An Activation-Selection View Of Homograph Disambiguation: A Matter of Emphasis?

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In constructing theories, researchers are under an injunction to minimize the number of processes and free parameters in their models of reality. A review of the literature with respect to the disambiguation of ambiguous or polysemous words shows that at least three mechanisms have been used alone or in combination to account for the outcomes of experiments in which a word has been disambiguated. These are semantic activation, suppression, and inhibition. Are three mechanisms necessary?

This chapter is divided into three parts. First, an attempt is made to clarify these mechanisms by examining their definitions, according to the theorists who proposed them. Second, the need for these mechanisms is examined in light of the evidence focusing on the effects of disambiguation at the level of the individual word (i.e., on the homograph and other lexical entries). Third, a minimal model is outlined to try to show how it could account for the data.

Defining the Mechanisms

Semantic activation has been used in several ways that suggest slightly different definitions of the concept. The most common definition corresponds to the activation of a node or nodes in a semantic network that correspond with the meaning or meanings of a word. Theorists (for reviews, see Bubka & Gorfein, 1989; Simpson, 1984) disagree as to the circumstances under which the multiple meanings of words are activated but not the fact of activation. The activa-

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tion of a word's meaning does not necessarily reach consciousness. Some theoretical views (notably those of Killion, 1979, as reported by Simpson, 1984; see also Onifer & Swinney, 1981; Swinney, 1979), classified as exhaustive access models, postulate the activation of all meanings of an ambiguous word followed by a rapid selection process that results in only a single interpretation of a word reaching a conscious state.

Gernsbacher (1990) extended the activation idea well beyond the activation of the single appropriate meaning. As part of her structure building framework, Gernsbacher postulated that once what in her model are called memory cells are activated, they transmit processing signals in an analog to neural activity. When the content of the memory cell is appropriate to the (comprehension) structure being built, these transmitted signals enhance or boost the activation of the relevant memory cells. (A corresponding suppression or dampening of memory cells when their contribution does not or no longer fits the structure being built is also proposed.)

Suppression is defined as a relatively rapid process that dampens the activity of those meanings of a word inappropriate to the task demands. Beyond this agreement, however, there lies considerable disagreement as to the nature of the process. Some of the suppression models (Yates, 1978) follow the lead of Posner and Snyder's (1975) studies of visual attention. As Simpson (1984) noted, this approach makes suppression "a by-product of the focal attention paid to the appropriate meaning" (p. 329). Others, including Gernsbacher and St. John (chapter 4, this volume), see suppression as an active control process. However, the viewpoint of suppression of meaning as a control process is disputed by researchers who argue that the temporal intervals involved are too short for a control process to operate, and these researchers therefore favor some form of automatic process.

Inhibition is the label given to a longer lasting process that makes it difficult to perform tasks in which the homograph is repeated within different contexts. Simpson and Kang (1994), the leading proponents of the inhibition view, described the process as "active and specific inhibition of competing meanings" (p. 178). They further indicated that the inhibition is contingent on a previous selection of a meaning for a homograph. Although they did not offer a mechanism for the inhibition, they speculated that it is the result of a meaning being selected that differs from the meaning selected on an earlier occurrence of the homograph (see Simpson & Adamopoulos, chapter 7, this volume). It is suggested that this selection process is not unlike that proposed by Gernsbacher (1990), and therefore there may be individual differences in the amount of inhibition consistent with Gernsbacher's claims that unskilled readers may lack the ability to suppress competing responses. Simpson and Adamopoulos see the difficulties associated with repetition of homographs in different semantic contexts as a case of negative priming (Tipper, 1985; Tipper & Cranston, 1985) in which ignoring an item on one occurrence leads to its inhibition on subsequent occurrences.

Gorfein, Berger, and Bubka (2000) proposed a mechanism for inhibition in terms of a conditioned suppression model. In that model, the suppression response engendered by the need to reduce competing associates to the context is conditioned to a sample of the stimuli active at the time of the suppression
response. Therefore, inhibition is seen as a result of suppression and follows directly from its occurrence.

The Evidence and the Mechanisms

In reviewing the evidence for each of the postulated mechanisms and their combinations, I emphasize the literature that postdates several reviews of the literature (Gorfein, 1989; Simpson, 1984, 1991; Simpson & Kang, 1994; Small, Cottrell, & Tannenhaus, 1988) and also recent work in my laboratory.

A large body of evidence has been garnered for the existence of lexical activation, much of it coming from the word priming literature (see Neely, 1991, for a review). The mechanism of enhancement of activation proposed by Gernsbacher (1990) has received much less attention in the literature. In fact, in Gernsbacher's own work, it has taken second place to suppression in explaining the processing of homographs and homophones (Gernsbacher, 1990; Gernsbacher & Faust, 1991a, 1991b, 1994; Gernsbacher & St. John, chapter 4, this volume). Activation enhancement is used as a construct primarily to explain findings with respect to anaphoric reference.

