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The effects of multiple script priming on word recognition by the two cerebral hemispheres: Implications for discourse processing

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Abstract

The present study examined left (LH) and right (RH) hemisphere involvement in discourse processing by testing the ability of each hemisphere to use world knowledge in the form of script contexts for word recognition. Participants made lexical decisions to laterally presented target words preceded by centrally presented script primes. (four sentences describing common situations). To examine the maintenance of script information across intervening text, there were six types of primes. These consisted of either single scripts or combinations of two different scripts: (1) a related script, (2) an unrelated script, (3) a related script + a neutral "filler," (4) a related script + an unrelated script, (5) an unrelated script + a related script, and (6) a neutral baseline condition. Results indicated that in the LH, only related scripts or related scripts preceded by unrelated scripts facilitated target word recognition. In contrast, the RH gained significant facilitation from all combinations of script primes, including related scripts followed by either filler materials or unrelated scripts. These results are consistent with the theory that the RH contributes in a critical way to discourse comprehension by maintaining widespread meaning activation for an extended period. This unique ability of the RH may be especially important for integrative processes needed to achieve global coherence during discourse processing.

Keywords: Hemispheres; Visual fields; Scripts; Priming; Discourse processing

1. Introduction

Anectodal as well as clinical evidence from right brain damaged individuals first provided hints that the right hemisphere (RH) might play a unique role in processing language in contexts that extend beyond the meanings of individual words or sentences. Thus, although they usually do not appear aphasic, RHD patients are often tangential in conversation, jumping from topic to topic and introducing new topics without bridging the gap for listeners. They are frequently unable to maintain the theme of a conversation and are prone to missing the overall point of a conversation or story (for reviews, see Beeman, 1998; Brownell & Martino, 1998). Many studies inspired by these early accounts have also shown that injury to the RH can disrupt discourse comprehension, i.e., the ability to understand a group of sentences that describes a sequence of events, as in a story or conversation (e.g., Chiarello, 2003; Tompkins, Baumgaertner, Lehman, & Fassbinder, 2000). The present study tested an explanation for the distinct role of the RH in discourse processing, that focuses on the ability of this hemisphere to maintain widespread script-related meaning activation for an extended period (e.g., Burgess & Simpson, 1988; Chiarello, 1991, 2003; Faust & Kahana, 2002). We suggest that this unique ability may underlie

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the contribution of the RH to the integrative processes needed to achieve global coherence during discourse processing. This would be consistent both with reports on difficulties in discourse comprehension demonstrated by RHD patients and with divided visual field studies indicating that the RH is more likely than the left hemisphere (LH) to process a wide range of word meanings and to maintain activation over long prime–target intervals (e.g., Atchley, Burgess, & Keeney, 1999; Beeman et al., 1994).

Previous research has implied substantial hemispheric differences in the nature and time course of information retrieval during word processing. Thus, the findings of visual half field studies indicate that while each hemisphere has access to a structured store of semantic knowledge, the LH and the RH differ in their sensitivity to different types of semantic relationship (for reviews, see Chiarello, 2003; Faust & Lavidor, 2003). Taken in its entirety, the literature on word-level semantic processing by the two hemispheres suggests that the LH is biased toward the maintenance of close lexical-semantic associations, while the processing of more loosely related semantic relations relies mainly on the RH. According to Beeman's coarse versus fine semantic coding model (Beeman, 1998; Beeman et al., 1994), when people read or hear a word, the LH uses relatively fine semantic coding to quickly select a single relevant meaning or a few relevant features, discarding others. This makes the LH extremely adept for most language tasks. In contrast, the RH employs relatively coarse semantic coding to weakly activate several meanings and many features of the word, including features that are only distantly related to the input word, given the context. The idea that the RH is especially sensitive to weak but overlapping activation from distantly related words was explicitly tested in a summation priming paradigm. Beeman et al. (1994) presented series of three weakly related prime words (e.g., "white," "ceremony," "tuxedo," or "foot," "cry," "glass") followed by laterally presented target words ("wedding" or "cut," respectively). They found that under conditions that encouraged intentional meaning processing, the RH gained more benefit than the LH from the multiple weakly related primes whereas the LH was more facilitated from a single, strongly related prime than from the three weakly related summation primes. Beeman et al. (1994) concluded that in the RH, meaning activation is distributed over many representations, rather than one or a few representations being much more active than the others.

In addition to the different scope of word meanings activated in each hemisphere, previous research has also shown hemispheric differences in the time course of meaning availability. Thus, findings of several priming studies have suggested that the RH activates weakly related semantic information more slowly and maintains it longer than the LH, making distantly related, unusual word meanings available for longer time periods (e.g., Anaki, Faust, & Kravetz, 1998; Burgess & Simpson, 1988; Faust & Kahana, 2002). These studies show that as a result of the different patterns of meaning availability, information that has been already suppressed in the LH might still be activated in the RH (e.g., subordinate and metaphoric word meanings).

