



Repetition priming within and between the two cerebral hemispheres[☆]

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Abstract

Two experiments explored repetition priming benefits in the left and right cerebral hemispheres. In both experiments, a lateralized lexical decision task was employed using repeated target stimuli. In the first experiment, all targets were repeated in the same visual field, and in the second experiment the visual field of presentation was switched following repetition. Both experiments demonstrated hemispheric specialization for the task (a RVF advantage for word identification) and hemispheric interaction for word processing (lexicality priming from contralateral distracters). In the first experiment, words were identified more quickly and accurately following repetition, with repetition facilitating faster but fewer correct responses for non-words. Complex interactions between visual field of first and second presentation in the second experiment indicate asymmetric interhemispheric repetition priming effects. These results provide a broad picture of hemispheric asymmetries in word processing and of complex interaction between the hemispheres during word recognition.

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Keywords: Lexical decision; Word recognition; Hemispheric specialization; Hemispheric interaction; Laterality

1. Introduction

A standard finding for lateralized lexical decision is a right visual field (RVF) advantage for the correct identification of word stimuli, but not for non-word stimuli (Babkoff & Ben-Uriah, 1983; Bradshaw & Gates, 1978; Chiarello, 1985; Iacoboni & Zaidel, 1996; Leiber, 1976). This result has been taken to indicate specialized resources within the left hemisphere for word processing, with no significant difference in resources available to the hemispheres for identifying non-words. Left hemi-

sphere specialization for word recognition has been supported not only by behavioral studies, but also through electroencephalographic recording (Lutzenberger, Pulvermuller, & Birbaumer, 1994; Pulvermuller, Eulitz, Pantev, & Mohr, 1996) and functional magnetic resonance imaging (Alvarez-Linera et al., 2002; Hart, Kraut, Kremen, Soher, & Gordon, 2000; Heun et al., 1999). Specifically, Calandra-Buonaura et al. (2002) observed stronger cortical activation along left hemisphere frontal, temporal, and parietal areas during lexical decision, but minimal right hemisphere response during the same task. Binder et al. (2001) observed similar results, with strong distributed left hemisphere activation for word recognition only. The minimal right hemisphere response in both studies underscores the important role of the left hemisphere, and inferior role of the right hemisphere, for word recognition.

Words and non-words also differ in the degree to which they require interhemispheric interaction for successful identification. For example, Iacoboni and Zaidel (1996) found that presenting distracting lexical stimuli in

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the visual field opposite the target reduces accuracy for identifying words, as would be predicted if word processing requires interhemispheric communication. In contrast, contralateral distracter stimuli had no impact on non-word recognition. Just as contralateral distracter stimuli disrupt lexical decision performance, duplicate copies of a target stimulus in each visual field can also improve word recognition. Mohr, Pulvermuller, and Zaidel (1994) observed that bilateral presentation of target words leads to faster and more accurate responses, while bilateral displays of non-words provides no performance benefit. Zaidel and Rayman (1994) further showed that this benefit occurs even when compared to duplicate copies contained within a single visual field, indicating that interhemispheric communication, and not simply additional stimulus information, is the source of the improved performance.

The differing patterns of interhemispheric interaction during word and non-word recognition highlight the different theoretical models used to describe the processing involved. Due to the lack of involvement from the contralateral hemisphere during non-word recognition, these stimuli are most likely processed in direct access manner. The term direct access follows from the assumption that the hemisphere that is provided stimulus information directly (left hemisphere for RVF and right hemisphere for LVF) is the one that performs the majority of the processing. Word recognition, however, must involve some level of interhemispheric interaction to account for contralateral hemispheric influences. This might follow if words are represented jointly in the two hemispheres, or perhaps if there exists some response competition that follows from having lexical stimuli presented to two hemispheres. Indeed, response competition/interference is observed for other cognitive tasks in which the hemispheres are differentially specialized (see Hubner & Malinowski, 2002 for a review).

