quite possible, for instance, that the

adoption of novel senses is delayed, but the adoption of conventionalized figurative senses is more straightforward. In short, the experimental data give no conclusive evidence for current models of figurative language processing.

APPLYING MODELS OF FIGURATIVE LANGUAGE PROCESSING TO SENSE AMBIGUITY RESOLUTION

Over the last 20 years or so, a whole array of models has been proposed to account for the comprehension of figurative language. Most of these accounts have paid little attention to the way in which words with multiple senses are disambiguated, even though many such words have at least one figurative sense. In this section, we discuss these accounts in relation to the resolution of individual words. We consider when these models make predictions that can be straightforwardly tested, just as theories of the resolution of homonyms can be and have been tested. In the next section, we relate these theories to recent eye-tracking evidence (Frisson & Pickering, 1999; Pickering & Frisson, 2001). The way that we categorize these accounts may be somewhat unusual and reflects the fact that we focus on the relevance of such accounts to single word ambiguities.

Frequency-Based Models

If sense ambiguity resolution is similar to meaning ambiguity resolution, and if lexical literal–figurative ambiguities (e.g., *Vietnam* as country or event) are a type of sense ambiguity, then we predict that the principles involved in homonym resolution would also hold for such literal–figurative ambiguities. If the more modular models of homonym resolution are supported, then meanings are accessed in order of frequency (or, possibly, something very closely related to frequency such as age of acquisition). We might therefore predict that senses would be accessed in order of frequency as well, and order of access would be unaffected by whether a particular sense was literal or figurative. Therefore, the first sense to be accessed would be the most frequent sense. This model does not seem to have been proposed explicitly in the figurative language literature. However, assuming that literal–figurative ambiguity is a type of sense ambiguity, and assuming Frazier and Rayner's (1990) conclusions hold, frequency is unlikely to be the determinant of the order of activation of senses. Another possibility is that the ordering of senses may depend on *saliency*, which is defined in terms of familiarity, conventionality, frequency, and prototypicality (e.g., Giora, 1997, in press).

Literal-First Model

This model, developed mainly by Grice (1975, 1989) and Searle (1979), holds that a figurative interpretation will only be sought after the literal interpretation has been re-

jected. Rejection of the literal interpretation occurs when one of the conversational maxims (e.g., the requirement that an interpretation needs to be informative) has been violated. The original literal-first model maintained that the figurative interpretation cannot begin until the whole utterance had been processed. However, it is now evident that interpretation is incremental and that semantic anomalies can be detected during the processing of a sentence, not just at its end. Thus, a more reasonable version of this model would predict that the figurative interpretation could be computed as soon as the literal interpretation became anomalous.

There are a number of reasons to believe that the literal-first model is reasonable. For example, when placed in a neutral or short prior context, the figurative interpretation of an expression is harder than the literal interpretation (Inhoff et al., 1984; Ortony et al., 1978; see also Gibbs, 1990; Pynte, Besson, Robichon, & Poli, 1996), although this disadvantage disappears when it is preceded by a more extensive context. In addition, most, if not all, figurative senses are derived from the literal sense (possibly, but not necessarily, by means of an underlying conceptual metaphor), and the literal sense can restrict or guide the figurative interpretation (see Paivio, 1979).

This model has come under considerable attack because experiments have shown that a figurative interpretation can, under certain conditions, be processed as quickly as a literal interpretation (e.g., Glucksberg et al., 1982). However, it is unclear whether such studies are indicative of the earliest stages of processing, and the *on-line* evidence against this model is rather limited. The model does, however, have difficulty explaining the results of Blasko and Connine (1993), McElree and Nordlie (1999), and our eye-tracking results described in the following. Using a cross-modal priming task, Blasko and Connine studied familiarity and aptness in metaphoric constructions like *"The family is a rock."* When compared to a control word, both the literal-related target word ("hard") and the metaphorical-related target word ("secure") showed immediate priming effects for highly familiar metaphoric constructions. McElree and Nordlie (1999) used the speed-accuracy trade-off task, in which participants are trained to respond immediately after hearing a tone, and found evidence that, initially, literal and metaphoric interpretations are computed in parallel. They also observed that, ultimately, the literal strings were easier to judge as being meaningful expressions. Of interest, this result led them to the conclusion that the interpretations of the metaphoric strings were less constrained than the interpretations of the literal strings.