An argument for enhanced activation could be made if a study showed activation persisting for more than a few seconds, the time limit of activation generally acknowledged (Collins & Loftus, 1975; Posner & Snyder, 1975). In a recent study (Gorfein, 2001), evidence was found for significant amounts of enhanced activation following decisions about relatedness in pairs that included a homograph. In a task in which a trial consisted of the successive presentation of two words, a homograph was presented as part of a related word pair. On a subsequent trial, a pair of words related to the same meaning as the earlier presentation was presented. For example, on Trial N of the relatedness decision task, the pair of words heart–organ was presented, and on Trial N+20 the pair liver–transplant was presented. Under these circumstances, the pair liver–transplant was responded to about 33 ms faster than if the homograph pair had not been presented. The facilitation observed did not occur in a control experiment in which the trial pair liver–transplant followed at similar intervals a related pair heart–kidney that did not contain the homograph. This suggests that ambiguous words may have a privileged status in terms of the amount they are activated. The presence of facilitation at intervals in excess of 1 minute is a strong argument for Gernsbacher's principle that selecting a meaning for an ambiguous word enhances the activation of the meaning selected.

An interesting example of what appears to be enhanced priming comes from a study using figurative language (idioms) in a study of knowledge-structure activation recently reported by Galinsky and Glucksberg (2000). In their Experiment 1, one of three expressions was included in a story presented as “a test of how delay might affect individuals' reactions to stories and events.” The idiomatic expression “you’re playing with fire” or “you’re on fire” and the literal statement “he sat by the fire” were presented in similar stories in a between-groups design. Participants were told that they would be asked questions about the story later. After a brief interval filled with counting backward, a subsequent paragraph with a different character, “Donald,” was presented.
Donald was described as engaging in such activities as demolition derby, mountain climbing, and shooting rapids. Ratings of Donald were required on a 9-point scale ranging from 1 (adventurous) to 9 (reckless). Consistent with an enhanced activation view that postulates that the interpretation of figurative language involves the enhancement of related concepts, the more reckless “you’re playing with fire” statement led to a judgment of greater recklessness than “you’re on fire” with the literal statement group falling in between. It is particularly notable that this persistence in priming occurred even though Galinsky and Glucksberg reported an effort to dissociate the two stories by changing the typography of the paragraphs. A similar but less dramatic example of facilitation across contexts was reported by Binder and Morris (1995) in a study of discourse processing using eye fixation durations as the dependent variable. In their study, the facilitation normally associated with reading a homograph in the same-meaning context did not decline when the discourse topic was shifted from first to second occurrence of the homograph. Therefore, there seems to be a small amount of converging evidence for the postulated enhancement of activation.

The evidence for a suppression mechanism in ambiguity processing is a good deal more controversial. As noted by a number of theorists (Gernsbacher, 1990; Neill, 1989), earlier theorists developed their claim on the basis of results such as those of Onifer and Swinney (1981) for the cross-modal lexical-decision task. In that task, at about the point of the occurrence of a homograph in an auditorally presented sentence, the visual presentation of a word related to either meaning of that homograph was classified as a word more rapidly than an unrelated control word matched for frequency. However, at an interval as short as 250 ms, only the amount of facilitation for the contextually appropriate meaning was still significantly above the control word mean. As Simpson (1984) noted, an initial advantage in facilitation for the contextually appropriate meaning is reliably obtained in studies of this type. Therefore, it can be argued that a simple decay of activation would account for these findings. Gernsbacher and Faust (1991b) attempted to counter this claim by showing that, following inclusion of a homograph in a sentence judged to bias a particular meaning of a homograph, the inappropriate meaning’s activity declined more rapidly than that for the same meaning presented in a context judged to be neutral with respect to the meaning of the homograph (see chapter 4, Figure 4.2, this volume). However, the very absence of a disambiguating context may encourage the reader to maintain both meanings of a homograph until a meaning decision is reached. It is noteworthy that no decline was observed for the neutral-sentence context across delay whereas the activation of the context-appropriate meaning did decrease. Such an outcome is consonant with my interpretation that participants actively maintain both meanings of an ambiguity until a meaning is selected.

In short, a convincing claim of suppression would seem to require performance in the suppression case that is significantly slower than that for an appropriate control. Indeed, considering the claims for the potency of the suppression mechanism, the numbers of studies, and the near-zero priming obtained for the inappropriate-meaning response tested at a delay, it is a wonder that a small percentage of the studies have not reported such an outcome. Alternatively, if as some (Gernsbacher & St. John, chapter 4, this volume; Killion, 1979,
cited by Simpson, 1984) claim, suppression is to be considered a control process, then it might well be disengaged when the suppressed material is at a level where it no longer is a competitor with the contextually appropriate meaning. However, as Simpson (1984) noted, if one can suppress activation at will, it is remarkable that interference is obtained in priming versions of the Stroop task (e.g., Conrad, 1974; Oden & Spira, 1983) when such interference could be avoided by suppressing competitors.