Research has shown that when distracter stimuli are of the same lexical category as the target (both word or both non-word), the performance loss resulting from the distracter is less than when distracter stimuli are incongruous with the target (Iacoboni & Zaidel, 1996). This benefit is termed lexicality priming, since lexicality of the distracter affects recognition performance for the target.

The lexicality priming effect may be due to a disruption of transfer from the hemisphere receiving the distracter to the one receiving the target, since the irrelevant lexical stimulus occupies available processing resources in this contralateral hemisphere. It is also possible that the distracter effects are due, in some degree, to response bias associated with the additional lexical stimulus. This theory has yet to be supported empirically, however, as signal detection measures of bias have failed to identify any effects from contralateral distracters (Weems & Zaidel, 2004). There is also little reason to believe that such response competition should be

stronger for word recognition than for non-word recognition. Since distracter lexicality has no impact on non-word recognition, it seems unlikely that distracter effects can be completely explained by hemispheric competition at time of response. It is conceivable, however, that disruption/facilitation from the contralateral lexical stimulus results not from a disruption of interhemispheric communication but a relative increase in task difficulty due to the presence of additional, distracting information. However, this cannot explain the finding that copies of a lexical stimulus in opposite visual fields lead to better performance than two in the same visual field; this result can only be explained by a facilitative effect from interhemispheric transfer.

Numerous experimental manipulations have explored the difference between word and non-word recognition, particularly between the two hemispheres. Factors such as length, regularity, and frequency have been studied extensively using lexical decision, as has stimulus repetition. For stimulus repetition, repeated targets are identified more quickly and accurately than during first presentation. Repetition priming effects have been shown to be long lasting (Grant & Logan, 1993) and stronger for words than for non-words (Forster & Davis, 1984). Two different sources could account for the repetition priming effect. First, repetition may modify lexical access by strengthening connections for a specific word logogen or node (Bower, 1996; Morton, 1969). A second possibility is that an episodic memory trace is established for the first presentation which becomes activated again when the target is repeated (Forster & Davis, 1984). These two alternatives are typically classified as lexical and non-lexical in nature, respectively, due to the different sources of benefit.

It is a well established finding that repetition priming is stronger for low-frequency than high frequency words (Duchek & Neely, 1989; Forster & Davis, 1984; Hintzman & Curran, 1997; Scarborough, Cortese, & Scarborough, 1977; Scarborough, Gerard, & Cortese, 1979). Some have cited this interaction as evidence for episodic recall, since episodic memory for a low frequency word is stronger than for a high frequency word. This is further supported by observing that masking the first presentation, thus minimizing its episodic trace, eliminates the frequency effect (Forster & Davis, 1984). Indeed, the idea that lexical decision may involve some episodic memory retrieval components is not new, although the lexical decision and recognition memory literatures seldom overlap (Hintzman & Curran, 1997).

While words strongly benefit from repetition priming, the status of non-word repetition is less clearly understood. Non-word repetition priming, when observed, is seldom as strong as for words. However, long term repetition effects have been observed for non-words under certain conditions, supporting a non-lexical source for repetition priming (McKone, 1995; Smith & Oscar-

Berman, 1990). Non-word repetition priming is likely due solely to episodic recall, as masking of the target stimulus eliminates the repetition effects for non-words but leaves repetition effects for words (Forster, Davis, Schoknecht, & Carter, 1987). McKone (1995) observed that both words and non-words exhibited long-term repetition priming, but that words also possess a stronger and more distinctive short-term, fast decaying non-episodic repetition priming benefit. This suggests a combination of both lexical and non-lexical sources for word repetition effects, in contrast to exclusively non-lexical repetition priming for non-words.

Very little is known about how stimulus repetition affects the two cerebral hemispheres, and even less regarding how they interact. Some laterality effects observed during implicit memory tasks for previously displayed lexical information do uncover important hemispheric asymmetries in the way memory traces are stored. Marsolek, Kosslyn, and Squire (1992) observed that both hemispheres demonstrate implicit memory priming during word stem completion for previously displayed words, but that the priming effect is greater for the right hemisphere when the format of the word (i.e., case) is the same at study and test. In other words, both hemispheres possess an abstract, form-independent implicit priming effect, but only the right hemisphere possesses an additional, form-specific priming (Marsolek et al., 1992; Marsolek, Schacter, & Nicholas, 1996). As word stem completion has also been shown to elicit reduced activity for primed words over right posterior cortex (Badgaiyan & Posner, 1997), these results suggest hemispheric asymmetries exist, specifically a right hemisphere advantage, in the priming of word representations.

