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Cerebral Mechanisms for Suppression of Inappropriate Information during Sentence Comprehension

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Abstract

In two experiments we investigated the extent to which interference from contextually inappropriate information was attenuated or suppressed over time in the two cerebral hemispheres during sentence comprehension. Subjects viewed centrally presented sentences ending in either a homophone or a homograph and made speeded judgments as to whether a laterally presented test word was related to the overall meaning of the sentence. Suppression of contextually inappropriate forms of homophones was found when test words were presented to either hemifield, but suppression of inappropriate senses of homographs was found only when test words were presented to the right visual hemifield. The results from the homograph experiment are consistent with the hypothesis that right and left hemisphere semantic selection systems operate in qualitatively different ways. The results from the homophone experiment suggest that while the left hemisphere may be more efficient at suppression, both hemispheres possess the ability to suppress inappropriate information to some degree.

A major challenge to text comprehension comes from the widespread lexical ambiguities present in language. Many, if not most, words have multiple associations (e.g., *apple* is associated with picking fruit from a tree or baking a pie); many words are ambiguous in that they have multiple distinct meanings (e.g., *watch* can be a verb associated with looking at something or a noun for a timepiece usually worn around the wrist). It is also true that many words are phonologically ambiguous (e.g., the word *patients* and *patience* sound the same when spoken). Thus, it is not surprising that studies of word sense activation have found that multiple meanings, and multiple associated concepts, become activated when a word is encountered in isolation (Balota, Ferraro, & Connor, 1991; Neely, 1977; Simpson, 1984; Simpson & Burgess, 1985). Furthermore, studies of word sense activation have found that multiple meanings and associated concepts are initially activated when a word is encountered within a sentential context, but that after a short delay only the meaning implied by the sentential context remains active (Conrad, 1974; Duffy, Morris, & Rayner, 1988; Gernsbacher, 1990, pp. 104–108; Merrill, Sperber, & McCauley, 1981; Onifer & Swinney, 1981; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979; Tanenhaus,

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Leiman, & Seidenberg, 1979; Till, Mross, & Kintsch, 1988; Van Petten & Kutas, 1987). While these results suggest that sense selection (Kintsch, 1988; Kintsch & Mross, 1985) plays an important role in comprehension ability, this view has not gone unchallenged. Several studies have found that the amount of information activated during word recognition may be constrained as sentence context becomes more biasing (Kellas, Paul, Martin, & Simpson, 1991; Tabossi, 1988a,b), suggesting that sense selection mechanisms and contextual bias work together during comprehension.

Our previous research has assumed that often more information becomes initially active during word recognition than is needed and has emphasized the role of mechanisms acting during sense selection to deactivate contextually inappropriate information and to further activate appropriate information (Gernsbacher, 1991; Gernsbacher & Faust, 1991b). Our results indicate that the ability to suppress, or deactivate, information that has little or no relationship to the overall sentence context is an important marker of comprehension ability (Gernsbacher & Faust, 1991a; Gernsbacher, Varner, & Faust, 1990).

Given a growing literature on hemispheric differences in language processing, and the importance of suppression mechanisms during language comprehension (Gernsbacher, 1990; Gernsbacher & Faust, 1991b), it would be informative to look at hemispheric differences in suppression during language comprehension. The results of several studies are consistent with significant language function in the right hemisphere (e.g., Beeman, 1993; Benson, 1986; Brownell, 1988; Hough, 1990; Moscovitch, 1983) and with a separate and relatively complete right hemisphere (RH) semantic activating system (e.g., Chiarello, 1988b, 1991; Zaidel, 1983; Zaidel, 1987). In fact, recent evidence points toward functional differences in the left hemisphere (LH) and RH semantic activation and selection systems that may have important implications for models of language comprehension (Beeman et al., 1993; Burgess & Simpson, 1988; Chiarello, 1985; Chiarello, Burgess, Richards, & Pollock, 1990; Chiarello, Richards, & Pollock, 1992; Lambert & Voot, 1993; Nakagawa, 1991; Rodel, Cook, Regard, & Landis, 1992).

A question of particular importance to theories of comprehension is the extent to which the mechanisms involved in the selection of appropriate word senses for integration with prior text differ in the two lateralized semantic systems (Burgess & Simpson, 1988; Chiarello, 1991). In other words, are the semantic systems in the two hemispheres functionally equivalent? Burgess and Simpson (1988) examined sense activation and selection for homographs in isolation and concluded that selection of a particular sense of a homograph occurred in the semantic system of the LH, but not the RH. Chiarello (1991) has also argued that the LH acts quickly to select a particular word sense for integration with prior text, while the RH holds a wide variety of information active for rapid recovery in case the interpretation selected by the LH is incorrect. If the LH is specialized for the selection of word sense meanings for further integration as Burgess and Simpson, and Chiarello, have argued, then the suppression of contextually inappropriate word senses during sentence comprehension (Gernsbacher et al., 1990; Gernsbacher & Faust, 1991b) should occur primarily in the LH.

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In what follows we will discuss suppression of inappropriate information during sentence comprehension and evidence for differential semantic activation and selection processes in the cerebral hemispheres. We will then present the results of two experiments that bear upon the question of hemispheric differences in the suppression of inappropriate information during sentence comprehension.

INHIBITORY PROCESSES AND SENTENCE COMPREHENSION

In our previous work we have emphasized the role of sense selection mechanisms in providing a well delineated subset of information for integration with the representation of previously comprehended text (Gernsbacher et al., 1990; Gernsbacher & Faust, 1991a). Gernsbacher (1990, 1991) has proposed that information that becomes active after a word is read is considered for incorporation into the representation of the meaning of the sentence. Two cognitive mechanisms are proposed to modulate the activation level of incoming information: (1) Enhancement, which increases activation levels of information that is consistent with prior sentential context; and (2) Suppression, which decreases or dampens activation levels of information inconsistent with prior sentential context. The mechanisms of suppression and enhancement should be particularly important during word sense disambiguation within a sentence context.

Previous studies of the resolution of homographs in context have, for the most part, provided a pattern of early activation of multiple senses of the homographs followed by contextually driven selection of the meaning most appropriate to the overall meaning of the sentence (Conrad, 1974; Duffy et al., 1988; Merrill et al., 1981; Onifer & Swinney, 1981; Seidenberg et al., 1982; Swinney, 1979; Tanenhaus et al., 1979; Till et al., 1988; Van Petten & Kutas, 1987). This basic pattern of results has been replicated in a number of studies using a wide variety of experimental paradigms such as Stroop color naming (Conrad, 1974), word naming (Tanenhaus et al., 1979; Van Petten & Kutas, 1987), event related potentials (Van Petten & Kutas, 1987), and eye fixations during reading (Duffy et al., 1988). However, several of these studies have provided evidence that less frequent (subordinate) senses of homographs may be activated more slowly, or to a lesser degree, than the more frequent senses (Duffy et al., 1988; Simpson, 1984; Van Petten & Kutas, 1987). In addition, a number of studies have found evidence that unbiased senses of homographs will not become active under conditions where sentence context is particularly biasing (Kellas et al., 1991; Tabossi, 1988a,b). We have sidestepped such issues in our previous research by assuming that, due to ambiguities of many types, on average more information is activated during word sense activation stages of processing than is appropriate or relevant to comprehension of the text as a whole (Gernsbacher et al., 1990; Gernsbacher & Faust, 1991a). We have concentrated instead upon the hypothesis that efficient suppression of contextually inappropriate or irrelevant information during sense selection underlies effective comprehension (Gernsbacher & Faust, 1991b).

More specifically, one important way more and less skilled comprehenders might differ is in their ability to remove inappropriate information from consideration during the formation of a mental representation of a sentence (Gernsbacher et al., 1990; Gernsbacher & Faust, 1991a). To test the hypothesis that less-skilled comprehenders are less efficient at suppressing inappropriate senses of homographs, Gernsbacher et al. (1990, Experiment 4) had subjects read short sentences each ending with a homograph (e.g., He dug with the *spade*) or a nonhomograph (e.g., He dug with the *shovel*). Subjects then verified whether a test word was related to the overall meaning of the sentence. Test words appeared after either a short (100 ms) or a long (850 ms) delay. For critical trials, test words were chosen that were not related to the overall meaning of either sentence, but were related to the unbiased meaning of the sentence-final homograph (e.g., *ACE*). The more time comprehenders needed to reject *ACE* after the spade versus the *shovel* sentence, the more activated the *ACE*-related meaning (inappropriate sense) of *spade* must have been. This difference is a measure of the amount of interference from inappropriate senses of the sentence-final homographs.