There are some cases reported in the ambiguity literature in which performance in an experimental group is significantly below that of the control group. These cases appear to fit the definition of inhibition as they all represent relatively long-term effects. Gernsbacher (1994b) reported a study in which individuals were required to decide whether sentences made sense. Embedded among 386 sentences were 24 sentence pairs, with trials in which two consecutive sentences contained the same homograph. Of these, some pairs were of the form, She blew out the match, which was preceded by a same-meaning sentence (She lit the match), a different-meaning sentence (She won the match), or a no-meaning prime (She prosecuted the match). The crucial result for the suppression hypothesis is that performance following the different-meaning sentence was significantly slower than that following the no-meaning condition.

My colleagues and I reported performance for homographs and homophones that indicated less priming of the ambiguous word in a different-meaning condition than the priming obtained to a first-occurrence prime. The homograph studies (Gorfein et al., 2000) measured the proportion of word associations indicating a particular meaning of a homograph. For example, as part of a continuous set of word association trials, a participant responded to the word liver on Trial N and the homograph organ on Trial N+1, which produced more secondary-meaning responses to organ than would be expected from the norms. More crucially, when the word organ was presented on Trial N+31 following the word music on Trial N+30, the proportion of responses that indicated that organ was being responded to as a musical instrument (e.g., piano, church, Bach, etc.) was significantly diminished compared with a first-occurrence sequence of music-organ. For homophones, Gorfein and DeBiasi (2001) demonstrated that processing a picture of a father and a son along with the verbal label son reduced the effectiveness of a prime star to evoke the spelling sun upon hearing son as part of a continuous set of spelling trials. Similarly, the likelihood that a word association would indicate that the auditory stimulus had been interpreted as a celestial object was reduced when the task required word associations.

In my work with the pair-relatedness task, my colleagues and I manipulated the meaning relationship of a homograph to a word with which it was paired on two widely separated occurrences (Gorfein & Amster, 2001). For example, the pair seal-walrus might occur 20 trials later than the pair seal-dolphin or the pair seal-envelope. We found that in contrast with a first-occurrence control condition, there was a significant decrement in accuracy when homograph meaning was changed from first to second occurrence and a significant facilitation with respect to the control in reaction time and a small gain in accuracy when the first-occurrence item was of similar meaning.

All of these studies meet the criterion of showing significant decrements in performance with respect to the inappropriate-to-context meaning of the homo-
graph, when as Simpson and Kang (1994) suggested, context is defined to include the meaning of the homograph primed on the first occurrence. Gernsbacher, Robertson, and Walker (chapter 8, this volume) attempt to extend Gernsbacher's (1994b) study to show this decrement even after substantial temporal intervals but failed to find inhibition after a lag of five intervening sentences. Simpson and Kang (1994) reported a study by Krueger in which the lag between sentences containing the same homograph was zero, one, or six sentences, and decrements associated with meaning change were obtained at all intervals. Simpson and Adamopoulos (chapter 7, this volume) report similar results. Therefore, all of these studies fit the studies that define what Simpson and Kang have labeled inhibition of competing meanings, and all but Gernsbacher et al.'s chapter show effects at substantial intervals following the initial processing of the homograph.

With respect to the concept of inhibition, although Galinsky and Glucksberg's (2000) study is not one that involves the processing of single ambiguous words, it is worth examining. In their study of idioms, another experiment was conducted in which a paragraph was read that contained the theatrical wish for good luck "break a leg," the expression "good luck," or the character, John, breaking a leg. In the rating of a different character, Donald, on a 9-point scale from 1 (not at all reckless) to 9 (very reckless), the idiomatic expression produced the lowest score 6.6, which was significantly lower than the control (good luck) condition. Galinsky and Glucksberg interpreted their results as suggesting that the act of interpretation of the idiom led to an inhibition of the negative consequences of breaking a leg, producing as a consequence lower recklessness ratings.

In summary, the data reviewed seem to call for an activation mechanism and some form of inhibitory or suppression mechanism. However, there are some additional details of the findings using the relatedness decision task that may help researchers refine their choice of the appropriate mechanisms.