Figurative-First Model

This model, which is the opposite of a literal-first model, holds 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 figura-

tive-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; Frisson & Pickering] 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; Gibbs & Gonzales, 1985; although cf. Colombo, 1993; Estill & Kemper, 1982). On 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 literal–figurative sense ambiguities that are limited to one word. Another version of this account assumes that the processor adopts the conventional (i.e., figurative) interpretation of idioms first, however, 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).Taken to an extreme, this version of the account therefore amounts to a general figurative-first model. For expressions that have both a literal and an established figurative interpretation, it predicts that the processor accesses the figurative interpretation before the literal interpretation (see also the discussion in Chiappe, 1998).

Although it might be justified to claim that figurative language is very pervasive in natural language (e.g., Lakoff, 1987), a general figurative-first model seems unlikely. For example, the finding that in neutral or short prior contexts the figurative interpretation requires more processing effort is strong evidence against this model (see previous discussion). Moreover, a word can have many different figurative interpretations, and it is unclear how the processor will select the right one.

Direct Access Model

The direct access model (Gibbs, 1994) proposes that a figurative sense can be accessed directly in "realistic social contexts" (p. 421). These contexts are thought to provide a pragmatic framework in which the figurative expression can be understood "without having to first analyze and reject their said [i.e., literal; Frisson & Pickering] meanings" (p. 421). In the other cases, the literal sense is accessed. The model explains the observed advantage for literal interpretations in neutral or short prior contexts (see previous discussion) and the equal processing times when figurative expressions are placed in longer figurative-inducing contexts.

This model is an extreme version of an interactive model, in that it assumes that context can indicate which sense of a literal–figurative sense ambiguity should be accessed. It is hard to see how this model could be correct in general, simply because it is hard to see how contexts could in general set up a clear expectation for a figura-

tive (or indeed a literal) sense. Consider *A lot of Americans protested during Vietnam*. It might appear that after *during* the processor could assume a figurative sense would follow. Any number of continuations are possible, however, some figurative (like this one), many literal (e.g., replacing *Vietnam* with *the winter*). Even if the context was sufficiently constraining that a continuation referring to the Vietnam war was extremely likely, the actual words could be *Vietnam*, which is figurative, or *the Vietnam war*, which is literal. It is difficult to imagine that direct access is a normal part of figurative language processing, even if a strongly interactive model is assumed (see also discussion of Frisson & Pickering, 1999, in the following). Moreover, because the figurative sense of a word is generally less frequent than the literal sense, it is unclear why the right (subordinate) *sense* of a word can be accessed immediately, but not the right (subordinate) *meaning* of a homonym.

Unranked Parallel

The unranked parallel model assumes that all senses are activated at the same time, and the reader has to choose which sense is applicable for a given context. Such an account may never actually have been proposed in the literature, but it is a reasonable possibility and is probably compatible with the results of Frazier and Rayner (1990). However, it faces the severe problem that many words have a very large number of different senses. For example, *Vietnam* can refer to a geographical space, an event, the government (*Vietnam raised interest rates*), a soccer team, and so on (though it is perhaps possible to argue that some of these senses are novel). A model that only considered a few senses is possible, but some kind of ranking would be needed to choose which senses. In addition, one would also expect to find competition due to the activation of different senses (as is the case for homonyms when the subordinate meaning is intended or when both meanings are equally likely; see, e.g., Rayner & Duffy, 1986). The results of Frazier and Rayner, however, only found reliable immediate effects of competition for homonyms and not for words with multiple senses.

The Underspecification Model

This model, proposed by Frisson and Pickering (1999) and Pickering and Frisson (2001), assumes that only one meaning gets activated initially. This meaning does not correspond to any particular sense, but is rather compatible with all senses. In other words, it is underspecified. No distinction is drawn between literal and figurative senses in this regard. Thus, the initial meaning of *paint* is underspecified with respect to whether it refers to artistic painting or decoration, and the initial meaning of *disarmed* is underspecified with respect to whether it refers to removing literal or figura-

tive arms. The model then assumes that the processor is subsequently able to refine this meaning on the basis of contextual information so that it can ultimately correspond to a particular sense. Hence, when a word with multiple senses is encountered, there is no immediate activation of a single fully specified sense.