Several studies that examined sentence processing by the two cerebral hemispheres have extended this model beyond the word level. Thus, the relatively sustained and nonspecific semantic processing by the RH versus the rapid, selective and more controlled semantic processing by the LH led to the hypothesis that the two hemispheres use different mechanisms to comprehend sentences. In a series of sentence priming studies (e.g., Chiarello, Liu, & Faust, 2001; Faust, 1998; Faust, Bar-Lev, & Chiarello, 2003; Faust & Chiarello, 1998) it was found that the LH uses the intralexical as well as the message-level information contained in the sentence to facilitate word recognition, whereas the RH relies mainly, although not solely, on intralexical information, that is, on the processing of semantic relations between single words appearing in the sentence. The most effectual use of message-level mechanisms by the LH, as compared to the use of intralexical mechanisms by the RH, occurs with highly structural and constrained linguistic contexts which require controlled, selective, and fast linguistic processing. According to this model, the advantages of the slow and nonselective sentence processing in the RH may become evident only when the sustained activation of multiple meanings, including contextually nonrelevant meanings, contributes to language comprehension, e.g., when several considerations must be integrated or when an initially attractive interpretation must be abandoned in favor of another (e.g., Faust & Chiarello, 1998; Faust et al., 2003).

In an ERP study, Federmeier and Kutas (1999) also reported important differences between the two hemispheres in processing sentence contexts. However, they characterize these differences as "predictive" versus "integrative" in the LH and RH, respectively. According to their interpretations, the LH selectively activates semantic features associated with the item most likely to be encountered in the upcoming words, whereas the RH directly compares the features of items in the context with those of the current word. Although proposing a different conceptualization of hemispheric differences in sentence processing, this model too suggests that language processing by the LH is more selective and constrained than that of the RH.

However, to gain a more complete understanding of how, in extracting and maintaining different types of information from language contexts, the LH and the RH each make their unique and critical contribution to language processing, the effects of contexts containing more than one complete sentence should also be investigated.

Since the main contribution of the RH to semantic processing includes long lasting facilitation effects from even weakly associated primes, the present study considered whether this mode of semantic processing could provide an account for discourse-level impairments reported in RHD patients (e.g., Brownell, Simpson, Bihrle, Potter, & Gardner, 1990; Brownell, Griffin, Winner, Friedman, & Happe, 2000; Hough, 1990; Joanette, Goulet, & Hannequin, 1990; Myers, 1994; Rehak et al., 1992; Roman, Brownell, Potter, Seibold, & Gardner, 1987) and for the results of visual field (e.g., Beeman, Bowden, & Gernsbacher, 2000; Long & Baynes, 2002) and neuroimaging (e.g., St. George, Kutas, Martinez, & Sereno,. 1999) studies indicating a unique role for the RH in discourse processing.

The overall complexity of discourse comprehension, in terms of number of processes and the interactions among them, implies corresponding complexity in the possibilities for RH involvement in discourse and text processing. Consequently, the findings that RH damage results in discourse deficits has been attributed to a wide array of cognitive and linguistic skills that are required for success in discourse processing. To build an understanding of a text, the reader uses words and sentences. However, for the larger purpose of discourse comprehension, word and sentence comprehension is only part of the picture. The reader must combine the message of each sentence with the message accumulated up to that point on the basis of prior text. In addition, the reader must engage in a range of processes that assign discourse referents, and that establish higher-level representations that capture the gist of the text as a whole. These text level processes must utilize sources of information that lie beyond the verbatim representation of the text, including the reader's knowledge about the semantic domain of the text and the type of text, as well as inferential processes that assist the integration of information (Perfetti, 1999).

According to Beeman (1998; Beeman et al., 2000), the unique mode of coarse semantic processing of word meanings by the RH underlies many of its contributions to discourse comprehension. Thus, coarse semantic coding implies not only an imprecision at the word level, but also a kind of precision at the discourse level. Beeman argues that each word may activate a large semantic field in the RH, providing only a coarse interpretation of that word. However, the larger the semantic field, the more likely it is to overlap with semantic fields activated by other input words sharing semantic features. This semantic overlap could be useful for noting distant semantic relations necessary to draw inferences (mainly predictive), maintain coherence, and integrate complex discourse.

Long and Baynes (2002) attribute RH contributions to discourse comprehension to the two different representations readers construct when they comprehend a text: a propositional representation of the explicit ideas in the text and the relations among them, and a discourse model that represents the context or situation to which the context refers (e.g., Gernsbacher, 1990; Graesser, Singer, & Trabasso, 1994; Kintsch, 1988). In their study, Long and Baynes (2002) compared responses to target words preceded by primes from the same proposition to targets preceded by primes from a different proposition in the same sentence. The results showed propositional priming effects only in the LH. However, priming for contextually appropriate semantic information was similar for both hemispheres. The authors concluded that although only the LH has access to the propositionally structured discourse representation, both hemispheres appear to represent contextually relevant semantic information. This study points to the ability of the RH to activate and maintain semantic information at the text level. However, it does not posit a unique RH processing mechanism that could explain the discourse-level processing deficit following RH damage.