In Gorfein and Amster (2001, Experiment 1 and 2), when a homograph was repeated and judged for relatedness with words associated with its meanings, the amount of facilitation and the size of decrement on same- and different-meaning pairs depended on the order in which the initial pair was presented. The results with respect to reaction time and accuracy are shown in Figure 10.1. When on the homograph's initial occurrence the related word preceded the homograph (heart-organ), sizable facilitation was observed for related pairs of similar meaning (organ-transplant), and a small decrement was observed when pair meaning was changed (organ-piano). In contrast, when the initial occurrence of the homograph had the homograph preceding the related word (organ-heart), subsequent tests of the same-meaning pair (organ-transplant) showed a significantly smaller facilitation effect, and a much larger decrement was observed for the different-meaning pair (organ-piano). The combination of the same treatment producing both greater facilitation and smaller inhibition must be part of an explanation as well. I believe that such order effects are a consequence of contextual constraints created by the first member of the pair on the meaning of the second pair member. I describe a model of how such constraints operate later in this chapter.

A different result was reported by Gorfein (2001), when instead of the homograph being repeated, the initial homograph pair was followed by a word
pair related to the homograph. In Experiment 2 of that article, the word pair liver–transplant showed facilitation an average of 20 trials after the homograph pair organ–heart; no inhibition was obtained on a different-meaning pair music–piano at that lag. In Experiment 1, a different-meaning pair, music–piano, showed significant facilitation on the trial immediately following the pair organ–heart. Facilitation rather than inhibition was obtained when the relatedness decision was a pair of words inappropriate to the meaning of the homograph selected.

In reviewing the literature with respect to homograph disambiguation effects, I noted a distinction between two forms of study. One type includes those of Simpson and his colleagues using word naming and reading speed (see Simpson & Kang, 1994, for a review), the word association and homophone spelling studies of my colleagues and I (Gorfein et al., 2000; Gorfein & DeBiasi, 2001; Gorfein & Walters, 1989), and the discourse processing study of Binder and Morris (1995), all of which presented an ambiguous word (homograph or homophone) more than once. Studies of the second type are those in which the ambiguous word occurred once, as in the studies of lexical decision (Gernsbacher & Faust, 1991a; Onifer & Swinney, 1981; Schvaneveldt, Meyer, & Becker, 1976) and judgments of whether a word fits a context (Gernsbacher & Faust, 1994). All of the studies that presented the ambiguous word twice found some “form of disruption” with respect to the altered meaning of a homograph on second occurrences, and in a small number of cases, facilitation occurred when meaning was maintained. The studies using single presentations uniformly found facilitation for same-meaning relationships and a change over time, whereby words that were inappropriate to the context showed smaller or no priming, whereas words that were appropriate to the context showed that priming was maintained for some period. In summary, when the meaning tested is inappropriate to that used on the initial occurrence of an ambiguous word, the two presentation studies show below-baseline performance (labeled inhibition by Simpson & Kang, 1994), whereas the single-presentation studies show near-baseline performance (labeled suppression by Gernsbacher, 1990; Neill, 1989; Onifer & Swinney, 1981). I discuss a single exception separately—the Galinsky and

Figure 10.1. Priming effects in reaction time (left) and accuracy (right) as a function of pair order: when the related word preceded the homograph (rel/HOM) and when the homograph preceded the related word (hom/REL). Error bars represent one standard error of the mean. From “Some Consequences of Homograph Disambiguation: The Effect of Pair Order on Relatedness Decision,” by D. S. Gorfein and H. Amster, 2001.
Glucksberg (2000) study that reported inhibition after processing the idiom “break a leg.”

Several findings addressing temporal intervals and inhibition are relevant to our understanding. A consistent finding in each of the studies designed to understand meaning change with respect to word association and homophone spelling (Gorfein et al., 2000; Gorfein & DeBiasi, 2001) is that in a subsequent test of the ambiguous word in the absence of a biasing semantic context, a primacy effect was obtained. Responses to homographs and homophones that had occurred in two different-meaning contexts were in the direction of the first-occurrence prime rather than the second-occurrence prime. Figure 10.2 illustrates that effect with respect to the homophone study. Participants who had been exposed to a picture representing the secondary spelling of a homophone (e.g., of a knight) in Phase 1 were both less influenced by a Phase 2 dominant spelling prime (afternoon) than a corresponding control participant who had not been exposed to the Phase 1 picture. Crucially, in Phase 3 the control condition showed a small change (.049) toward the normative baseline in the proportion of dominant responses. However, the picture-primed condition produced a much larger change (.12), which was away from the norm and toward the first-occurrence prime. Similar effects were reported by Gorfein and Walters (1989).

**Toward a Minimal Model of the Effects of Disambiguation**

It is my belief that the fact that facilitation acts at a distance from the disambiguated homograph while inhibition appears to act only in the presence of the disambiguated word can be reconciled by a single process account. That process is activation. I suggest that homographs, homophones, figurative language (idioms and metaphors), and perhaps even category labels are privileged in terms of the amount of activation they produce appropriate to the meaning selected. This enhanced activation serves to facilitate comprehension in the ensuing discourse. At the same time, the lexical representation of the ambiguous word remains activated to adjust to the meaning selected.