Examination of repetition priming effects using fMRI has also uncovered hemispheric asymmetries consistent with the above behavioral findings. The neural substrates of the repetition benefit likely are those implicated in perceptual priming, modality specific parts of the neocortex such as bilateral occipito-temporal regions (see Gabrieli, 1998 for review). Functional neuroimaging study of these areas has shown an attenuation of cortical activation following repetition, compared to during first presentation (Henson, 2003; Henson & Rugg, 2003). Hemispheric asymmetries are also apparent in this attenuation, with greater right hemisphere reduction of activity when the second presentation is a form-specific match to the first (Vuilleumier, Henson, Driver, & Dolan, 2002). In a study of masked repetition priming of words, Dehaene et al. (2001) showed form-independent repetition priming (i.e., suppressed haemodynamic response) in the left hemisphere, but form-specific repetition priming in the right hemisphere, consistent with the behavioral results.

For lexical decision, the task used in the current study, less is known about how the two hemispheres are

affected by previous presentation of the lexical stimulus. To our knowledge, no study has explored differences between repetition priming within the left or right hemisphere, and indeed no model exists for how repetition priming is shared between the hemispheres. If we are to believe that non-words are processed in direct access fashion, then it follows that little to no repetition priming should be shared between the hemispheres. For words, however, previous presentation of a target word should benefit later identification of that word regardless to which hemisphere each presentation was directed, since both hemispheres are believed to participate in its recognition. Additionally, inclusion of distracter stimuli provide an additional opportunity to measure hemispheric interaction at time of lexical decision. If lexicality priming provides a measure of interhemispheric interaction during word recognition, then it becomes possible to measure to what degree such interaction is related to the repetition priming effect.

2. Experiment 1

2.1. Methods

2.1.1. Participants

Sixty-six right-handed undergraduate UCLA students (19 males and 47 females) participated in the study for course credit. Each subject had normal or corrected-to-normal vision and no history of neurological illness. Handedness was assessed using a modified version of the Edinburgh Handedness Inventory (Oldfield, 1971). This 17 question survey includes questions regarding preferred handedness for simple daily tasks (e.g., drawing, writing, throwing,...), as well as questions regarding family sinistrality. All subjects reported possessing strong right-handed dominance. All reported English as a first language.

2.1.2. Stimuli

A list of 144 words and 144 non-words was modified from the list used by Iacoboni and Zaidel (1996). All stimuli were between three and five letters in length.

2.1.3. Design and procedure

Subjects were seated at a fixed distance of 57.3 cm from a 16 in. MAG Innovision DJ714 color monitor with their chins in a chin-rest and eyes aligned with a black fixation cross in the center of the screen. Subjects were instructed to maintain their gaze on the fixation point throughout the experiment. Each trial began with presentation of the lexical stimulus, followed by the subject's response. The stimuli, which were black words or non-words on a white background, were displayed either to the left or right of the fixation point for 165 ms (11 refresh cycles of the monitor). The innermost edges of the stimuli were 1.0° of

visual angle from fixation, and stimuli subtended between one and 3° in length. Subjects responded manually using a response box placed at midline and aligned vertically. Subjects were instructed to depress one button if the target was a word and another button if it was a non-word, using their index and middle fingers, respectively. Subjects responded bimanually by depressing buttons with corresponding fingers of both their left and right hands if the target was a word, and different buttons with both hands if the target was a non-word. The next trial began 3 s after the previous stimulus was shown.

Stimuli were underlined to discriminate the target from the distracter letter string, the latter presented in the visual field opposite the target. The distracter string was matched in length with the target but was not underlined. Subjects were instructed to ignore the distracter letter string and respond based solely on the lexical category of the target. On half the trials, the target and distracter were of the same lexical category (both words or both non-words), and on the remaining trials they differed in lexical category. Targets and distracters were taken from the same lists, although for no trial were target and distracter the same stimulus.