The goal of the present study was to test another potential explanation for the unique contribution of the RH to discourse comprehension that focuses on the ability of this hemisphere to activate and maintain script-related semantic information. As mentioned above, it is generally accepted that the two most general levels of text representation are a model of what the text says, i.e., the text base, and a model of what the text is about, i.e., the situation model (e.g., Kintsch, 1988). The text base is a mental representation of the propositions of the text, whereas the situation model is built from the text base by combining various knowledge sources through additional inference processes. In addition, whereas the text base is essentially linguistic, the situation model may also be non-linguistic, a mental model that directly represents referential or other kinds of information in a nonpropositional format (Perfetti, 1999). To get from a text to a situation, the reader must go beyond the explicit text information, to add information and to make inferences about what is in the text. One type of information that is added to the explicit information in the text is a schema. A schema can be defined as structured units of knowledge invoked during text and discourse comprehension that enable the reader to make sense of new information. Scripts are a special type of schema that represent our knowledge of routine actions and familiar repeated sequences (Shank & Abelson, 1977). Scripts include information about the usual roles, objects, and the sequence of events to be found in an action and are also defined as "… a simple way to describe a group of action propositions which characterize human knowledge about specific situations in the real world" (Sharkey & Mitchell, 1985, p. 255) or as "… mental devices by which individuals organize knowledge of common situations. This knowledge is acquired after repeated experience with the situation" (Armus, Brookshire, & Nicholas, 1989, p. 518). Thus, world

knowledge in the form of scripts enable the reader to draw inferences about what is not explicitly mentioned in the text.

Sharkey and Mitchell (1985) investigated the priming effects of script contexts on lexical decisions for related and unrelated target words. Scripts were operationally expressed as a series of complete sentences describing events which are very well practiced in everyday life (e.g., "restaurant script" "birthday party script"). The findings showed a clear-cut pattern of facilitation for script-related target words, although these words were not highly related in any simple way to single words appearing in the script text. No inhibition was found for words unrelated to the script primes. Furthermore, in a series of experiments, Sharkey and Mitchell (1985) also showed that script priming effects were relatively unaffected by neutral intervening material up to three sentence long as well as by a single sentence that introduced a new, unrelated script. Scripts were found to be deactivated only when multiple explicit cues were present in the text, i.e., three complete sentences that introduced a new unrelated script. The relative robustness of script priming effects with respect to intervening material was explained in terms of the multiple associative links within a script. Thus, Sharkey and Mitchell argue that script priming effects were sustained longer than would be predicted from simple word priming because activation from script concepts summates on a central script subnode.

In a previous study, Faust and Babkoff (1997) used Sharkey and Mitchell's paradigm to examine the effects of script primes, consisting of two complete sentences, on the recognition of related target words presented to the RVF/LH and the LVF/RH. They found that both the LH and the RH could use world knowledge in the form of script primes to facilitate target word recognition, although the LH showed larger priming effects. These findings indicate that both hemispheres represent script-related semantic information that could be used for going beyond the explicit text information and for making inferences needed to maintain inferential coherence. This conclusion is consistent with studies showing that both RHD and LHD patients demonstrate deficits in script processing (Armus et al., 1989; Roman et al., 1987).

However, since texts usually refer to several scripts or contain intervening neutral materials that do not introduce a new script, the present study examined the ability of the LH and the RH to maintain script meaning activation across neutral or unrelated information appearing in a text. This ability could be crucial to achieve global coherence during text processing. In accordance with the broad and long lasting priming effects shown in the RH for word priming, we hypothesized that in this hemisphere, two different scripts can remain active at the same time so that target words related to both scripts will be simultaneously primed. In addition, script-related words will be facilitated across intervening unrelated material. In contrast, we hypothesized that the highly selective and fast processing mode of the LH will lead to deactivation of an initial script when a second, unrelated script is activated, or when two neutral sentences intervene between the script and the target word. Thus, in this hemisphere no priming effects will be found for target words related to a script that is followed by either two neutral sentences or by two sentences introducing a new script. Such results could offer an explanation for the unique role of the RH in discourse processing that is consistent with ability of this hemisphere to sustain the availability of widespread, nonselective semantic information. Furthermore, such results could show how discourse impairment associated with RHD fits within a larger model of what the intact RH contributes to normal discourse processing.

2. Method

2.1. Participants

Thirty-three undergraduate students, aged 20–30, participated in the experiment. All were native Hebrew speakers and yielded a laterality quotient of at least +80 on the Edinburgh Inventory, indicating right handedness (Oldfield, 1971). All participants had normal or corrected to normal vision.