My colleagues and I have suggested in the past (Gorfein, 1987; Gorfein & Bubka, 1989; Gorfein & Viviani, 1981) that a word’s meaning is based on a weighted\(^1\) (or ordered) set of features or attributes. In the absence of a biasing semantic context, these attributes are used in order of weight. A sufficient number of attributes are activated to meet the task demands (different tasks requiring the activation of more or less features). My colleagues and I have also postulated the operation of a mechanism—the *set principle*—that allows the local semantic context to interact with this hierarchy of features to help set (constrain) which features are activated. In effect, the weights of individual features can be altered in the course of processing. Although I believe the principles extend to figurative language, it is far easier to describe the process with

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\(^1\)In a recent discussion with Curt Burgess, I was persuaded that order and weight are for most purposes analogous and that weight, being a ratio scale, is far more tractable for quantitative modeling.
Figure 10.2. Effect of dominant prime (Phase 2) and no prime (Phase 3) on the responses (Rs) to a homophone that had been shown as a picture or not shown in an orienting task. Error bars represent one standard error of the mean. From “The Priming of Homophones: The Sun Comes Out After the Son,” by D. S. Gorfein and C. DeBiasi, 2001.

I begin with the following principles:

1. Words are represented by a weighted set of attributes.
2. The processing of a word activates a number (N) of attributes; the number is limited by (a) task constraints—the number necessary to meet the requirements of the task, and (b) the processing time available—if it is less than the time necessary to meet the task demand.
3. Attributes are activated as a function of their strength: \( P(\text{Att}_i) = \frac{\text{Watt}_i}{\text{O Watt}} \).
4. The set principle: Processing a word in the context of active attributes will result in the use of those attributes to the extent that the word possesses attributes in common with those that are active.
5. Attributes activated are increased in activity from their prior level by an amount that will depend on the task requirements. Use of a matching attribute, as in the set principle, adds the normal increment to the active level.

\(^2\)In earlier versions of the model, the nonmatch of attributes led to a decrement in the activity of the attribute. I no longer see a need for that process.
6. Activation of an attribute decays over time as a function of the initial amount of activation.

7. When a meaning is selected, the weight of attributes associated with that meaning is increased as a function of their recency: \[ \text{Watt}_r = \text{Watt}_r + D^* \text{inc}, \]
   where \( D \) is a decay constant and \( r \) is a measure that goes from 1 to \( N \), with 1 being the most recent attribute selected. In similar fashion, attributes that are not consistent with the meaning selected are reweighted to decrease the weight of those attributes, and greater decrements occur for those items that are most interfering (were easily activated): \[ \text{Watt}_r = \text{Watt}_r - D^* \text{dec}, \]
   where \( D \) is a decay constant and \( r \) is a measure that goes from 1 to \( N \), with 1 being the earliest attribute selected.

Principle 7 is new to the activation-selection model. It derives from the necessity of explaining long-term effects of processing. Specifically, in an experiment described by Gorfein and Walters (19891), participants were required to fill in a blank in a sentence intended to elicit a particular spelling of a homophone (e.g., \textit{sun}, the dominant spelling, or \textit{son}, the secondary spelling). The study used such sentences as \textit{The earth revolves around the s—} or \textit{Like father, like s—}. In one condition of this study, half of the participants took part in a spelling test that included those and other not-presented homophones after an intermediate activity. In another condition, the intermediate activity and the spelling test were conducted the next day. Some of the homophones primed by the sentences did not appear again in the experiment until the spelling test. Some homophones appeared for the first time in the experiment on the spelling test. Of course, this was suitably counterbalanced. The point of interest here is the effect of the 1-day interval. Figure 10.3 shows the proportion of dominant spellings produced following dominant, secondary, and no sentence on each day. As can be seen, the sentence manipulation had an average priming effect of .128 after an interval of 10 to 25 minutes on Day 1. Although this effect declined significantly over the 1-day interval, priming remained a significant .068 on the 2nd day. The enhanced activation view might conceivably account for the Day 1 effect, but intuitively it seems obvious that activation would not persist a day later.