After a short delay (100 ms), both the more- and less-skilled comprehenders experienced a significant amount of interference. However, after a long delay (850 ms), only the less-skilled comprehenders experienced a significant amount of interference. We concluded from these data that more-skilled comprehenders were able to suppress the contextually inappropriate meanings of the sentence-final homographs, while the less-skilled comprehenders were not. Gernsbacher and Faust (1991a, Experiment 1) found a similar pattern of results when sentence final words were homophones (i.e., two written words that are spelled differently are alternative forms of a homophone if they sound the same when spoken, e.g., *patients* and *patience*). More skilled comprehenders in this study were able to suppress the contextually inappropriate forms of the homophones while less skilled comprehenders were not.

SEMANTIC ACTIVATION AND SELECTION IN THE CEREBRAL HEMISPHERES

The results of several recent studies employing a visual split field methodology (Chiarello, 1988a; Young, 1982) have indicated that the cerebral hemispheres activate different subsets of information. While different authors have proposed explanations of hemisphere differences in semantic activation that differ in details (Beeman, 1993; Beeman et al., 1993; Drews, 1987; Rodel et al., 1992), overall, the evidence is consistent with a general view that the LH semantic system activates a narrower range of information that is more strongly related to the stimulus word than does the RH semantic system (Chiarello, 1991). While the issue of hemispheric differences in semantic activation is an intriguing one, the present study will concentrate on identifying hemispheric differences in the mechanisms underlying selection of a subset of active information for integration with prior text. For our purposes all that we require is that each hemisphere initially activate more information associated with homographs and homophones than is necessary for proper comprehension.

Chiarello (1991; Chiarello et al. 1992) has suggested that the LH is specialized to select a subset of activated information for integration with prior text. Chiarello (1985, Experiment 6), and Chiarello, Senehi, and Nuding (1987, Experiment 3) found either greater priming in the lvf/RH (left visual field) condition or no hemifield difference, when the proportion of related trials was low. In contrast, there was greater priming in the rvf/LH (right visual field) for the same critical items when presented among a high proportion of related trials

(Chiarello, 1985, Experiment 3; Chiarello et al., 1987, Experiment l). The results of these two experiments are consistent with the notion that rvf/LH priming is greater under conditions which promote controlled processing (i.e., a high proportion of related trials).

Chiarello et al. (1992) measured two controlled priming effects, cost (Neeley, 1977) and an effect they termed additive priming. They used a high proportion of related trials with a relatively long ISI and found that hemifield differences in priming depended on the type of relationship between prime and test words. Priming for the categorical associates (e.g., DOG–CAT) was greater than the priming for either noncategorical associates (e.g., BEE–HONEY) or categorical nonassociates (e.g., DOG–GOAT), but only when test words were presented to the rvf/LH. They argued that this additive priming (i.e., priming effects are greater when prime and target are related via two types of relationship, category membership and association, versus only one type) effect was characteristic of the influence of prime–target relatedness checking (Balota & Chumbley, 1984; Neely, Keefe, & Ross, 1989). They argued further that the same processes responsible for comparing the meanings of successive words are also intimately involved in semantic integration processes during comprehension. Chiarello et al. (1992) also found reliable and equivalent costs, or slowing of unrelated trials in relation to a neutral control condition, for both hemifields. Since costs have been taken as a measure of controlled selection processes (Neely, 1977) they concluded that their results were consistent with equivalent controlled selection processes in both hemispheres, but semantic integration in the LH only.

To date, only one study has effectively tracked the activation of alternative senses of homographs in the two hemispheres over time (Burgess & Simpson, 1988). In this study primes were ampiguous in that they were words with more than one distinct meaning. For example, the word *BANK* has a more frequent (dominant) meaning of a financial institution, and it also has a less frequent (subordinate) meaning of the side of a river. Priming was found for both the dominant and subordinate meanings in the short delay (35 ms SOA) condition, but for only the dominant meaning in the long delay (750 ms SOA) condition, following targets presented to the rvf/LH. In fact, in the long delay condition lexical decision for the rvf/LH subordinate targets was significantly slower than for the rvf/LH unrelated targets. This same basic pattern of early priming of both dominant and subordinate senses of homographs, followed by later priming for just the dominant meaning, was also found in an earlier study using the same stimuli, but centrally presented primes and targets (Simpson & Burgess, 1985). Such a pattern of activation of word senses over time suggests that selection of the dominant meaning is occurring. The observation of a negative priming effect for rvf/LH subordinate long delay targets suggests further that subordinate meanings were actually inhibited, presumably due to being selected against (Yee, 1991).

The results from the lvf/RH target trials in the Burgess and Simpson (1988) study were quite different from the results for the rvf/LH trials. Priming was found for the subordinate meanings in the long delay (750 ms), but not the short delay (35 ms), condition. In contrast, priming for the dominant meanings was found in both the short and the long delay conditions. While the finding that dominant meanings become active earlier than subordinate meanings is consistent with ordered access models of ambiguity resolution (Simpson, 1984; Van Petten & Kutas, 1987), the fact that both meanings are active after a significant delay is inconsistent with prior research on the time course of activation of alternative meanings of homographs in isolation using centrally presented primes and targets (Seidenberg et al., 1982; Simpson, 1984; Simpson & Burgess, 1985; Swinney, 1979). Burgess and Simpson (1988) argued that their results were indicative of qualitative differences in the selection of word senses in the cerebral hemispheres. They proposed that the LH quickly activates and selects the interpretation of the homograph which is most likely to be needed for comprehension of the overall text. In the absence of prior sentence context, the LH chooses the sense of the homograph with the highest frequency of occurrence (i.e., the most dominant sense). The RH, on the other hand, activates a wide range of information and, Burgess and Simpson suggested, holds alternative meanings active in case the LH selects incorrectly and needs to recover from its mistake.

This tentative model of qualitative differences in the activation and selection of alternative word senses in the hemispheres has been developed further by Chiarello (1991; Chiarello et al., 1992). Chiarello has added the proposal that both the RH and the LH can employ controlled semantic processes to modulate the activation of information, but that it is the LH that “predominates for meaning integration across successively presented words” (Chiarello et al., 1992, p. 52).

The proposal that the LH dominates for selection of word senses for integration with prior text has important implications for models of language comprehension. Due to the fact that the Burgess and Simpson (1988) study used single word primes, the generality of their results for language comprehension per se can be questioned. In this study, the only basis for selection of word senses was the dominance of various senses. In fact, selection of word senses has been shown to be dependent upon at least two factors: (a) relative frequency of meanings and (b) constraints imposed by prior text (Simpson & Kellas, 1989). In fact, these two factors can interact in complex ways (Kellas et al., 1991; Simpson & Kellas, 1989). Given that models of language comprehension are concerned with the probelm of integrating information with prior text, it is important that the hypothesis of LH dominance be examined under conditions where disambiguation is performed within sentences. To this end, we modified two previous experiments (Gernsbacher et al., 1990, Experiment 4; Gernsbacher & Faust, 1991, Experiment 1) of sentence disambiguation to fit a split field methodology. This modification allowed us to probe the activation of information that is inappropriate given the sentence context in the two cerebral hemispheres.

SUMMARY

Studies of word sense disambiguation with sentence contexts have consistently found a pattern of initial multiple word sense activation followed by selection of the sense that best fits the context (Conrad, 1974; Duffy et al., 1988; Merrill et al., 1981; Onifer & Swinney, 1981; Seidenberg et al., 1982; Swinney, 1979; Tanenhaus et al., 1979; Till et al., 1988; Van Petten & Kutas, 1987). Gernsbacher (1991; Gernsbacher & Faust, 1991b) has argued that the inappropriate word sense is suppressed or deactivated and that suppression of inappropriate information underlies efficient comprehension. In our previous research we have found that suppression of contextually inappropriate senses of homographs is an important mechanism underlying individual differences in comprehension (Gernsbacher et al., 1990; Gernsbacher & Faust, 1991a).

Simpson and Burgess (1985) have demonstrated that sense dominance, that is, the relative frequency of meanings of a homograph, can act as the default context when homographs are presented in isolation. These researchers modified their procedure to probe the activation of senses of homographs in the cerebral hemispheres (Burgess & Simpson, 1988). The results indicated that both the dominant and the subordinate meanings of ambiguous words were initially active in both hemispheres. After a delay, only the dominant meaning remained active in the LH whereas both meanings remained active in the RH. Burgess and Simpson (1988) argued that the LH acts to select the dominant sense of the homograph, while the RH holds both dominant and subordinate senses active.