2.2. Stimuli

The stimulus pool consisted of priming scripts and target words and nonwords items, all in Hebrew. Target words were 108 nouns (all 3–5 letters in length). Each target word (shown in uppercase in the example below) was preceded by six types of script contexts. These were (1) a related all-script condition consisting of four script relevant sentences, (2) an unrelated all-script condition consisting of four script nonrelevant sentences, (3) a related script + neutral "filler" condition consisting of two script relevant sentences plus two sentences which neither add to the script nor suggest a script change, (4) a related script + unrelated "exit" condition consisting of two initial script relevant sentences followed by two sentences from another, unrelated script, (5) an unrelated script + related "exit" condition consisting of two initial unrelated script sentences followed by two sentences from another, related script, and (6) a neutral baseline condition consisting of four neutral sentences that do not form any script. The method of deriving the relation between the target words and their related script primes was similar to that described by Sharkey and Mitchell (1985) and Faust and Babkoff (1997). This relation was neither a simple semantic relation, as in single word primes, nor a highly probable continuation of an

incomplete sentence prime. Instead, both script primes and target words were taken directly from normative script lists.

2.2.1. Collection of normative script lists

Both the priming scripts and the target words were generated by using a script-based free association procedure. Fifty students, who did not participate in the experiment, served as respondents in the norm collection. Fifty-four different "situations" provided the scenarios for the 108 script primes, i.e., two scripts per "situation," For example, the scenario titled "eating in a restaurant" was used to generate two different scripts based on the same situation. Each judge was given 11 titles of different scripts and asked to fill in the objects, actors, and actions associated with each script.

Each of the 50 respondents generated 11 completed scripts. Hence, for each title, 10 respondents provided a script. All objects, actors, and actions reported by at least half of the respondents were used to form a normative list for each of the 54 scripts. On the basis of the empirical script norms, a set of 2 four-sentence contexts was compiled for each of the 54 scripts, yielding 108 scripts for the subsequent experiment. The first sentence was constructed to identify a particular situation (script) and the three other sentences were based on actions from specific scenes within the script. Each sentence contained 4–6 words.

Each of the 108 related target words (one for each script prime) was an object noun from the main concept (Sharkey & Mitchell, 1985) of the scene indicated by its corresponding script prime. Ten judges, who did not participate in the experiment, examined the materials to ensure that none of the target words was semantically related, in any simple way, to the last word in the preceding script context. In most cases, the target word was not strongly associated with any of the preceding words appearing in the script. All of the target words associated with one script were exclusive to it and never appeared as either target words or words in any other script prime.

Ten additional judges, who neither participated in the experiment nor took part in generating the scripts, were presented with the 54 scripts along with a list of nouns taken from the normative script lists and asked to indicate the degree of script-word relatedness on a one ("highly related") to seven ("completely unrelated") point scale. Only nouns that were ranked between 1 and 2 by all judges were used in the experiment as related targets. Only targets that were ranked by all judges as completely unrelated to a specific script (7) were used in the experiment as unrelated targets for that script. In a fourth pretest, 10 additional judges, who neither participated in the experiment nor in the previous pretests, were asked to read the scripts and indicate whether all of them, including those combined of two different scripts made sense. Only scripts that were judged by at least nine judges as coherent and logical were used in the experiment as priming stimuli.

In addition to the 108 target words, 108 target nonwords, that were constructed by randomly rearranging the letters in the target words, were presented in the experiment. All nonword targets were orthographically legal and pronounceable. The target nonwords were preceded by the same 108 script primes as their corresponding target words.

Examples of the six types of script primes used in the experiment for the target word "TIP" are shown below.

Related all-script condition:

The restaurant was quite empty when we got there.
We sat down at a vacant table.
We asked for the menu.
The meal was delicious.

Related script + neutral "filler" condition:

The restaurant was quite empty when we got there.
We sat down at a vacant table.
It had been quite a good day.
We were lucky.

Related script + unrelated "exit" condition:

The restaurant was quite empty when we got there.
We sat down at a vacant table.
Then we went to the library.
The poetry section was upstairs.

Unrelated script + related "exit" condition:

We went to the library.
The poetry section was upstairs.
The restaurant was quite empty when we got there.
We sat down at a vacant table.

Unrelated all-script condition:

We went to the library.
The poetry section was upstairs.
We asked the librarian for help.
But all the Wordsworth was out.

Neutral condition (no script):

You will see a series of letters.
It will appear on the screen.
It can be either a word or a nonword.
You have to respond as quickly as possible.

3. Procedure

There were 2592 permutations for the target words [108 target words following 6 types of primes × 2 visual

fields × 2 types of target stimuli (word/nonword)]. Eight stimulus lists, each containing 156 target words and 156 target nonwords, were needed to completely rotate items over experimental conditions in the full experimental design. Each target word appeared either once or twice per list but in different experimental condition and visual field. Cell means were based on 13 word trials per condition per participant. Each list was seen by 4–5 participants. Stimulus presentation and responses were controlled and recorded by a PC Elite 586 computer.