When an ambiguous word occurs in a disambiguating context, the need to activate additional features to change the local representation of the meaning will depend on that context and the task. Specifically, if the word easily fits the context (as in the case in which a related word precedes the homograph in my relatedness studies), a smaller change in weight is necessary than when the word is initially processed out of context. On a subsequent occurrence of a homograph, the altered weights are used. To the degree that representation has been biased by the previous context, performance will be affected. A decrement in performance will only occur when the pattern of activation produced by the combination of the setting context (activated attributes) and higher weighted features of the homograph is inappropriate to the task. The form of the decrement will depend on the nature of the task and therefore will range from slowing in some tasks to errors in others.
Figure 10.3. Effect of cloze procedure on homophone spelling. Prop. Dominant = proportion of dominant spellings produced following dominant sentence, none, or secondary sentence on each day. Error bars represent one standard error of the mean. From “When Does ‘Soar’ Become ‘Sore’? Some Comments on the Chapter of Simpson and Kellas,” by D. S. Gorfein and M. F. Walters, 1989. In D. S. Gorfein (Ed.), Resolving Semantic Ambiguity, p. 59 (derived from Table 5.1). Copyright 1989 by Springer-Verlag. Adapted with permission.

Explaining the Data

I view the relatedness task as requiring attribute matching. The decision depends on whether some criterion of matching features is obtained prior to some deadline. The altered pattern of activation produced by a different meaning on the first occurrence of the homograph can result both in a longer search to find the matching features and the possibility that a sufficient excess of nonmatches will occur for the participant to decide a match is not present. The decrement would only occur when the homograph (i.e., the altered representation) was part of the matching task. Obviously, when the match is between two words related to the homograph but does not include the homograph, such a possibility is unlikely.

Facilitation will occur for all conditions in which the task depends on the activation of similar meanings, whether or not the homograph is present, and it will be greatest when more of the appropriate attributes were activated earlier. The set principle suggests that a greater number of appropriate attributes will be activated when the disambiguating context precedes the ambiguity. Therefore, the theory would predict greater facilitation in that case as more appropriate attributes would be available to activate the target pair. The model predicts facilitation for same-meaning pairs and interference for different-meaning pairs that include the homograph but only facilitation for related-word pairs that do not include the homograph. More facilitation and less inhibition are predicted for homograph-related word pairs when the context precedes the homograph at...
first occurrence through both greater activation of attributes and smaller alterations of the representation of the homograph. Similarly, when the context precedes the homograph at second occurrence, it has the effect of helping activate the appropriate (matching) features, leading to faster and more accurate responding.

According to the view I have presented, activation decays over time or trials, from an initial level to an asymptotic level as a function of the initial activation. As a consequence of this decay, what looks like suppression in tasks like the cross-modal lexical-decision task is obtained. Because of the semantic constraint (the set principle), some attributes of the appropriate-to-context meaning will receive enhanced activation. In addition, fewer attributes of the inappropriate-to-context meaning will be included among the activated attributes of the homograph, resulting in an initially lower level of priming for a word related to that meaning of the homograph.

The sentence-pair studies of Krueger (1990), Gernsbacher et al. (chapter 8, this volume), and Simpson and Adamopoulos (chapter 7, this volume) are easily accommodated by the model. In each case, the first occurrence of the homograph augments the activation of attributes specific to the context-appropriate meaning and possibly alters the weights of the attributes. When the alternative-meaning sentence is presented, these active attributes will set the inappropriate meaning of the homograph, just as any change in attribute weights will increase selection of attributes associated with the now inappropriate meaning of the homograph. The failure of Gernsbacher et al. to obtain inhibition at a trial lag of five sentences follows directly from the fact that the conditions they used place the homograph as the final word in each sentence. This is exactly the condition that the model predicts should produce the most facilitation and least inhibition. Indeed, inhibition in this condition is largely absent in the relatedness judgment data reported by Gorfein and Amster (2001) and in sentence study reported in this volume by Simpson and Adamopoulos.

An Experimental Contrast of the Activation-Selection Model to the Suppression Enhancement Model

To confirm our very strong claim that suppression is not the explanation for what I have called inhibition effects, my colleagues and I designed an additional experiment to test the predictions of a general suppression model against those of our activation-selection model. Consider a relatedness decision experiment that has the following conditions:

1. For some subset of homographs, each homograph is presented once as part of a related pair. About 20 trials later, two related-word pairs without the homograph are presented. One pair is appropriate to the first presentation meaning and one pair is related to the nonselected meaning of the homograph.
2. For another subset of homographs, each homograph is presented as part of a related pair, and about 10 trials later it is paired with a word related to the other meaning. Then in about an additional
Table 10.1. Examples of Trial Pairs in the Experiment Contrasting the Activation-Selection Model and the Suppression-Enhancement Model

<table>
<thead>
<tr>
<th>Conditions of the Experiment</th>
<th>Single occurrence</th>
<th>Contrasting occurrences</th>
<th>Baseline control</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>seal–DOLPHIN</td>
<td>seal–DOLPHIN</td>
<td>diamond–RUBY</td>
</tr>
<tr>
<td>N+10</td>
<td>bank–RIVER</td>
<td>seal–ENVELOPE</td>
<td>bank–RIVER</td>
</tr>
<tr>
<td>&gt;=20</td>
<td>walrus–OTTER</td>
<td>walrus–OTTER</td>
<td>walrus–OTTER</td>
</tr>
<tr>
<td>&gt;=20</td>
<td>glue–SHUT</td>
<td>glue–SHUT</td>
<td>glue–SHUT</td>
</tr>
</tbody>
</table>

10 trials, comparable pairs related to the first and second occurrences without the homograph are presented.