The model then assumes that the processor can subsequently home in on a specific sense. If preceding context helps determine which sense is appropriate, then the processor may home in fairly rapidly. If preceding context is neutral with respect to the different senses, then the processor may delay deciding which sense to adopt. In Frazier and Rayner's (1990) terms, the processor employs minimal semantic commitments.

Because the underspecified meaning is the same for all related senses of a word, there should be no need for alternative senses to compete for activation. This contrasts with many accounts of the resolution of words with multiple meanings, where competition between alternative meanings is assumed to be the cause of processing difficulty (Rayner & Duffy, 1986).

The underspecified meaning is only applicable for *established* senses. Because the underspecified meaning is an abstraction over the features of specific senses, a *novel* interpretation for a word cannot be captured by the underspecified meaning. In this case, sense creation will occur (possibly using the underspecified meaning as a starting point of interpretation; see Frisson, 2000). The underspecification model is compatible, on the one hand, with Frazier and Rayner's (1990) data and their minimal commitment account (see also Gildea & Glucksberg, 1983), and, on the other hand, with recent proposals in linguistics (e.g., Bezuidenhout, 1997; Langacker, 1987) and computational semantics (e.g., Poesio, 1991; Van Deemter & Peters, 1996).

EXPERIMENTAL EVIDENCE

We now summarize recent experimental evidence from our laboratory that helps us distinguish between the previously discussed models of figurative language processing (Frisson & Pickering, 1999; Pickering & Frisson, 2001). All of these experiments are concerned with cases of sense ambiguity where one sense is literal and one is figurative. As in much previous lexical ambiguity research (e.g., Rayner & Duffy, 1986), we employed the eye-tracking paradigm. In this method, people read sentences (or texts) on a computer screen and the position of their eye is monitored every millisecond (or few milliseconds). There is very good evidence that the point at which a person is looking is extremely closely linked to the thing that they are currently "thinking about" (see Rayner & Pollatsek, 1989). In addition, eye movements are extremely sensitive to processing difficulty, so that as soon as a person encounters cognitive difficulty (e.g., an anomaly in a text), the pattern of eye movements is disrupted. For example, people tend to fixate a rare word for considerably

longer than a common word as soon as they encounter the word. It follows that we can monitor eye movements to determine what particular aspects of a sentence cause difficulty.

Frisson and Pickering (1999) examined the processing of two types of metonymy: *place-for-institution* and *place-for-event*. Consider the place-for-institution metonymy first (Experiment 1). The word *convent* has literal and established metonymic senses (as discussed previously). In one condition (4a), preceding context indicated that only the literal interpretation of the target word (in italics) was appropriate; in another condition (4b), only the established metonymic sense was appropriate. In the other two conditions (4c and 4d), the same sentences were used, but the target word was replaced by a word that did not have a contextually appropriate established metonymic sense. The items were carefully controlled for irrelevant factors that could in principle explain any effects, such as length, frequency, and predictability:

4a. These two businessmen tried to purchase the *convent* at the end of last April, which upset quite a lot of people.
4b. That blasphemous woman had to answer to the *convent* at the end of last March, but did not get a lot of support.
4c. These two businessmen tried to purchase the *stadium* at the end of last April, which upset quite a lot of people.
4d. That blasphemous woman had to answer to the *stadium* at the end of last March, but did not get a lot of support.

For example, if the literal-first model is correct, people should have no problem processing 4a, because the literal sense is contextually appropriate. They should have difficulty reading 4b, however, because the literal sense is anomalous: It is not plausible to talk to a building. More specifically, they should have difficulty as soon as they encounter *convent*. In terms of eye movements, we would therefore expect difficulty to emerge when the word is first fixated and before the rest of the sentence has been fixated. Frisson and Pickering (1999) measured this using the *first-pass* or *gaze-duration* measure, which is the time the eye spends fixating a word before leaving it (Rayner, Sereno, Morris, Schmauder, & Clifton, 1989). Another related measure is the *first-pass regressions* measure, which measures the likelihood that the eye regresses (i.e., goes backward) after reading the critical word. If processing is disrupted, then regressions are more likely.