The priming scripts were centrally presented in their entirety, followed by the target stimulus displayed 2° to the right or to the left of a centrally presented "+." Targets subtended, on average, 1.90° of horizontal visual angle (0.7° vertical) at a viewing distance of 60 cm. Participants viewed the screen while resting their head on a chin rest. The participant placed his/her right index finger on the middle key of the computer mouse and waited for a focusing signal (100 ms duration) which appeared on the center of the screen and indicated the onset of a trial. Immediately following the disappearance of the focusing signal, the prime script appeared for 5000 ms (pilot testing indicated that these primes could be read and comprehended within 5000 ms). Participants were instructed to read the scripts silently. Next, the focusing signal reappeared and remained on the screen for 450 ms, until the end of the target stimulus presentation to ensure full fixation. The participant was instructed at the beginning of the session to focus on the central "+" and not to move his/her eye while it was present. Three hundred millisecond after the appearance of the focusing signal, the target stimulus was presented randomly to the RVF or LVF for 150 ms.

Participants were instructed to indicate as rapidly and accurately as possible whether the target stimulus was a word or a nonword by lifting and moving the right index finger from the middle mouse key to the right or left mouse keys. Assignment of the keys to word/nonword responses was counterbalanced over participants. The next trial began when a response was made or, in the case of no response, after 3000 ms from the target onset. The session began with a practice list, consisting of 30 priming sentences and target stimuli not used in the experimental lists.

4. Results

A 2 × 6 repeated measures analysis of variance with visual field and type of priming script was performed on accuracy and correct RTs for target words. Only responses whose RTs ranged between 300 and 1600 ms were included in the analysis (95% of all the data collected). Means and *SD*s for correct response times and for percent correct are given in Table 1. In accordance with previous research (for review, see Babkoff & Faust, 1988), response latency was negatively correlated with response accuracy in both the RVF/LH, $r(33) = -.88$ and the LVF/RH, $r(33) = -.67$. Thus, participants were not sacrificing accuracy for speed when responding to either RVF/LH or LVF/RH targets.

Table 1
Means and *SD*s for RT and percent correct for target words presented to the RVF and LVF following six types of script primes

Type of script prime	Visual field	
	RVF	LVF
Script A (related)	849 (114)	892 (118)
	95 (6)	93 (10)
Script B (unrelated)	915 (135)	943 (108)
	94 (9)	89 (10)
Script A (related) + Filler	892 (126)	924 (109)
	95 (8)	90 (10)
Script A (related) + Script B (unrelated)	911 (139)	914 (100)
	94 (10)	89 (10)
Script B (unrelated) + Script A (related)	860 (123)	927 (113)
	95 (9)	91 (9)
Neutral script	920 (134)	957 (109)
	94 (8)	90 (9)

The main effect of visual field was significant. Participants responded more quickly and accurately to RVF (891 ms, 94%) than to LVF (920 ms, 90%) target words, RT $F(1,32) = 19.8$, $p < .001$; accuracy $F(1,32) = 24.4$, $p < .0001$. In addition, a main effect of type of priming script was significant for RT, $F(5,28) = 13.2$, $p < .01$. Post hoc analyses (Scheffe, $p < .05$) revealed that this was due to the faster responses to target words following related all-script primes (870 ms) than to target words following unrelated all-script primes (930 ms), related scripts + filler primes (908 ms), related script + unrelated script primes (913 ms), unrelated script + related script primes (894 ms), and neutral primes (939 ms). In addition, responses to target words following related scripts + filler primes (908 ms), related + unrelated script primes (913 ms), and unrelated + related script primes (894 ms) were faster than responses to target words following either unrelated all-script primes (930 ms) or neutral primes (939 ms).

The predicted two-way interaction between visual field and type of priming script was obtained for RT, $F(5,28) = 2.6$, $p < .05$, but not for accuracy ($F < 1$). The critical priming predictions are tested by contrasting each of the five script primes with the neutral prime in each visual field (see Figs. 1 and 2 for RT priming in RVF and LVF, respectively).