Chiarello et al. (1992) has added to this view by proposing that while both hemispheres possess the ability to employ controlled expectancies during sense selection, the LH is specialized for integrating word meanings across successive words. However, even though Chiarello et al. (1992) and Burgess and Simpson (1988) have interpreted their results as having implications for our understanding of sense disambiguation in general, their stimuli consisted of single word primes. Because studies of word sense disambiguation have shown that context provided by single words, and by prior text, are separate factors (Kellas et al., 1991; Simpson & Kellas, 1989) the claim of LH dominance for integration with prior text must therefore be supported by studies of sense disambiguation within a sentence context before strong conclusions regarding hemispheric differences in word sense disambiguation can be made.

In two experiments the present study tested the hypothesis that the LH is specialized for word sense selection for integration with prior text. In the first experiment we presented homographs in sentences and probe the activation of senses of the homographs which are inappropriate given the context. If the LH is indeed specialized to select meanings of homographs for integration with prior text, while the RH is not, we expected to see suppression of the inappropriate senses of homographs when words were presented to the rvf/LH but not the lvf/RH. In the second experiment we tested the same hypothesis with the same methodology but with a separate set of sentences containing homophones instead of homographs, that is, a different type of ambiguity.

EXPERIMENT 1

We used a modified version of the context verification task (Gernsbacher et al., 1990, Experiment 4) to probe the activation of contextually inappropriate senses of homographs in the two cerebral hemispheres. Subjects viewed centrally presented sentence contexts, one word at a time (e.g., He dug with the *spade/shovel*), followed either after a short (100 ms) or after a long (1000 ms) delay by a briefly presented lateral test word. They then judged whether the test word was related to the overall meaning of the preceding sentence. We computed an interference measure by subtracting each subject’s mean reaction time (error rate) to reject test words like *ACE* after nonhomographs (e.g., *shovel*) from their mean reaction time (error rate) to reject test words like *ACE* after homographs (e.g., *spade*). To the extent that the contextually inappropriate meaning of the homograph is active and interferes with performance on the task of context verification we expect the interference measure to be reliably greater than zero.

We predicted interference at the short delay but little or no interference at the long delay (i.e., decreasing interference over time) when test words were presented to the rvf/LH. We also predicted no suppression effect when test words were presented to the lvf/RH.

Method

Subjects—Of the 220 Air Force recruits tested, 204 subjects provided at least 4 of 10 possible correct responses within 3 *SD*' s of that subject's overall mean response time in all eight experimental conditions. For several reasons beyond our control (e.g., subject scheduling and hardware problems), the number of subjects included in each of the eight stimulus list conditions became unbalanced. The number of subjects in each condition was brought down to that of the condition with the lowest number (21) of participants by discarding subjects with the highest overall error rates in the other list conditions. Data from the resulting 168 subjects were then analyzed.

Materials and Design—The materials employed were identical to those from Gernsbacher et al. (1990, Experiment 4). Eighty homographs with two predominant meanings of relatively equal frequency were each matched with two sentences which differed only in their final word. In one sentence, the final word was a homograph (e.g., "He dug with the *spade*"); in the other sentence, the final word was a different, nonhomographic word that was semantically comparable, though not necessarily synonymous (e.g., "He dug with the *shovel*"). Finally, we selected a test word for each of the 80 homographs. Each test word represented the meaning of the homograph that was *not* captured in the sentence. Test words were moderate to high associates chosen from the same homograph norms used to generate the sentence-final homographs. For example, the test word *ACE* (related to the card suit sense of spade) followed the sentence, "He dug with the *spade*." The test words were also unrelated to the sentences when the semantically comparable, nonhomographic words were the final words (e.g., the test word *ACE* is unrelated to the sentence, "He dug with the shovel"). All sentences were four or five words long and consisted of simple vocabulary.

We also constructed 80 filler sentences that required a "yes" response. These sentences were identical in structure to experimental sentences, and the final words for approximately half were homographs. However, these filler sentences differed from the experimental sentences because their test words were related to the sentences' meaning. For example, the sentence "She liked the rose" was followed by the test word *FLOWER*.

We counterbalanced our materials by manipulating three variables. First, for each experimental sentence, half the subjects were presented with the homograph as the final word of the sentence (e.g., He dug with the spade), and the other half were presented with the semantically comparable, nonhomographic word as the final word (e.g., He dug with the shovel). Second, for each experimental sentence, half the subjects of each group were presented with the test word at the short (100 ms) interval, and half were presented with it at the long (1000 ms) interval. Finally, for each experimental sentence in each form, homograph or nonhomograph, half the subjects were presented the target word (e.g., *ACE*) to the right visual field, and half to the left visual field. By counterbalancing these three variables, we created eight between-subjects material sets.

Procedure—Stimuli were presented on an IBM 386 AT compatible computer with a standard VGA color monitor at a viewing distance of approximately 0.5 m. Text was presented in Turbo Pascal Small Font, with individual characters that ranged from 0.4 to 0.7 cm in height, and 0.4 to 0.5 cm in width. Subjects responded by pressing the “?-key” of the computer keyboard with the index finger of their right hands to indicate a *YES* response, and the “Z-key” with the index finger of their left hands to indicate a *NO* response. Response latencies were timed to the nearest millisecond using an internal timing routine that programmed a chip on the motherboard to cycle at an appropriate rate. Overall task time was approximately 40–45 min, in which there were two short breaks. Four demonstration trials for which the correct answer was provided prior to presentation, and 20 practice trials, were presented. The practice trials contained the same approximate balance of trials types as the main body of trials.

Each trial began with a warning signal, which was a plus sign that appeared for 500 ms in the center of the screen. Then, each sentence was presented, one word at a time, centered horizontally, with each successive word replacing the previous one. Each word’s presentation duration was a function of its number of characters plus a constant. The constant was 300 ms, and the function was 16.7 ms per character. The interval between words was 50 ms. Approximately 16.7 ms after the offset of the final word in each sentence a plus sign was presented in the center of the screen, and remained visible until response. Also, the test word appeared either 100 ms (short delay) or 1000 ms (long delay) after the offset of the sentence final word. Each test word was capitalized and flanked by a space and two asterisks, for example: ** ACE **. Test words were presented for 200 ms in a horizontal orientation, with the center of the word falling 2.25 cm (approximately 2.6 degrees of visual angle) to the right or left of the plus sign. Since the longest target word subtended approximately 3 cm, and the shortest approximately 1.5 cm, the inner edge of the target word ranged from 0.75 to 1.5 cm (0.9 to 1.7 degrees) from the center of the plus sign. The test words remained on the screen until the subjects responded, with a legal response limit between 200 and 4000 ms. Feedback, either the word *WRONG* or a number indicating response latency, was presented for 700 ms in the center of the screen, directly below where the sentence had been presented.

Results and Discussion

We calculated the mean and SD for each subject in each condition and removed responses more extreme than 3 *SD*’s from the subject’s mean from any further analysis. We also removed responses made by pressing a key other than a legal response key. The procedure resulted in 2.6% of all correct responses being removed. Response latency and accuracy data were analyzed in separate repeated measures ANOVAs. In addition, to directly assess suppression effects within each hemifield, the response latency and the error rates were separated by hemifield and each analyzed in two separate, a priori ANOVAs.

Table 1 presents the subjects' mean reaction times and error rates on the experimental trials. Subjects rejected the test word more rapidly, $F(1, 167) = 30.39$, $p < .001$, but not more accurately, $F(1, 167) = .29$, $p = .588$, when test words were presented to the rvf/LH, compared to the lvf/RH. Subjects responded more rapidly, $F(1, 167) = 365.60$, $p < .001$, and more accurately, $F(1, 167) = 40.77$, $p < .001$, after the long versus the short delay. However, delay interval and visual hemifield did not interact for either the response latency or accuracy measures (all *F*'s < 1).

From the data presented in Table 1, we computed an interference measure by subtracting each subject's mean reaction time to reject test words like *ACE* after nonhomographs (e.g., *shovel*) from their mean reaction time to reject test words like *ACE* after homographs (e.g., *spade*). To the extent that the contextually inappropriate meanings of the homographs were active and interfered with performance on the task of context verification we would expect the interference measure to be reliably greater than zero. Figure 1 displays how much interference the subjects experienced at the two test intervals. Of primary interest was whether a reliable reduction of interference from the short to the long delay interval would be observed. Such a suppression effect would be an indication that the contextually inappropriate sense of the sentence final homograph has become less active or suppressed.