In fact, people experienced no difficulty reading *convent* in either 4a or 4b. In contrast, they experienced immediate disruption reading *stadium* in 4d versus 4c. The difference between 4c and 4d is that *stadium* is plausible in 4c but not in 4d. Hence, we can conclude that people are disrupted by anomalous words, but that *convent* is not anomalous when only either the literal interpretation or the figurative interpretation is acceptable. These results are therefore incompatible with either the

literal-first or the figurative-first model. Reading times and regression analyses showed that both interpretations were processed equally fast, during both initial processing and later processing (as indicated by other measures such as the total time spent fixating a word). Moreover, detailed analyses showed that the relative frequency of the senses did not affect processing time, so that people were no faster reading a more frequent than a less frequent sense. This causes difficulty for the frequency-based model and provides further evidence that senses are not activated in order of frequency (Frazier & Rayner, 1990). In addition, processing of the more "basic" sense, defined as the first given in a dictionary entry, was not predictive of difficulty either. In conclusion, there was no evidence for ordering of senses. The direct access model would also predict this result on the condition that the prior context for the metonymic sense was strong enough. However, evidence from a completion test, in which participants had to complete fragments like *The blasphemous woman had to answer to the …* showed that these context fragments were completed with a noun with a literal interpretation 82.8% of the time. This means that the contexts cannot have supported direct access to the figurative sense, and so people should normally have adopted the literal interpretation initially. Thus, the direct access model counterfactually predicts difficulty for the figurative sense. In conclusion, the results are compatible with the unranked parallel account and the underspecification account. Because of the difficulty of activating a potentially very large number of senses at once, the evidence favors the underspecification account.

Experiment 2 used place-for-institution metonymies and broadly supported this conclusion. The structure of the conditions was the same as in Experiment 1: In 5a, preceding context indicated that only the literal interpretation of the target word (in italics) was appropriate (*Vietnam* referring to the place); in 5b, only the established metonymic sense was appropriate (*Vietnam* referring to the war). In 5c and 5d, the target word was replaced by a word (*Finland*) that did not have a contextually appropriate established metonymic sense. This was established by pretests that indicated that people did not associate any particular event with Finland.

5a. During my trip, I hitchhiked around *Vietnam*, but in the end I decided to rent a car for a couple of days.
5b. A lot of Americans protested during *Vietnam*, but in the end this did not alter the president's decision.
5c. During my trip, I hitchhiked around *Finland*, but in the end I decided to rent a car for a couple of days.
5d. A lot of Americans protested during *Finland*, but in the end this did not alter the president's decision.

Participants did experience difficulty with 5d, like 4d, but the difficulty was somewhat delayed. In fact, pretests indicated that 5d was judged much less implausible than 4d (though much more implausible than 5a through 5c). Hence, par-

ticipants probably made some kind of effort to determine a meaning for *during Finland*. Most important, they experienced no difficulty with either 5a or 5b, again suggesting that the senses were not ordered and that neither a literal nor a figurative sense had to be rejected before the right sense was attained. Because data from a completion test showed that the prior contexts for the metonymic expressions were in 93.8% of the cases completed nonfiguratively, the direct access model cannot explain these results either.

Pickering and Frisson (2001) considered the processing of meaning ambiguous (transitive) verbs and found considerable evidence that they behaved differently from sense ambiguous verbs. Experiment 2 looked at the processing of verbs with multiple senses, one of which was an established metaphorical sense. The verbs were presented in one of four conditions:

6a. (Supportive preceding context, dominant sense):
After the capture of the village, we *disarmed* almost every rebel and sent them to prison for a very long time.

6b. (Supportive preceding context, subordinate sense):
With his wit and humor, the speaker *disarmed* almost every critic who was opposed to spending more money on art.

6c. (Neutral preceding context, dominant sense):
Mr. Graham is quite certain that they *disarmed* almost every rebel and sent them to prison for a very long time.