Half the stimuli were presented only once as a target. The other half of the stimuli were presented twice, and all repeated stimuli appeared in the same visual field for both presentations. Trials were divided into four consecutive testing sessions of 108 trials with brief rests in between to minimize subject fatigue, for a total of 432 trials. Repeated stimuli were shown for a second time either in the same testing block (within-block condition), or in the following testing block (between-block condition). The number of trials between first and second presentation for both within and between conditions was randomized. The mean number of intervening trials for the within condition was 44.7 and the mean number of intervening trials for the between condition was 134.6 (with the break). Stimulus length and word frequency (as determined by Francis & Kucera, 1982) were counter-balanced between visual fields and repetition conditions.

Before testing began, subjects were given a 24 trial practice in which to familiarize themselves with the

response box mechanism. Testing lasted approximately 45 min.

2.2. Results

2.2.1. Hemispheric specialization

A four-way ANOVA was performed with factors: distracter wordness (word, non-word), target wordness (word, non-word), repetition (first, repeat), and visual field (LVF, RVF). There was a main effect of visual field for both accuracy ($F_{1,65}=40.84$, $p<.0001$) and latency ($F_{1,65}=14.94$, $p<.0005$). Right visual field trials were responded to more quickly and more accurately (85% and 745 ms, respectively) than LVF trials (79 and 767 ms, respectively). Target wordness effects were also observed for accuracy ($F_{1,65}=7.14$, $p<.01$) and for latency ($F_{1,65}=222.5$, $p<.0001$). Words were identified more quickly than non-words (721 ms vs. 791 ms) and also more accurately (84% vs. 80%). Visual field and target wordness also interacted for both accuracy ($F_{1,65}=24.43$, $p<.0001$) and latency ($F_{1,65}=43.33$, $p<.0001$, see Fig. 1). For accuracy, performance was best for RVF word trials, leading to a RVF advantage for word trials only ($F_{1,65}=42.55$, $p<.0001$) and to a higher accuracy for words compared to non-words for RVF trials only ($F_{1,65}=34.39$, $p<.0001$). For latency, words were identified more quickly in both LVF ($F_{1,65}=52.82$, $p<.0001$) and RVF ($F_{1,65}=297.81$, $p<.0001$) trials. However, in contrast to non-word performance, words were identified more quickly in RVF trials than LVF trials ($F_{1,65}=39.61$, $p<.0001$).

2.2.2. Lexicality priming

Distracter wordness influenced both accuracy and latency performance, with distracter words leading to a more accurate performance (82.8 and 81.4%; $F_{1,65}=9.28$, $p<.005$) and faster responses (720.9 and 745.3 ms; $F_{1,65}=4.19$, $p<.05$). For accuracy, distracter wordness interacted with visual field ($F_{1,65}=5.06$, $p<.05$). A RVF advantage was observed for both distracter word trials (85.2 and 80.4%; $F_{1,65}=25.07$, $p<.0001$) and distracter non-word trials (84.7 and 78.0%; $F_{1,65}=43.03$, $p<.0001$), although higher accuracy was observed for distracter

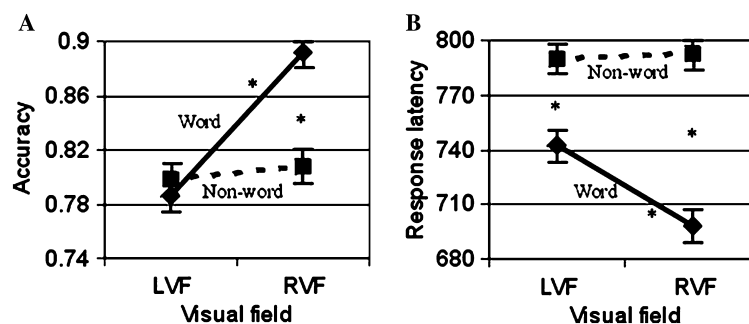


Fig. 1. (A and B) Experiment 1. Wordness by visual field effects for accuracy (A) and latency (B). A RVF advantage was observed for words in both dependent measures, but was absent for non-words. A word advantage is also apparent for both response accuracy and latency. $*p<.0001$.