As illustrated in Fig. 1, subjects experienced a significant amount of over-all interference, $F(l, 167) = 69 .99$, $p < .001$, which did not differ across hemifield, $F(1, 167) = .07$, $p = .793$. There was a reliable reduction in interference across delay, that is, a suppression effect, $F(l, 167) = 4.97$, $p = .027$. The interpretation of this main effect is constrained by the significant, $F(1, 167) = 4.00$, $p = .047$, hemifield by delay interval interaction. As is apparent from inspection of Fig. 1, there was a reliable suppression effect when targets were presented in the rvf/LH, $F(1, 167) = 10.35$, $p = .002$, but not when targets were presented to the lvf/RH, $F(l, 167) = .03$, $p = .853$. This suggests that the contextually inappropriate meanings of the homographs were active for targets presented to either hemifield at the short delay, and that contextually inappropriate meanings were suppressed within the 1000-ms long delay period only for targets presented to the rvf/LH.

It is worth noting that, because suppression is defined as a decrease in interference across delay within a particular hemifield, suppression is a completely within hemifield construct. There is no comparison made of interference effects across hemifield. Thus, the fact that subjects were in general slower to reject inappropriate test words when they were presented to the lvf/RH than to the rvf/LH does not affect our interpretation of suppression effects.

We computed another measure of interference, analogous to the one depicted in Fig. 1, by subtracting the subjects' proportion of failures to reject test words like *ACE* after nonhomographs (e.g., *shovel*) from the proportion of failures to reject test words like *ACE* after homographs (e.g., *spade*). To the extent that the contextually inappropriate meanings of the homographs are active we would expect that subjects will fail to reject a test word like *ACE* after a homograph (e.g., *spade*) more often than after a nonhomograph (e.g., *shovel*). Note that, if the error rate interference effect mirrors the reaction time interference effect described above, differences in error rates will be in opposition to a speed/accuracy trade-off (i.e., for conditions with slower reaction times, more errors are predicted).

The results from the error interference measures (error differential) are presented in Fig. 2. As can be seen these data are similar to the latency data presented in Fig. 1. Overall, subjects experienced interference, $F(1, 167 = 203.73$, $p < .001$, which did not differ across hemifields, $F(1, 167) = .004$, $p = .950$. There was a reliable suppression effect, that is, a reduction in interference across delay, $F(1, 167) = 13 .31$, $p < .001$. But there was no reliable hemifield by delay interval interaction, $F(1, 167) = 2.14$, $p = .145$. There was a reliable suppression effect when targets were presented to the rvf/LH, $F(1, 167) = 12.60$, $p = .001$, but not when targets were presented to the lvf/RH, $F(1, 167) = 2.18$, $p = .142$. The trend toward more suppression for targets presented to the rvf/LH is consistent with the response latency results depicted in Fig. 1. The separate planned comparisons for each hemifield are also consistent with the response latency results in that there was no reliable suppression for targets presented to the lvf/RH, and there was reliable suppression for targets presented to the rvf/LH.

One might suspect at this point that, even though we used homographs with two major meanings of approximately equal dominance, it might be the case that the contextually inappropriate senses of the homographs might be of slightly less dominance. If this were the case then the pattern of results we found for the present experiment may be due not to sentence contexts, but to sense dominance. According to this logic, had we presented the sentence-final homographs in isolation, instead of in a sentence, we might have observed the same results. This would merely be a replication of Burgess and Simpson (1988). However, this is unlikely to be the case for two reasons. First, any difference in dominance between the senses of the sentence-final homographs biased by sentence contexts, and the senses not biased by sentence contexts, is probably small. We would not have expected to find such large interference effects if sense dominance were the major factor driving the effect. Second, we have used a subset of 48 of these homographs and matching test words in a previous experiment (Gernsbacher & Faust, 1991b, Experiment 2). In this experiment we constructed three sentences for each sentence-final homograph, one biasing each of the two balanced senses, and one neutral in bias. We found initial activation for appropriate, inappropriate, and unbiased senses of the sentence-final homograph, but suppression for only the inappropriate sense. Thus, in an experiment where we did construct sentences for each of two major alternatives for the sentence-final homographs, and used the same homographs and matched test words, we found that context was driving our results. Thus, it is unlikely that our current results were affected by the choice of which sense of the sentence-final homograph was chosen the be contextually inappropriate, and which was chosen to be appropriate.

Overall, the results from the response latency and the error rate analyses suggest that while the left hemisphere can suppress inappropriate senses of homographs, the right hemisphere provides marginal suppression at best. We now turn to the question of generality of the suppression laterality observed in Experiment 1. Burgess and Simpson (1988) found a similar pattern for homographs presented in isolation. They suggested that the two hemispheres may employ word sense selection mechanisms in a qualitatively different manner, with the left hemisphere selecting the sense with the most likelihood of being appropriate (dominant) and suppressing the other sense (subordinate), while the right hemisphere held both senses active. However, Chiarello et al. (1992) found reliable controlled lexical processing effects in the right hemisphere. Perhaps word sense selection of homographs is a unique case and the RH will suppress inappropriate information associated with other types of ambiguity.

EXPERIMENT 2

Consider the case of homophones presented in a sentence context (e.g., He had lots of *patients*). Previously, we have found that shortly after reading such sentences comprehenders activate information related to the inappropriate form of the homophone, that is, *patience* (Gernsbacher & Faust, 1991a). When probed with a target word related to the inappropriate form (e.g., *CALM*) subjects are slower to reject the target word as being unrelated to the overall meaning of the homophone sentence (e.g., He had lots of *patients*) as opposed to a nonhomophone control sentence (e.g., He had lots of *students*). This result is consistent with that of van Orden (1987; van Orden, Johnston, & Hale, 1988) using similar stimuli. Gernsbacher and Faust (1991a) also found that people who were skilled at story comprehension were more efficient at suppressing inappropriate forms of homophones than were less-skilled comprehenders.

In experiment 2, we used a modified version of the context verification task (Gernsbacher & Faust, 1991a, Experiment 1) to probe the activation of contextually inappropriate forms of homophones in the two cerebral hemispheres. Subjects viewed centrally presented sentence contexts, one word at a time, followed either after a short (100 ms) or after a long (1000 ms) delay by a briefly presented lateral test word. They then judged whether the test word was related to the overall meaning of the preceding sentence. We computed an interference measure by subtracting each subject's mean reaction time (error rate) to reject test words like *CALM* after nonhomophones (e.g., *students*) from their mean reaction time (error rate) to reject test words like *CALM* after homophones (e.g., *patients*). To the extent that the contextually inappropriate form (e.g., *patience*) of the homophone is active and interferes with performance on the task of context verification we would expect the interference measure to be reliably greater than zero.

We predicted interference at the short delay but little or no interference at the long delay (i.e., decreasing interference over time), when test words were presented to the rvf/LH. We also predicted no suppression effect when test words were presented to the lvf/RH.

METHOD

Subjects—We tested 223 Air Force recruits, none of whom had participated in Experiment 1. Of these, 145 subjects provided at least 4 of 10 possible correct responses within 3 *SD*'s of that subject's overall mean response time in all eight experimental conditions. For several reasons beyond our control (e.g., subject scheduling and hardware problems), the number of subjects included in each of the eight stimulus list conditions became unbalanced. The number of subjects in each condition was brought down to that of the condition with the lowest number (17) of participants by discarding subjects with the highest overall error rates in the other list conditions. Data from the resulting 136 subjects were then analyzed.

Materials and Design—The materials employed were identical to those of Gernsbacher and Faust (1991a, Experiment 1). Eighty homophones were each matched with two sentences which differed only in their final word. In one sentence, the final word was the homophone itself (e.g., "She had lots of *patients*"); in the other sentence, the final word was a different word that was semantically comparable though not necessarily synonymous (e.g., "She had lots of *students*"). Finally, we selected a test word for each of the 80 homophones. Each test word was related to the form of the homophone that was *not* in the homophone sentence. Test words were moderate to high associates chosen from the same homophone norms used to generate the sentence-final homophones. For example, the test word *CAIM* (related to *patience*) followed the sentence, "She had lots of patients." The test words were also unrelated to the sentences when the semantically comparable words were the final words (e.g., the test word *CAIM* is unrelated to the sentence, "She had lots of students"). All sentences were four or five words long and consisted of simple vocabulary.

We also constructed 80 filler sentences. These sentences were identical in structure to experimental sentences, and the final words for approximately half were homophones. However, these filler sentences differed from the experimental sentences because their test words were related to the sentences' meaning. For example, the sentence "She liked the *rose*" was followed by the test word *FLOWER*.