RVF target words: post hoc analyses (Scheffe, $p < .05$) revealed that responses were faster when targets followed either related all-script primes (849 ms) or unrelated + related script primes (861 ms) than when they followed unrelated script primes (915 ms), related + unrelated script primes (911 ms), related script + filler primes (filler, 908 ms), and neutral primes (921 ms). In addition, responses to target words following

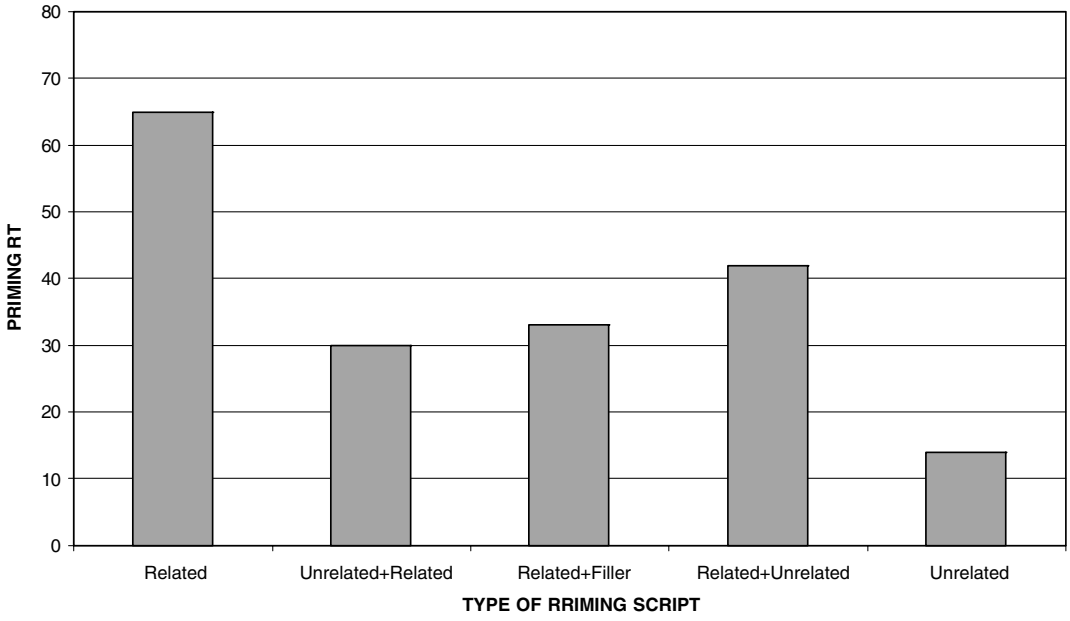

Fig. 2. RT priming for target words presented to the LVF following five types of script primes.

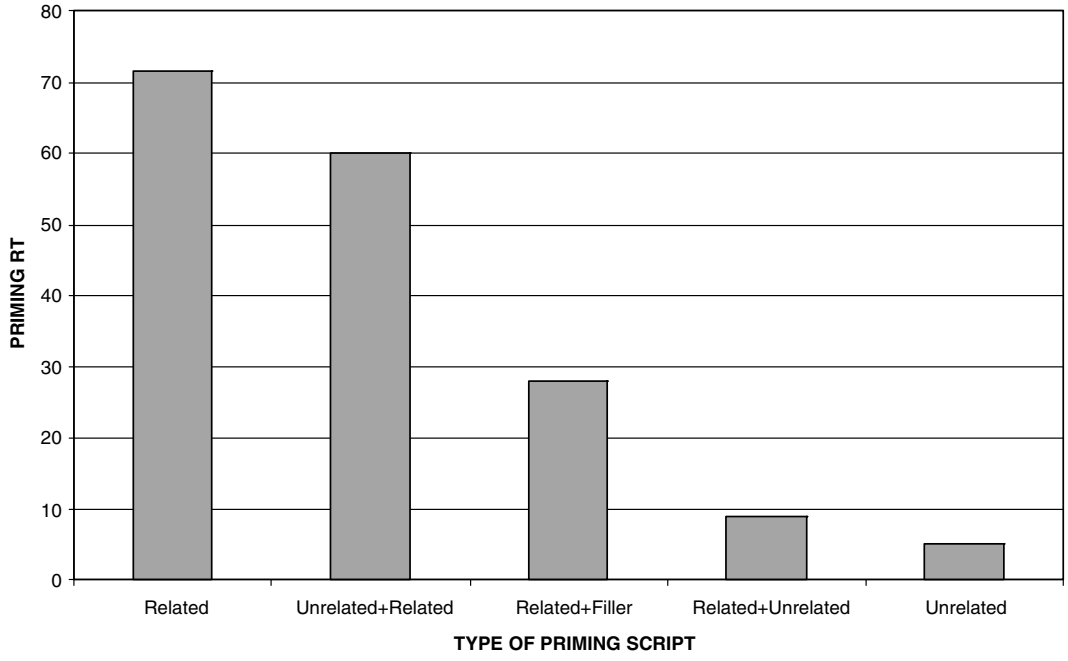

Fig. 1. RT priming for target words presented to the RVF following five types of script primes.

related script + filler primes and related + unrelated script primes were not significantly different than responses to target words following either unrelated all-script or neutral primes.