6d. (Neutral preceding context, subordinate sense):
Mr. Graham is quite certain that they *disarmed* almost every critic who was opposed to spending more money on art.

The dominant (most frequent) sense always coincided with the literal interpretation, whereas the subordinate sense was always a metaphorical interpretation. The metaphorical sense was determined on the basis of pretests or taken from a dictionary. A pretest established that people interpreted the literal and metaphorical sense as being closely related semantically. Again, the items were carefully controlled for length, frequency, and predictability. The dominant, literal sense was much more frequent than the subordinate, figurative sense.

In addition to being able to localize the processing cost to an individual word, eye tracking also allows us to distinguish between early processing (as reflected in measures such as gaze duration and first-pass regressions) and later processing (as reflected in, e.g., second-pass and total reading times, and measures of later regions of the sentence). The early measures provide us with an estimation of how much time or effort is needed to process a word initially, whereas the later measures permit us to examine more integrative processes.

The most important finding was that processing difficulty with the subordinate sense relative to the dominant sense did not emerge until much after the critical

verb was first encountered. Similarly, prior disambiguating context reduced processing difficulty, but again this difference did not emerge until later processing. These results suggest that people did not initially adopt either sense and then reanalyze. Thus, the results are incompatible with literal-first, figurative-first, and frequency-based models. In addition, because there was no evidence that in the neutral context-subordinate sense condition, the literal sense was assigned to the verb which would have led to increased processing on the noun, the results are also incompatible with the direct access model.

The delayed effect of context was also found for the processing of verbs that were relatively unambiguous (e.g., *fined* the … driver; see Pickering & Frisson, 2001, Experiment 3). Pretests indicated that these verbs had only one relatively frequent sense (though different shades of interpretation are of course still possible). We manipulated whether a constraining context preceded the verb and found that reliable context effects only occurred on later measures of processing. Hence, context had similar effects on verbs with multiple senses and unambiguous verbs (cf. Frazier & Rayner, 1990). The pattern that was found for the verbs with multiple senses contrasted starkly with the pattern for verbs with multiple meanings (i.e., verb homonyms). In Experiment 1 of Pickering and Frisson (2001), the two meanings were either preceded by a supportive context or a neutral context. The design is comparable to Experiment 2 described previously:

7a. (Supportive preceding context, dominant meaning):
As he had all the power, that sultan *ruled* this very nice country as he thought best.

7b. (Supportive preceding context, subordinate meaning):
By using a fine artist's pencil, Max *ruled* this very nice line on all his papers.

7c. (Neutral preceding context, dominant meaning):
As there was no-one to ask, Mr. Jones *ruled* this very nice country as he thought best.

7d. (Neutral preceding context, subordinate meaning):
As there was no-one to ask, Mr. Jones *ruled* this very nice line on all his papers.

This time pretests indicated that the interpretations were not semantically related. This is compatible with intuitions and dictionary definitions, which suggested that the two interpretations were unrelated meanings. These verbs showed a much earlier context effect, with the sentences containing a preceding supportive context being read significantly faster than the neutral conditions. This result suggested that the processor selected between the two meanings fairly rapidly. (Of interest, early frequency effects did not occur, in contrast to nouns with multiple meanings; Duffy et al., 1988. See Pickering & Frisson, 2001, for discussion.)

Direct comparisons between verbs with multiple meanings and verbs with multiple senses also showed that, on some early measures, processing of sentences

containing verbs with multiple meanings was slower and caused more regressive eye-movements in comparison to verbs with multiple senses. We argue that this is caused by a competition between the two meanings of the homonymous verb, although this competition did not seem to occur for the two interpretations of the verbs with multiple senses (see Rayner & Duffy, 1986). These results indicate that an underspecified meaning of the sense-ambiguous verb was activated rather than that all senses were activated in an unranked fashion. If the latter had been the case, we would have expected competition for these verbs as well.

In conclusion, our data for words involving literal–figurative sense ambiguities can only be explained adequately by a model in which the initial activation of a word's meaning is not dependent on a specific sense interpretation or on the frequency-ranked activation of multiple senses. Because the contexts for the figurative senses were not so strong that people expected a word that had to be taken figuratively, and because the literal sense was not assigned immediately in the neutral context conditions, the direct access model can be ruled out as well. Given the problems with the unranked parallel model discussed previously, we conclude that the underspecification model can best explain our data.