We again counterbalanced our materials by manipulating three variables. First, for each experimental sentence, half the subjects were presented with the homophone as the final word of the sentence (e.g., She had lots of *patients*), and the other half were presented with a semantically comparable nonhomophone as the final word (e.g., She had lots of *students*). Second, for each experimental sentence, half the subjects of each group were presented with the test word at the short (100 ms) interval, and half were presented with it after the long (1000 ms) interval. Finally, for each experimental sentence in each form, homophone and nonhomophone, half the subjects were presented the target word (e.g., *CALM*) to the right visual field, and half to the left visual field. By counterbalancing these three variables, we created eight between-subjects material sets.

Procedure—The procedure and apparatus were identical to those employed in Experiment 1.

Results and Discussion

We calculated the mean and *SD* for each subject in each condition and removed responses more extreme than 3 *SD*'s from the subject's mean from any further analysis. We also removed responses made by pressing a key other than a legal response key. This procedure resulted in 2.1 % of all correct responses being removed. Response latency and accuracy data were analyzed in separate repeated measures ANOVAs. In addition, to directly assess suppression effects within each hemifield, the response latency and the error rates were separated by hemifield and each analyzed in two separate, a priori ANOVAs.

Table 2 presents the subjects' mean reaction times and error rates on the experimental trials. The results of the factors of hemifield and delay interval are remarkably similar to those of Experiment 1. Thus, the change from homographs to homophones did not seem to affect these factors. Subjects rejected test words more rapidly, $F(1, 135) = 46.38$, $p < .001$, and more accurately, $F(l, 135) = 4.34$, $p = .039$, when they were presented to the rvf/LH versus the lvf/RH. Subjects also rejected test words more rapidly, $F(l, 135) = 254.67$, $p < .001$), and more accurately, $F(1, 135) = 32.61$, $p < .001$, after the long versus the short delay. However, delay interval and visual hemifield did not interact for either response latency or accuracy measures (all *F*'s < 1).

From the data presented in Table 2, we computed an interference measure by subtracting each subject's mean reaction time to reject test words like *CALM* after nonhomophones (e.g., *students*) from their mean reaction time to reject test words like *CALM* after homophones (e.g., *patients*). To the extent that the contextually inappropriate form of the homophone was active and interfered with performance on the task of context verification the interference measure would be expected to be reliably greater than zero. Figure 3 displays how much interference the subjects experienced at the two test intervals. Of primary interest was whether a reliable reduction of interference from the short to the long delay interval would be observed. Such a suppression effect would be an indication that the contextually inappropriate form of the sentence-final homophone had become active or suppressed.

As illustrated in Fig. 3, subjects experienced a significant amount of over-all interference, $F(1, 135) = 15 .92$, $p < .001$, which did not differ across hemifield, $F(l, 135) = .13$, $p = .724$. There was a reliable reduction in interference across delay, that is, a suppression effect, $F(1, 135) = 9 .25$, $p = .003$. However, unlike Experiment 1, there was no hemifield by delay interval interaction, $F(1, 135) = .69$, $p = .409$. The trend was for a greater suppression effect for rvf /LH test words, which was supported by the reliable suppression effect for test words presented to the rvf/LH, $F(1, 135) = 5.42$, $p = .021$, but not when targets were presented to the left visual field, $F(1, 135) = 1.85$, $p = .176$. In other words, the reliable overall suppression effect was carried predominantly by the rvf/LH conditions. The results suggest that the contextually inappropriate forms of the homophones were active for targets presented to either hemifield at the short delay. The suppression effect results are somewhat ambiguous in that the hemifield by delay interval interaction for the interference measure has an *F*-value less than one, indicating no difference in suppression across hemifields. However, when the interference measure is tested for each hemifield separately, reliable suppression is found for the rvf/LH conditions only, while the lvf/RH conditions show only a trend toward suppression.

To provide converging evidence regarding suppression effects, we computed another measure of interference, analogous to the one depicted in Fig. 3, by subtracting the subjects' proportion of failures to reject test words like *CALM* after nonhomophones (e.g., *students*) from the proportion of failures to reject test words like *CALM* after homophones (e.g., *patients*). To the extent that the contextually inappropriate form of the homophone is active we would expect that subjects will fail to reject a test word like *CALM* after a homophone (e.g., *patients*) more often than after a nonhomophone (e.g., *students*). Note that, if the error rate interference effect mirrors the reaction time interference effect described above, differences in error rates will be in opposition to a speed/accuracy trade-off (i.e., for conditions with slower reaction times, more errors are predicted).

The results of the error interference measures (error differential) are presented in Fig. 4. As can be seen, these data are similar to the latency results presented in Fig. 3. Overall, subjects experienced interference, $F(1, 135) = 361.33$, $p < .001$, which did not differ across hemifields, $F(l, 135) = .18$, $p = .67$). There was a reliable reduction in interference across delay, that is, a suppression effect, $F(1, 135) = 16 .93$, $p < .001$. However, there was no reliable hemifield by delay interval interaction, $F(1, 135) = .60$, $p = .440$. There was a reliable suppression effect for both the rvf/LH conditions, $F(1, 135) = 11.32$, $p = .001$, and for the lvf/RH conditions, $F(l, 135) = 4.07$, $p = .046$). These results suggest that there was reliable interference from the contextually inappropriate form of the sentence final homophone in the error rate measure at the short delay. Suppression of the inappropriate form of the homophone occurred overall, did not interact with hemifield, and was reliable for each hemifield. These results are consistent with the notion that both cerebral hemispheres used suppression during sentence comprehension.

While the results of the error rate analysis suggest that both hemispheres suppressed inappropriate information to some extent, the results of the response latency analysis are somewhat ambiguous in that they indicate that the RH may have suppressed inappropriate forms of homophones to a lesser extent than the LH.

GENERAL DISCUSSION

Gernsbacher (1991; Gernsbacher & Faust, 1991b) has argued that suppression of inappropriate information is an important mechanism underlying the efficient integration of information with prior text. The mechanism of suppression has been previously shown to be a marker of comprehension skill among young adults (Gernsbacher et al., 1990; Gernsbacher & Faust, 1991a). In the present study, we found suppression of inappropriate senses of homographs during sentence comprehension when test words were presented to the rvf/LH, but not when test words were presented to the lvf/RH. In contrast, we found suppression in both hemispheres for inappropriate forms of homophones (Experiment 2) with a trend toward a weaker suppression effect in the RH than in the LH. Thus, our results indicate a LH dominance for integration processes during comprehension, at least for alternative senses of homographs.

The results from Experiment 1 (homographs) are consistent with and extend the results of Burgess and Simpson (1988). Burgess and Simpson found a similar pattern of selection against the subordinate (inappropriate from a frequency of occurrence standpoint) sense of an homograph in the left, but not the right, hemisphere when homographs were presented in isolation. We have extended this basic result to the case of sentence context. Chiarello (1991; Chiarello et al., 1992) has argued that the LH is dominant in controlled selection of information for integration during comprehension. Prior research has demonstrated that both sense dominance and constraints generated by prior text can act to affect word sense selection (Kellas et al., 1991; Simpson & Kellas, 1989). It is therefore important to evaluate the claim of LH dominance for integration with prior text using sentence contexts.

While the results from Experiment 1 are in complete accord with a LH dominance account, the results from Experiment 2 (homophones) indicate that the right hemisphere can engage in suppression of contextually inappropriate information under some, as yet undefined,

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conditions. However, the results of a planned comparison analysis on response latencies (see Fig. 3) suggest that suppression in the RH, when it occurs, may be less efficient.

Suppression and Types of Ambiguity—At this point it is tempting to speculate that the crucial factor underlying the finding of strong hemifield asymmetry in suppression in Experiment 1, and little if any in Experiment 2, is the type of ambiguity to-be-resolved per se. However, a closer examination of the potential information available to facilitate the context verification judgment calls into question such a conclusion. The visually presented homophones from Experiment 2 provided the potential for a conflict between orthographic and phonological information which is unlikely to have occurred for the homographs (Experiment 1).

In Experiment 1, we measured interference from contextually inappropriate senses of homographs (e.g., He dug with the *spade*–followed by *ACE*), while in Experiment 2 we measured interference from inappropriate forms of homophones (e.g., She had lots of *patients*–followed by *CALM*). Note that the word *spade* is ambiguous in terms of both its phonology and its orthography when presented in isolation and can be disambiguated only after a comparison with the semantic context of the sentence. However, this is not the case with the word *patients*, which is only ambiguous in terms of its phonology, and not its orthography. Thus, subjects did not have to rely solely upon a comparison with sentence context to disambiguate the homophones used in Experiment 2. They may have also had an unambiguous orthographic code available to help disambiguate the homophones. In other words, subjects may have been able to facilitate rejection of *CALM* following the *patients* sentence by recognizing that the orthographic string “patience“ was not presented. Once such a recognition is made, then any information related to the alternative form of the homophone is clearly wrong. This is not the case with alternative senses of homographs, as the following sentence will attest: “He dug with the spade until the corners of the playing card became bent and frayed.” Here even after subjects have used the overall meaning of the sentence prior to the word *spade* to disambiguate it, the potential still exists for them to be “wrong.”