When the magnitude of RVF priming across different script conditions was compared (Scheffe, $p < .05$), it was found that RVF priming effects were equal for the related and the unrelated + related script primes. In addition, priming effects for the related and unrelated + related script primes were significantly larger than those for the related + filler script prime, which, in turn, were significantly larger than the priming effects for the related + unrelated and the unrelated script primes. Finally, priming effects were equal for the related + unrelated and the unrelated script primes.

LVF target words: post hoc analyses (Scheffe, $p < .05$) revealed that responses were faster when targets followed related all-script primes (892 ms), related + unrelated script primes (914 ms), unrelated + related script

primes (927 ms), and related script + filler primes (923 ms), than when they followed either unrelated script primes (943 ms) or neutral primes (957 ms).

When the magnitude of LVF priming across different script conditions was compared (Scheffe, $p < .05$), it was found that LVF priming effects were equal for the related and the related + unrelated script primes. In addition, priming effects for the related and related + unrelated script primes were significantly larger than those for the related + filler and the unrelated + related script primes. Finally, priming effects were equal for the related + filler and the unrelated + related script primes. However, these two types of script primes showed significantly larger priming effects than the unrelated script primes.

5. Discussion

Discourse comprehension crucially relies on the recruitment and integration of world knowledge stored in long-term memory. These processes may depend on the ability to maintain widespread script-related meaning activation for an extended period during text comprehension. The present experiment sought to determine the extent to which the two cerebral hemispheres contribute to discourse processing by accessing real-world knowledge from long-term memory. Specifically, the goal of the present study was to examine the hypothesis that the RH uniquely contributes to discourse processing by sustaining simultaneous activation of word meanings related to two different world knowledge domains, presented in the form of two different script contexts appearing sequentially. This ability may be linked in an important way to discourse comprehension (Sharkey & Mitchell, 1985).

Previous research indicates that word meaning activation proceeds differently within each cerebral hemisphere. The RH is more likely than the LH to maintain activation for a wide range of word meanings over long prime–target intervals. In contrast, the LH actively dampens or inhibits activation of alternative meanings and focuses on the contextually most dominant reading (for review, see Chiarello, 1991, 1998). It has been suggested that the unique ability of the RH to distribute activation over many representations, rather than over only one or a few representations, may be important for the integrative processes needed to achieve global coherence during discourse processing. This would be consistent with reports of difficulties in discourse comprehension typically demonstrated by RHD patients (for reviews, see Beeman, 1998; Brownell et al., 2000; Roman et al., 1987).

In line with these prior findings, we hypothesized that in the LH, script priming will be easily disrupted by intervening material. However, in the RH, priming derived from script contexts will exert an influence beyond the current script. This was tested by interposing either neutral "filler" material or another, different script prime, between the original script prime and the target word. The results generally confirmed the hypothesis, showing that a different subset of script-related word meanings can be maintained in each cerebral hemisphere during discourse comprehension. Thus, when target words were presented to the RVF/LH, only words immediately preceded by a related script were activated. Words related to an earlier script appearing in the text did not differ from words preceded by either unrelated or "neutral" scripts. These findings support the claim that within a five second delay, the LH had completely deactivated word meanings related to earlier scripts appearing in the text, so that their level of activation was not different from that of unrelated words.

However, when target words were presented to the LVF/RH, the meanings of words related to either the first or the second script appearing in the text were simultaneously activated. Words related to an earlier script did not differ from words related to a later appearing script. These findings support the claim that the maintenance of word meanings related to an earlier script appearing in the text only occurs within the RH. Since there was no evidence of either decay over time or of straightforward interference by a new script in the RH, this hemisphere seems to be able to maintain for relatively long intervals simultaneous activation of word meanings related to two different scripts appearing sequentially in the text. Thus, we suggest that during a potentially temporary detour from a currently active script, the RH can use the activation from two world knowledge domains at the same time without any observable processing deficits in either. In contrast, the LH is able to maintain activation of word meanings related to only the most recent script appearing in the text. Furthermore, even the activation of these meanings is relatively short lived, as shown by the results for related script followed by neutral filler sentences.

Because semantic processing of script related word meanings by the RH is qualitatively different from semantic processing by the LH, under some circumstances there should be discourse-related information that is activated more strongly in the RH than in the LH. The differences in the scope and time course of script-related meaning activation could thus account for the unique role played by the RH in discourse processing. As shown by our results, in the RH, both the initial script and a second, unrelated script, were active at the same time. Accordingly, both scripts facilitated their own sets of associated words by an equal amount. This information may be used for integrating the meanings of individual words into the representation of several different real-world events being described in the text. Since texts frequently refer to different real-world knowledge

domains, comprehending discourse might depend on the ability to maintain simultaneous activation of word meanings related to each of these knowledge domains to organize one's representation of the information, draw inferences, fill informational gaps, and increase coherence. These processes seem to involve the RH to a much greater extent than single word or sentence comprehension.