The finding that the metaphorical interpretation of the verbs (e.g., *"disarm a critic"*) required more processing effort in the later stages is, we argue, not due to a difference in meaning activation, but is situated at the homing-in level. However, because the metaphorical interpretations were also considerably lower in frequency than the literal ones, it is unclear whether this effect is related to literalness or frequency. Crucial is that no effects were found in the immediate processing measures. In the remainder of the article, we consider some consequences of this view for the on-line semantic processing of words with multiple senses.

CONSEQUENCES OF THE UNDERSPECIFICATION MODEL

The view that, at least in reading, words with multiple senses are not immediately interpreted to the fullest degree, but that a specific interpretation is achieved on the basis of the activation of an underspecified meaning and the interaction with contextual information can explain why, in most cases, semantic interpretation of a sentence evolves so effortlessly and effectively. If the processor assigned a specific sense immediately, it would have to reanalyze frequently because the wrong sense will be chosen regularly. According to the underspecification model, however, a wrong sense will never be assigned and, thus, context does not have to act as a judge (*Is this interpretation compatible or not?*). Rather, context is actively involved in refining the interpretation of a word by changing the underspecified meaning into a specific interpretation.

The underspecification model assumes that the processor initially adopts a single underspecified meaning corresponding to a set of senses. It then uses context to home in on the contextually appropriate sense. This model holds whether the differ-

ent senses are all literal or are a mixture of literal and figurative ones. For instance, in *Mr. Graham is quite certain that they disarmed almost every rebel*, the processor initially adopts a meaning of *disarmed* that indicates an act of removing a threat, but is underspecified as to whether it refers to a physical or linguistic act (say). When, however, it encounters *rebel*, the literal interpretation as a physical act of removing weapons becomes much more plausible, and so the meaning of the verb is made much more precise, now corresponding to a fully specified sense. Hence, as long as there is no semantic "clash" between the activated underspecified meaning and the ongoing context, sentential processing can continue and specification of meaning can occur when more information has been processed or when the need arises to do so. It is quite likely therefore that the process of homing in on a specific sense is not immediate, although it is possible that under certain conditions (e.g., a very constraining context), this specification will happen more quickly than in other cases. When there is not just one underspecified meaning, as is the case for homonyms, the processor will make a selection between the (underspecified) meanings much more quickly so as not to have to keep different, semantically incompatible interpretations activated in parallel (see Pickering & Frisson, 2001).

There is good reason to believe that words are not always interpreted to their deepest extent. For example, Barton and Sanford (1993) showed that, following a context about a plane crash on the border between two countries, almost half of the participants did not notice the anomaly in the sentence *Where should the survivors be buried?* (See also the "Moses illusion" investigated by Erickson & Mattson, 1981; Van Oostendorp & de Mul, 1990.) They interpreted this finding as indicative of shallow semantic processing in which initially the "core meaning" of a word is accessed, and when this meaning fits well into the scenario, further or deeper semantic analysis is less likely to occur. We suggest that shallow processing can happen on reading a sentence like *John painted yesterday* in which it is left unspecified what kind of painting is intended. The same applies to literal–figurative sense ambiguities. Consider *The man was wounded in Vietnam*. Here, it does not really seem to matter whether Vietnam has to be interpreted literally or metonymically.

That a word can have two different senses at the same time is also apparent in the sentence *I've been reading that adulterer Dickens over the summer*. Here, *that adulterer Dickens* seems to be a literal reference to Dickens (as the man) whereas *reading that adulterer Dickens* seems to be a reference to the works of Dickens (hence, producer-for-product metonymy). Linguistically, the explanation for this paradox is presumably that *Dickens* is used literally at the level of the noun phrase, but the noun phrase itself is then interpreted metonymically at the level of the sentence (or verb phrase). In terms of incremental processing, however, the word *Dickens* appears to require a literal and a figurative interpretation at the same time. This seems incompatible with a sense-selection account. Notice that such multiple interpretations are not normally possible for meaning ambiguities (e.g., *"The telephone had a diamond ring"*)—although it may not always be possible in cases of

sense ambiguity either, or is odd (e.g., *I spoke to the freshly painted gallery*). The possibility of multiple senses at the same time for a word is most straightforwardly compatible with an underspecification account.