Thus, the differing results between Experiment 1 and 2 may have been due to the fact that the homophones in Experiment 2 were ambiguous in a qualitatively different manner than were the homographs in Experiment 1. One way to test this hypothesis would be to modify Experiment 2 such that both forms of the sentence-final homophones can be rejected only through comparison with the context. This can be accomplished by constructing biasing sentences similar to those used in Experiment 1, but ending in homophones instead of homographs (e.g., He treated his patients). Such sentences would be equivalent to those used in Experiment 1 if they were presented auditorily. We predict that such an experiment would produce a pattern of results consistent with suppression of inappropriate information in the LH only.

Perhaps comprehenders are sensitive to a somewhat subtle difference between inappropriate information not in accord with prior sentence context but not clearly wrong, and inappropriate information that does not fit context and is clearly wrong. In other words, comprehenders may be sensitive to the type of conflict between active inappropriate information and prior sentence context. The Structure Building Framework (SBF) proposed by Gernsbacher (1990, 1991) is consistent with such a notion. The role of processes which check the coherence of information activated by a particular word with the representation of previous text is given central importance in the SBF. In fact, Gernsbacher et al. (1990) found some evidence that more- and less-skilled comprehenders differ in their ability to employ coherence checking to keep their on-line mental representation of text streamlined. Thus, to the extent that a coherence checking process is central to comprehension as proposed in the SBF, one might expect that suppression mechanisms might work more strongly on inappropriate information that is in strong conflict with prior sentence context. The above explanation is admittedly speculative, and post hoc in nature, but certainly bears further consideration.

Controlled Lexical Processing in the Cerebral Hemispheres—The results from Experiment 1 are consistent with those from other studies (Burgess & Simpson, 1988; Chiarello et al., 1992) showing that the LH is dominant for controlled processes associated with integrating current information with prior text. Our results are also consistent with the notion that the right and left hemispheres are dominant for different types of controlled linguistic processes. Studies specifically designed to measure controlled priming effects have found either similar priming effects in the right and left hemispheres or greater priming in the LH (Chiarello et al., 1992). This is in contrast to studies of automatic priming effects where either similar priming was found in the two hemispheres or priming was greater in the RH (Chiarello, 1991). While the boundary conditions for hemispheric differences in automatic and in controlled priming effects need to be better delineated, the available evidence from split visual field priming studies indicates that the LH dominates for some types of controlled priming. However, studies of RH damaged individuals have suggested that there are some controlled activation and selection processes that the RH is dominant for such as dealing with the emotional content of language and the appreciation of metaphor (Brownell, 1988). Thus, more research (e.g., split visual field priming studies of metaphors) is necessary to put our finding of LH dominance for integration processes into a larger perspective.

Central versus Lateral Primes—Recently Chiarello and her colleagues (Chiarello et al., 1990, 1992) have explored differences in priming effects in the cerebral hemispheres by comparing conditions where both prime and test words are lateralized with conditions where the prime is presented centrally and only the test word is lateralized. Chiarello et al. (1990, Experiment 1) used a high proportion of unrelated prime–test word pairs and a low proportion of pairs related in one of three ways to examine automatic priming effects. They found similar priming effects for all conditions except the case of categorical nonassociates (e.g., DEER–PONY) with primes and test words presented to the same visual field. In the lateralized prime and categorical nonassociates conditions, priming was found only for test words presented to the lvf/RH. Similarly, Chiarello et al. (1992) found hemispheric differences in a controlled priming effect (a particular effect they termed *additive priming*) when both primes and test words were lateralized, but not when primes were presented centrally.

The above examples highlight the potential importance of distinguishing between central and lateral primes. Lateral primes presumably provide a better estimate of priming effects in each hemisphere independent of the other. However, we purposefully chose to not employ this methodology for two reasons. First, we were interested in replicating and extending Burgess and Simpson (1988) who used central primes. Second, we were interested in the activation of information on-line during normal sentence comprehension. We feel that the lateral prime methodology is too far removed from normal text reading for an initial study of hemispheric differences in sense selection during sentence comprehension. While it is true that our single word at a time, central presentation methodology lacks some aspects of normal text reading, eye movements and slight rvf/LH lookahead, for example, we feel that it is close enough to normal text reading for our purposes. Furthermore, by having sentences presented one word at a time in the same position, we minimized eye movements by providing strong incentive for central fixation prior to lateralized target presentation.

Implications for Models of Language Comprehension—The present results have implications for models of language comprehension. If both cerebral hemispheres possess relatively independent semantic systems as some have suggested (Beeman et al., 1993; Chiarello, 1991), and if, as our results and those of Burgess and Simpson (1988) suggest, semantic information is processed in qualitatively different ways in the hemispheres, then current models of language comprehension (e.g., Gernsbacher, 1990; Just & Carpenter, 1992; Kintsch, 1988) may have to be modified to include two semantic systems. Such a dual semantic framework may be important for effective ambiguity resolution on-line during comprehension. However, we believe it is premature to assume the importance of dual semantic systems to models of comprehension as it is not yet clear exactly what the contribution of the right hemisphere is to ambiguity resolution in specific, or to comprehension in general. Studies of right-hemisphere-damaged individuals suggest that the right hemisphere does actively participate in comprehension of the connotative (emotional content) and metaphoric aspects of language (Brownell, 1988) and in making inferences across sentences (Beeman, 1993). Our results, and those of Burgess and Simpson (1988), are consistent with a model where the right hemisphere acts as a lookup buffer in case the left hemisphere selects incorrectly during ambiguity resolution. Further research is required to more directly determine the contribution of the right hemisphere during ambiguity resolution.

Hemispheric Differences in Inhibitory Control—Finally, Posner and colleagues (Compton, Grossenbacher, Posner, & Tucker, 1991; Posner, Sandson, Dhawan, & Shulman, 1989) have argued for an anatomically separate attentional system for controlled processing of lexical/semantic information. Gernsbacher (1990, 1991) has argued that the cognitive processes and mechanisms underlying language comprehension are general to the human cognitive system as a whole and play just as important a role in comprehending nonlinguistic media. Furthermore, Gernsbacher and Faust (1991a) have argued for a generalized ability to suppress irrelevant or inappropriate information. On this view, the finding of hemispheric asymmetry in the suppression of inappropriate senses of homographs found in Experiment 1 might be expected to generalize to attentional paradigms where subjects are asked to pay attention to one aspect of a display and actively ignore others. For example, negative priming (Tipper & Cranston, 1985; Tipper & Driver, 1988), selective inhibition (Neill & Westberry, 1987), and semantic inhibition (Yee, 1991) all provide evidence that semantic information from to-be-ignored spatial locations, or to-be-ignored aspects of a stimulus, is inhibited as a consequence of being selected against. If the same attentional system involved in suppression of contextually inappropriate information during sentence comprehension is involved in the selection of semantic information in these experimental paradigms (see Pardo, Pardo, Janer, & Raichle, 1991, for converging evidence), then we would expect a similar lateral asymmetry in inhibition to emerge if these paradigms are modified for split field presentation.