In contrast, the LH quickly loses activation of script-related meanings either by rapid decay or by active inhibition through attentional processing (Chiarello, 1991, 2003). Thus, it seems that to activate a second script in the LH, the existing one must first be deactivated. Furthermore, in the LH script related meaning activation is short-lived and is disrupted even by two neutral sentences that do not introduce any new script. These findings are consistent with the results of previous research suggesting that LH maintains activation for a narrow semantic field, including only the interpretations that are dominant or most relevant to the immediate context. In a given context, these interpretations may be related to dominant word meanings (Anaki et al., 1998; Burgess & Simpson, 1988), to contextually relevant word meanings (Faust & Chiarello, 1998; Faust & Gernsbacher, 1996), or to meanings of words related to the most current script prime. This implies that the focus of activation of the LH can be quickly shifted from one subset of meanings to another.

This fast and highly focused mode of semantic activation may offer the LH considerable advantages in language processing, mainly at the word and sentence level. However, since understanding connected discourse, as opposed to just understanding the individual words or sentences it contains, depends upon establishing various kinds of appropriate links, the LH might be at a disadvantage when activation of previous background information is quickly lost. Given the rapid and demanding unfolding of discourse, it may be easier for the LH to capitalize on the information still activated in the less selective RH than to reinterpret many of the script-related words that have already passed. According to this explanation, the two hemispheres subserve complementary, rather than redundant, functions during discourse processing. The RH may have a unique role in maintaining a wider range of script-related information, including word meanings related to previous scripts, for relatively long periods, whereas the LH may have a unique role by focusing, and, hence, offering extra salience only to the most recent, up-to-date, script-related information. This explanation seems very likely given the fact that patients with RHD, with fully intact LHs, have measurable difficulty drawing inferences and building and integrating discourse representations.

The ability to simultaneously activate and maintain the meanings of words related to two different scripts seems to be well within the cognitive linguistic capacities of the RH. Thus, previous research indicates that the RH is able to activate and maintain a wide range of word meanings, including seemingly incongruous meanings (e.g., Chiarello, 1991; Faust & Lavidor, 2003), to process world-knowledge in the form of script contexts (Faust & Babkoff, 1997), to represent the discourse (or situation) model of a text (Long & Baynes, 2002), and to sustain meaning activation for an extended period (Burgess & Simpson, 1988; Whitehead, 1991). In contrast, activating and maintaining multiple script meanings does not seem to depend in any direct way on syntactic processing abilities that the RH seems to lack (Caplan, 1992; Faust et al., 2003). Furthermore, the relative robustness of script priming effects with respect to intervening material, either neutral or unrelated, is explained by Sharkey and Mitchell (1985) in terms of the multiple associative links within a script. Thus, Sharkey and Mitchell attribute long-lasting script priming effects to the activation of a wide active region of the associative network. This explanation fits well with findings indicating that, as compared to the LH, the scope of meaning activation in the RH is much wider and includes a broader range of related meanings that that of the LH (e.g., Anaki et al., 1998; Beeman, 1998).

Finally, the unique abilities of the RH to maintain multiple script meanings might be another expression of coarse semantic coding (Beeman, 1998; Beeman et al., 1994). Thus, the larger the semantic field, the more likely it is to overlap with semantic fields activated by other input words sharing semantic features. The simultaneous activation and maintenance of the meanings of words related to several scripts may increase the probability of semantic overlap between different world knowledge domains. This could be useful for noting distant semantic relations, drawing inferences, maintaining coherence, integrating complex discourse and, consequently, for getting the "gist" of the story. This may be one aspect of the unique contribution of the RH to discourse processing.

The generalizability of the present study's results and conclusions to normal reading conditions may be limited by the specific selection of stimuli and time course. Thus, given the unique ability of the RH to activate and maintain weaker, more distant associations (e.g., Beeman, 1998), it might be argued that the selection of target words that were not strongly associated with any of the preceding words appearing in the scripts could provide an advantage for RH processing strategies. Furthermore, the results strongly suggest that whereas for the RH, the presence of a semantic relationship induces facilitation in word recognition, for the LH, the prime–target temporal relationship is more important for inducing facilitation. Thus, the use in the present study of relatively long SOAs could also provide an advantage for RH processing strategies. However, although in the present study, target words were not strongly associated

with any single word, they were ranked by 10 judges as highly related to the script (1 or 2 on a 7-point scale). In addition, the results show significant LH priming for the related script condition, indicating that the LH made use of the prime–target relationship even given the relatively weak association between the target word and proceeding words and the relatively long SOA's. Nevertheless, future research should investigate the effects of strongly related words or short SOAs on the processing of script primes by the two cerebral hemispheres. If the priming patterns uncovered by the present study's results are due to hemispheric responses to scripts, and not to single words appearing in these scripts, similar results should be obtained. Thus, the LH should deactivate everything but the immediate script whereas the RH should activate the meanings of a wide range of word meaning including meanings related to previous scripts appearing in the text.

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