3. For a third subset, the homograph is never presented but the corresponding word pairs as those used in 1 and 2 above are presented as controls to provide a baseline for the measurement of facilitation and inhibition.

Table 10.1 depicts the design.

Predictions of the two models were defined with respect to the baseline control condition. My colleagues and I knew from our earlier studies that after about 4 intervening trials, a pair related to a first-occurrence homograph-related pair shows facilitation that does not decline appreciably over an interval of at least 20 trials. After about 4 trials, pairs related to the homograph but inappropriate to the particular meaning selected do not differ significantly in reaction time (or accuracy) from the control. Therefore, the prediction for Condition 1 is a straightforward priming effect for the pair related to the homograph pair (walrus–OTTER) in our example and only chance differences from the baseline for the inappropriate-to-context pair in our example (glue–SHUT). The suppression enhancement model would not in all likelihood predict anything different for the inappropriate-to-context pair as 20 trials is a long interval over which to maintain suppression.

Now let us consider predictions for Condition 2 in which both meanings are paired with the homograph on a first and second occurrence prior to the pairs without the homograph. In our activation-selection model, there is no suppression mechanism. When the participant processes the first homograph, pair activation will be enhanced (as in Condition 1), producing facilitation when the same meaning pair is presented 20 trials later. When the second (different meaning) homograph pair is presented, the meaning selected will result in enhanced activation for words related to that meaning and thereby produces facilitation on the pair related to its meaning when it occurs about 10 trials later. Therefore, the activation-selection model predicts the outcomes shown in Figure 10.4 (top) for priming in Conditions 1 and 2 of the experiment. Alternatively, a suppression enhancement model would operate in the same way for the first occurrence of the homograph. However, when the homograph is presented with a different meaning on a second occurrence, the residual activation of the first occurrence must be dampened. The activation of the attributes of the new mean-
Figure 10.4. Top: Hypothetical outcome of experiment based on the activation-selection model. Middle: Hypothetical outcome of experiment based on the suppression-enhancement model. Bottom: Priming obtained in the experiment. Error bars represent one standard error of the mean.

ing selected will be enhanced. Figure 10.4 (middle) shows the predictions of the suppression enhancement model for priming in Conditions 1 and 2.

The outcome of the actual experiment is presented in Figure 10.4 (bottom). Three of the four conditions do not differ in the amount of priming. Only pairs related to the inappropriate-to-context meaning presented in Condition 1, the single occurrence of the homograph, differ. In that condition, priming does not significantly differ from the no-homograph control pairs. The results are clearly
incompatible with the predictions of the suppression enhancement model and quite consistent with the predictions of the activation-selection model.

My research with word association and homophone spelling, which shows both the primacy of the first experience and difficulty in priming an alternative meaning (spelling) of an ambiguous word, would easily fit the model. Both the enhanced activation produced by the first experience and any changes in the weights of the attributes induced by the first experience reduce the likelihood that the alternative meaning would be activated on the second occurrence of the ambiguity. Therefore, the alternative meaning is harder to prime. A subset of items from the initially primed meaning will remain with their attributes weighted toward the initial experience. When attributes are reweighted following the second ambiguity occurrence, the additivity of the combined weights will tend to bring those items back to the initial baseline. That is the combination of items unaffected by the second experience, and those that revert to initial baseline will produce what I have labeled a primacy effect.

Simpson and his colleagues (Simpson & Kang, 1994; Simpson & Kellas, 1989) have reported three results with the primed naming task for which any model of disambiguation must account. First, when the relationship of the prime to the target changes meaning, a slowing in naming is obtained. For example, if the participant sees bank as a prime for the naming target RIVER on one trial, naming speed is slowed when the target word MONEY is named following the prime bank on an ensuing trial. Second, a trial pair table–CHART preceding a pair table–MONEY has no effect even though in both instances a homograph (e.g., bank or table) is disambiguated. The crucial factor is the relatedness of the target to the homograph that produces the slowing. Third, no facilitation is obtained when the subsequent naming target is related to the same meaning as the first pair as when bank–SAVINGS precedes bank–MONEY.