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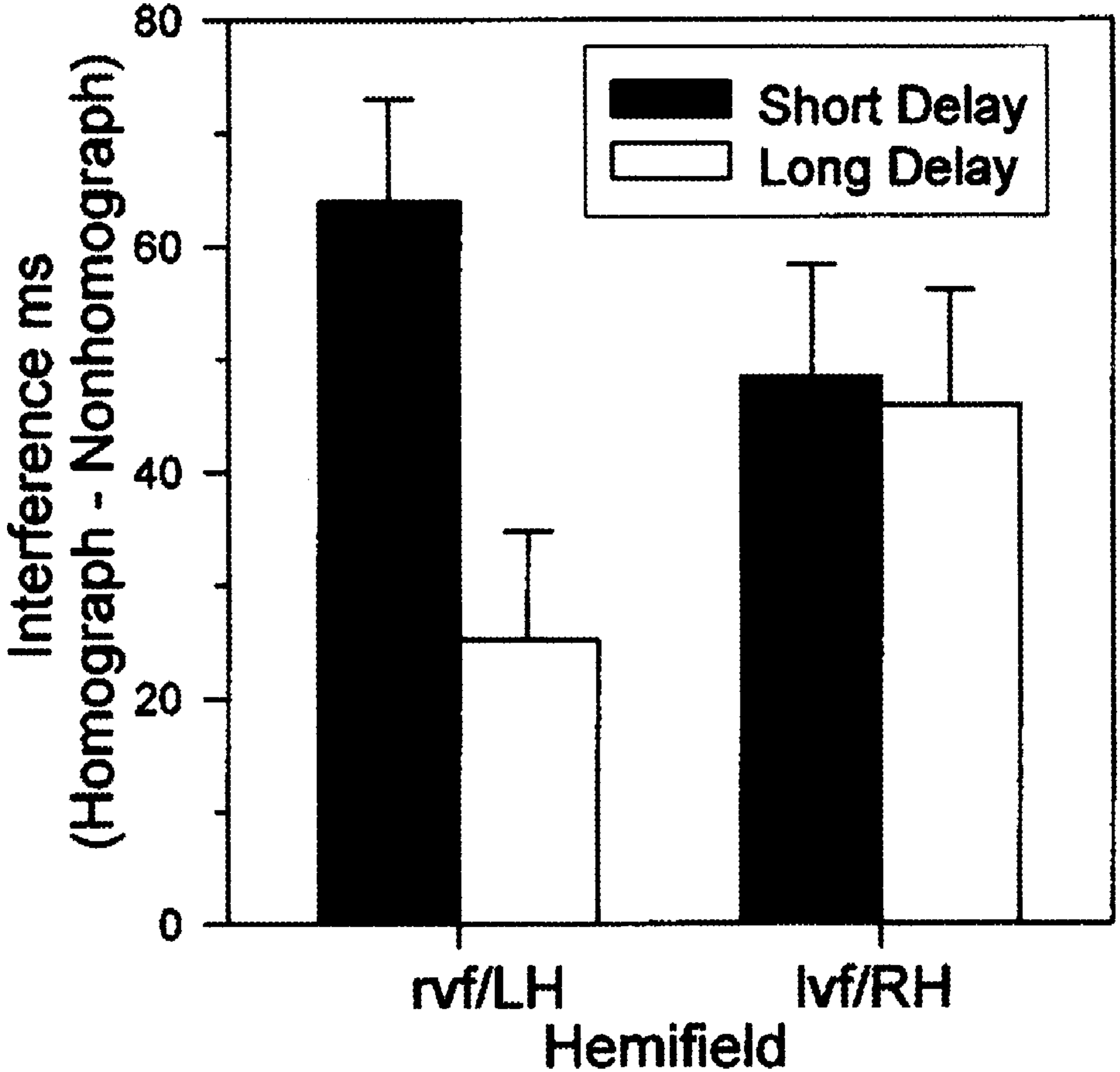

Fig. 1.

Interference (mean response latency for the inappropriate minus the mean response latency for the appropriate condition, with standard error bars) as a function of delay interval (100 or 1000 ms) and hemifield of test word presentation for Experiment 1 (homographs).

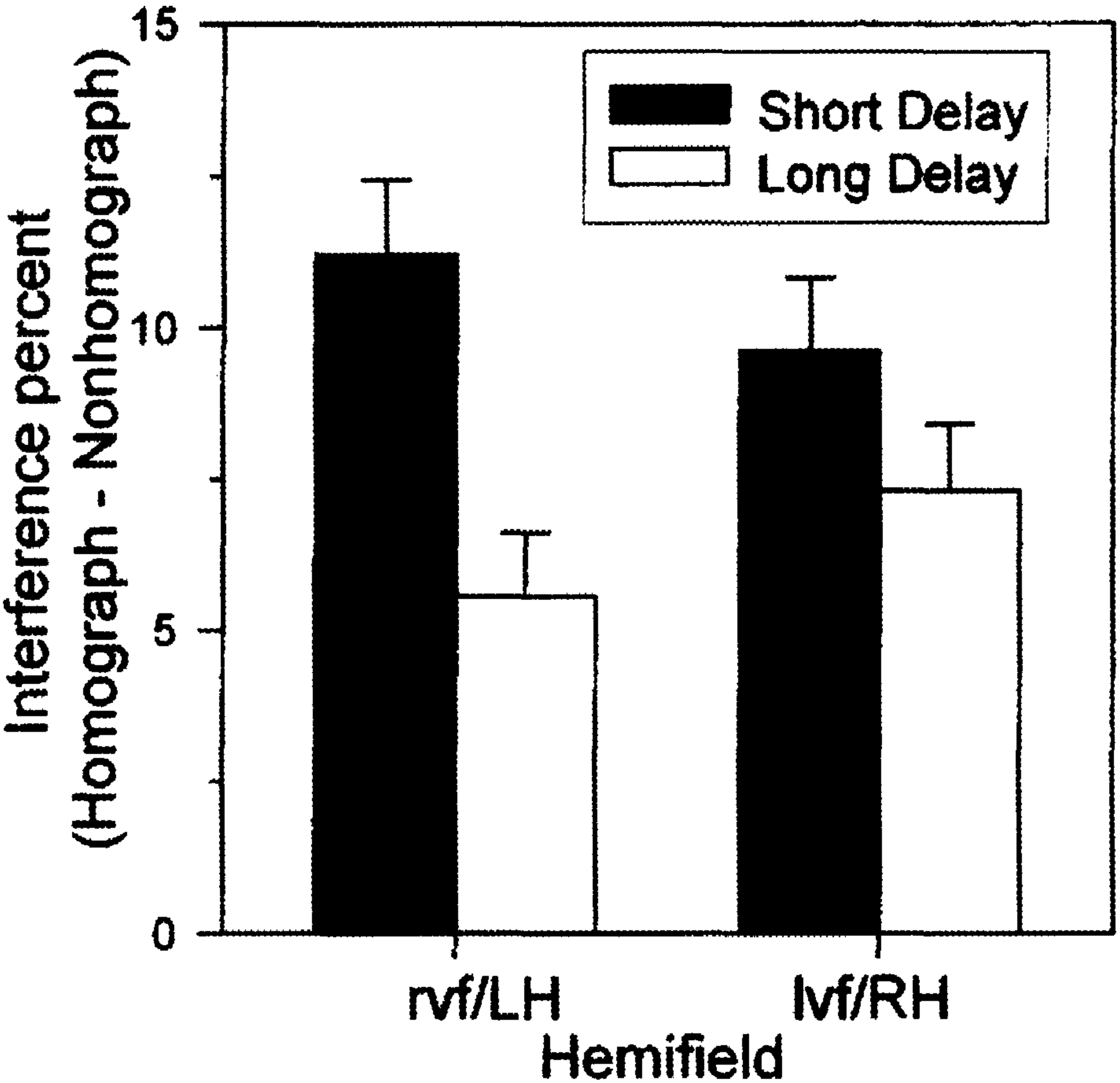

Fig. 2.

Interference (mean percent error for the inappropriate minus the mean percent error for the appropriate condition, with standard error bars) as a function of delay interval (100 or 1000 ms) and hemifield of test word presentation for Experiment 1 (homographs).