Related to this, the underspecification model predicts that words with more senses will not be harder to process than words with fewer senses (unlike homonyms; see Rayner & Duffy, 1986). If all senses of a word were immediately activated on encountering a sense-ambiguous word, one would predict increased competition the more senses a word has. The underspecification model, however, predicts no differences because just one underspecified meaning will be activated. The results for the unambiguous verbs, which behaved very much like the verbs with multiple senses, and the results from the metonymy experiments, which showed no differences between sense-ambiguous words (e.g., Vietnam) and words that do not have an established metonymic sense (e.g., Finland), lend support to this idea.

The psychological status of figurative senses has generated a lot of discussions in the field of figurative language processing (see, e.g., Cacciari & Glucksberg, 1994; Dascal, 1987, 1989; Gibbs, 1984, 1989, 1994; Gibbs & Gerrig, 1989; Murphy, 1996, 1997). More specifically, the debate at hand is whether figurative senses are "special" senses, requiring different processing mechanisms from the other nonfigurative senses of a word, or whether they are fundamentally similar. A consequence of the idea of underspecified meanings is that figurative language processing is, at least in the initial processing stages, not different from the processing of other types of language. Hence, the distinction between literal and figurative senses of a word is not crucial to early processing (see also Gibbs, 1992). In fact, the underspecification model goes a step further: Not only is initial processing of a figurative sense identical to the processing of a literal sense, but the initial *activation* of a word's semantics is identical as well. Because the underspecified meaning does not distinguish between different senses of a word, the separation between literal and figurative senses is not relevant at this stage.

Throughout this article, we assumed that the different established senses of a word are also represented in the mental lexicon. However, this need not necessarily be the case. In contemporary linguistic theories that are also interested in the representational aspect of language, there is a lot of controversy about what part of a word's meaning gets represented. Two extreme positions can be discerned: the radical *polysemy* view, which maintains that all specific representations of a word are stored, and the radical *monosemy* view, which claims that only one meaning of a word is stored and that specific interpretations are computed on the basis of contextual information (for an overview of the possible models, see, e.g., Croft, 1998; Ruhl, 1989; Sandra, 1998). The underspecification model is in principle compatible with both views, at least as long as underspecified meanings are also part of a polysemous lexicon. However, if we are correct that homing in on a specific interpretation involves using contextual information to refine an underspecified meaning rather than using context to guide the selection of an established sense, this would be

more compatible with a monosemous account. If so, the whole distinction between literal and figurative senses becomes even more irrelevant in processing terms.

CONCLUSION

The aim of this article was to outline a model of semantic processing that also explains the mechanisms behind the on-line interpretation of figurative language. In fact, the experimental evidence strongly suggests that established figurative senses are, at least initially, treated in exactly the same way as any other established sense of a word and that context is used to arrive at a specific interpretation. This should come as no surprise: In almost all cases, the processor is completely ignorant about what word will come next, let alone whether that word will have to be taken literally or figuratively. Hence, because the processor does not know beforehand how the next word needs to be interpreted, it does not seem sensible to propose different processing mechanisms for different types of language. Rather, to process lexical input quickly and effectively, a procedure needs to be employed that can handle all types of language and that ensures that the activated semantic information of a word need not be rejected regularly. The idea of underspecified meanings fits well into this picture.

The model we propose is in essence a modular model because context is believed not to affect the initial activation of a word's meaning. At the same time, however, context plays an important role in semantic processing because it influences the ultimate, specific interpretation of a word. In other words, we believe that the full interpretation of a word is the interpretation of that word in a given context. The on-line experimental evidence that was reviewed here did not directly address this aspect of interpretation, though, but concentrated on the *initial* processing of sense-ambiguous words. And these results, with no immediate effects of frequency or measurable effects of competition between senses, favors the initial activation of word meanings that are not sense-specific.

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