It is possible that neither an explanation from the point of view of an activation-selection model nor one from a suppression view is necessary to account for these results. It seems reasonable that the naming task with repeated primes might depend on a mechanism like that suggested by Becker (1976, 1980) and Norris (1986), in which the prime provides a set of candidates that are searched in order. Simpson used a 200-ms stimulus onset asynchrony between prime and target to minimize this possibility. However, when primes are repeated, there is nothing to prevent the creation of a candidate set for subsequent trials during the intertrial interval following a response. Such a set would be related to the primed target and whether remembered or not might more easily be generated when the prime word reoccurs. This would lead to a fruitless but time-consuming search among these candidates when the prime is repeated and the naming target meaning is changed. If one assumes a fast relationship check is performed prior to search, the candidate set of an unrelated prime will be ignored. However, the unaltered activation pattern of the related prime would still meet the relatedness criterion. In those cases, the candidate set engendered by the prime will be searched, leading to a decrement in speed for the related but altered prime with respect to an unrelated prime. Finally, the absence of positive priming in the same-meaning case (bank–SAVINGS, bank–MONEY) may result from a ceiling effect, as Simpson and Adamopolous (chapter 7, this volume) have speculated.
The results of the work reported on idiom processing of Galinsky and Glucksberg (2000, Experiment 3) could be interpreted as an activation effect. Having to process the idiom “break a leg,” the participant will need to activate positive attributes. With respect to the privileged position afforded to ambiguity and figurative language, the model suggests enhanced activation. Therefore, it would not be unreasonable to expect that the idiom “break a leg” will show persistence in activation greater than the expression “good luck.” Unfortunately, the study lacks a fourth group who read a completely irrelevant paragraph. The three conditions that exist in the study—actually breaking a leg, “good luck,” and “break a leg”—are perfectly ordered with respect to the predictions of a model that has active activation setting (or constraining) the interpretation of what is read. As I noted earlier, the alternative—that inhibition is operating in the absence of the ambiguity—is inconsistent with other findings in which the below-baseline case only occurs in the presence of the ambiguous word.

Newsome (1999) reported that the processing of the metaphor My lawyer is a shark failed to prime the concept swim, even at 100 ms following the word shark. The issue becomes whether suppression acts rapidly for metaphors as opposed to homographs where considerable activation is observed for context-inappropriate meanings of homographs presented at the end of sentences as measured by the lexical-decision task (e.g., Gernsbacher & Faust, 1991a). Priming in Newsome’s study was obtained for the metaphorically relevant word vicious. These results seem to be easily explained by the activation-selection model because the activated context of lawyer is unlikely to set the attribute swim but could activate vicious.

Most notable, therefore, for current theory is that the model requires neither suppression nor inhibition to account for the data reviewed. Perfetti and Hart (chapter 5, this volume) have presented an explanation of the differential results for good and poor readers in the priming studies reported by Gernsbacher and Faust (1991a) that does not depend on differential suppression.

Toward a Realization of the Model

The model offered here is a further refinement of a model first proposed to account for the build-up of proactive interference in the short-term memory literature (Gorfein & Viviani, 1981) and extended to the lexical ambiguity literature by Gorfein and Bubka (1989). At the time of the original presentation, there appeared to be no way of defining attributes in a way that would make the model realizable in a concrete form. However, the emphasis on the selection and activation of attributes might be neatly tied to one of the high-dimensional semantic space models, that is, Burgess and Lund’s (2000) version of the hyper-space analogue to language (HAL) model or the latent semantic analysis (LSA) view of Landauer and Dumais (1997). Burgess (chapter 14, this volume) begins a discussion of how a contextual constraint model might be operationalized with respect to the HAL database.

It is certainly the case that I have offered only a barebones analysis of the model. Specifically, I have not directly addressed the role of language frequency.
and homograph balance in the model, although my colleague and I (Gorfein & Bubka, 1989), as well as others (Neill, 1989), have placed heavy emphasis on these factors in our analysis of the literature. How the problem of frequency dominance plays out in high-dimensional space may be an empirical matter for the modelers: Is an ordering of attribute weights sufficient to account for the data, or will the weight of an attribute of a word interact with its ease of activation? My instincts tell me that weights must be continuously adjustable, which will necessitate any model being recency sensitive.

It is hoped that the framework offered here will be of sufficient interest to excite the efforts of modelers. In the meantime, there appears to be a lot of interesting experimental work to be done on the basis of the informal model.

**Conclusion**

Although the present chapter argues that suppression is not a necessary construct to account for the data reviewed, I have not examined the larger literature that makes use of the suppression mechanism. It is conceivable that two processes may be necessary. However, I feel that great care must be taken not to confuse differences in performance with respect to some baseline in which one or another condition is below baseline with the requirement that suppression and inhibition are necessary mechanisms in explaining that performance. In Gorfein et al. (2000), my colleagues and I too were seduced into confusing such decrements in performance with the need for such a mechanism. In view of this present analysis, I believe that some of the emphasis on inhibitory mechanisms in the literature may have been misplaced. Activation mechanisms appear to produce large and relatively long-lasting effects and in my opinion need reemphasis.