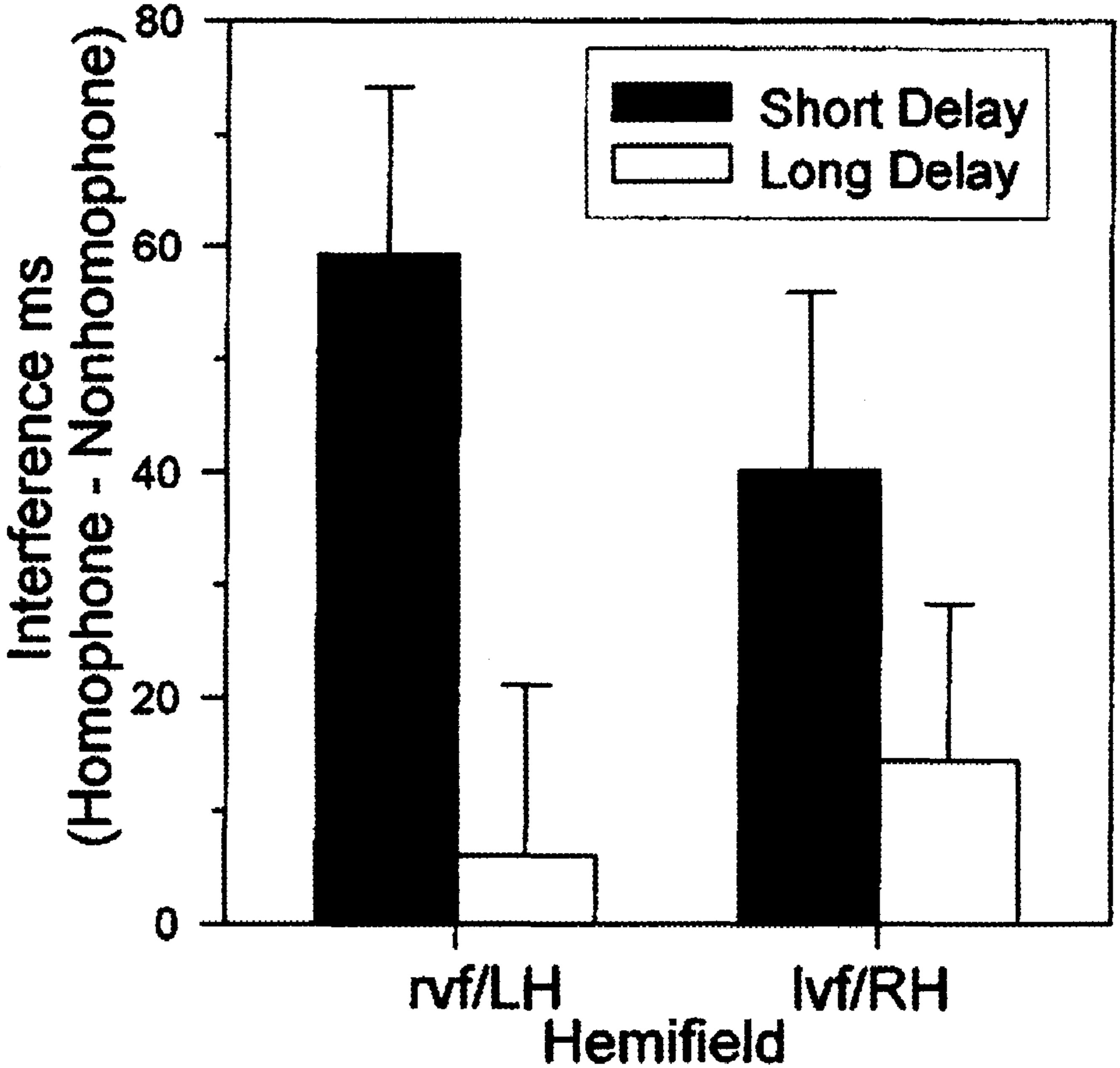

Fig. 3.
Interference (mean response latency for the inappropriate minus the mean response latency for the appropriate condition, with standard error bars) as a function of delay interval (100 or 1000 ms) and hemifield of test word presentation for Experiment 2 (homophones).

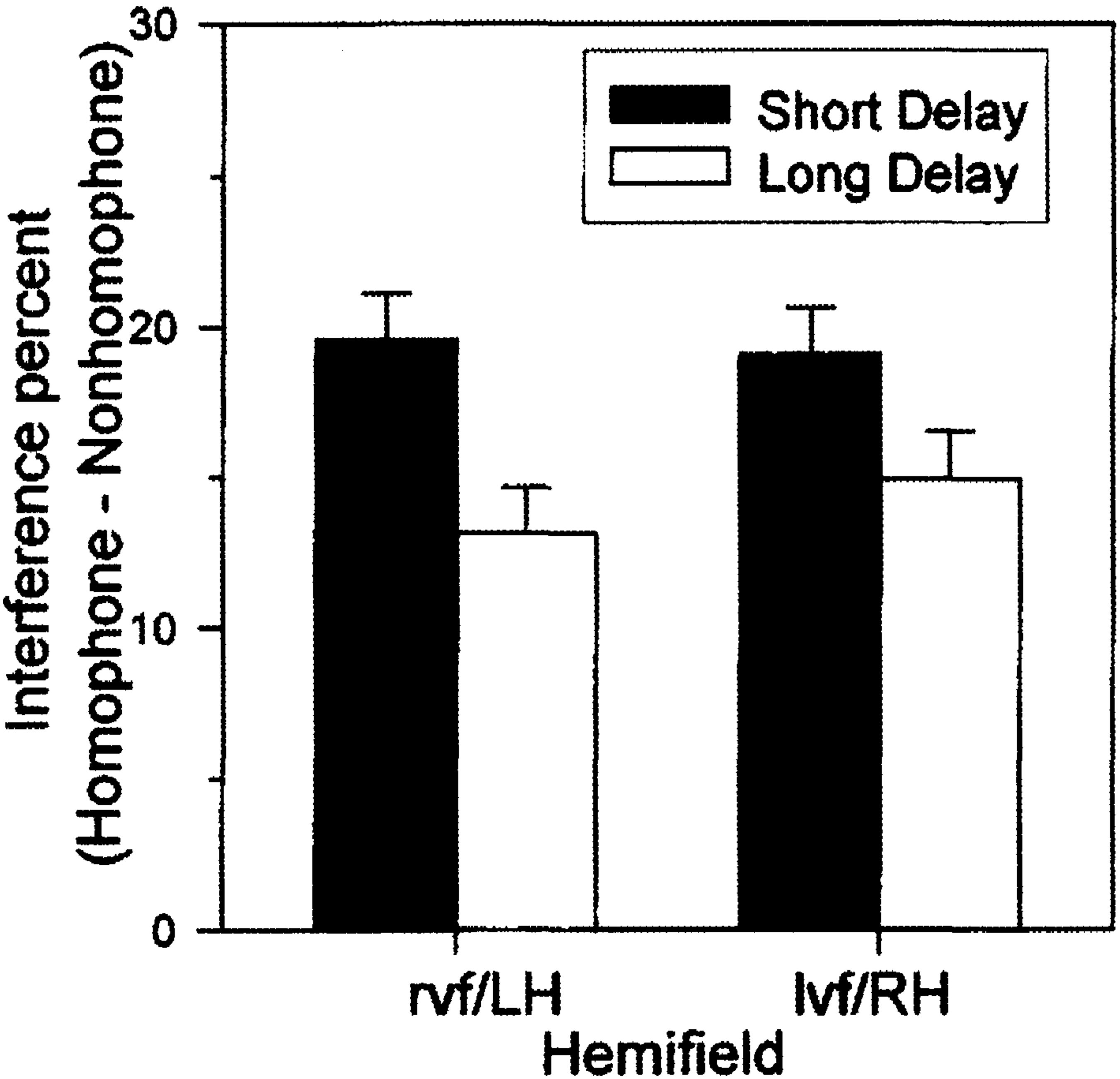

Fig. 4.

Interference (mean percent error for the inappropriate minus the mean percent error for the appropriate condition, with standard error bars) as a function of delay interval (100 or 1000 ms) and hemifield of test word presentation for Experiment 2 (homophones).

TABLE 1

Means and Standard Deviations of Subjects' Mean Reaction Times and Error Rates in Experiment 1 As a Function of Visual Field, Test Interval, and Sentence Type

	Test interval			
	Short (100 ms)		**Long (1000 ms)**	
Visual field	**Homograph SFW**[a]	**Nonhomograph SFW**	**Homograph SFW**	**Nonhomograph SFW**
Right visual field				
RT (ms)	953 (228)	890 (201)	831 (208)	806 (178)
Error Rate[b]	20.9 (13.9)	9.7 (9.9)	14.3 (12.6)	8.8 (9.5)
Left visual field				
RT (ms)	975 (238)	927 (199)	873 (234)	828 (180)
Error Rate[b]	20.6 (14.2)	11.1 (11.7)	15.2 (12.0)	7.9(10.1)

[a]Sentence-final word.

[b]Percentage error.

TABLE 2

Means and Standard Deviations of Subjects' Mean Reaction Times and Error Rates in Experiment 2 As a Function of Visual Field, Test Interval, and Sentence Type

	Test interval			
	Short (100 ms)		Long (1000 ms)	
Visual field	**Homophone SFW**[a]	**Nonhomophone SFW**	**Homophone SFW**	**Nonhomophone SFW**
Right visual field				
RT (ms)	1058 (297)	999 (266)	890 (284)	883 (230)
Error rate[b]	32.9 (16.3)	13.4 (12.0)	25.8 (15.8)	12.7 (12.5)
Left visual field				
RT (ms)	1100 (349)	1060 (302)	956 (303)	942 (269)
Error rate[b]	34.9 (14.6)	15.8 (12.0)	27.7 (16.l)	12.7 (11.4)

[a] Sentence-final word.

[b] Percentage error.