words than for distracter non-words for only LVF trials ($F_{1,65} = 11.63, p < .005$). Lexicality priming is measured as the interactive effect of distracter wordness on target wordness. For accuracy, a distracter wordness by target wordness interaction was observed ($F_{1,65} = 9.12, p < .005$, see Fig. 2). The best performance was found during target word/distracter word trials, leading to a distracter word advantage for target word trials ($F_{1,65} = 19.24, p < .0001$). For latency, a similar distracter wordness by target wordness interaction was observed ($F_{1,65} = 4.28, p < .05$). Faster reaction times were observed for target word/distracter word trials compared to target word/distracter non-word trials ($F_{1,65} = 8.20, p < .01$).

2.2.3. Repetition priming

A main effect of repetition showed that repeated targets were identified both more quickly (745.5 and 766.6 ms; $F_{1,65} = 61.10, p < .0001$) and more accurately (82.8 and 81.4%; $F_{1,65} = 7.80, p < .01$) than unrepeated targets. Repetition interacted with target wordness for both accuracy ($F_{1,65} = 35.97, p < .0001$) and latency ($F_{1,65} = 20.84, p < .0001$, see Fig. 3). Accuracy performance did not significantly differ between target words and non-words during first presentation, but for repeated stimulus accuracy was significantly higher for target words ($F_{1,65} = 19.37, p < .0001$). Repetition had opposite effects on target words and non-words, as accuracy increased for target words following repetition

($F_{1,65} = 43.35, p < .0001$), but decreased for non-words ($F_{1,54} = 4.37, p < .05$). For latency, responses were faster for target words both during first presentation ($F_{1,65} = 124.13, p < .0001$) and following repetition ($F_{1,65} = 182.50, p < .0001$). However, the effect of repetition was greater for target words as faster responses were associated with repeated words ($F_{1,65} = 77.62, p < .0001$), than with their first presentation.

A separate analysis was performed to examine the difference between stimuli repeated in the same testing block and in the following testing block. An ANOVA for repeated stimuli only was performed with the factors target wordness (word, non-word), visual field (LVF, RVF), distracter wordness (word, non-word), and repetition interval (same block, following block). No main effects or interactions were observed for accuracy. However, an interaction between target wordness and repetition interval was observed in response latency ($F_{1,65} = 5.21, p < .05$). Repetition interval had no effect on target words, but non-words repeated over subsequent testing blocks were identified faster than those repeated in the same testing block (785.8 and 800.1 ms; $F_{1,65} = 4.76, p < .05$).

2.3. Discussion

Several standard findings were replicated in the current experiment. First, a RVF advantage was observed for words but not for non-words. This finding, a hall-

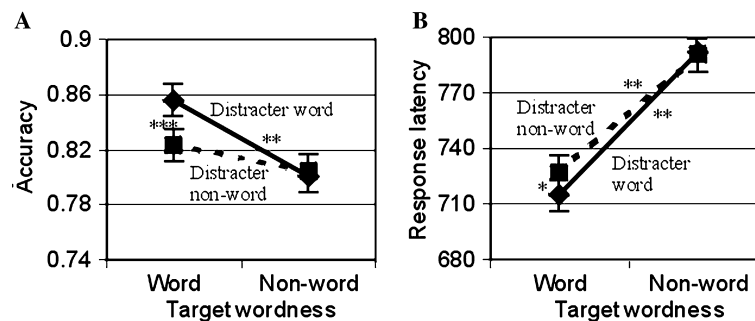


Fig. 2. (A and B) Experiment 1. The effect of distracter wordness on target wordness accuracy and latency, respectively. Lexicality priming, which is the benefit from having congruent target and distracter lexicality, was observed for words in both response accuracy and latency. * $p < .01$, ** $p < .0005$, and *** $p < .0001$.

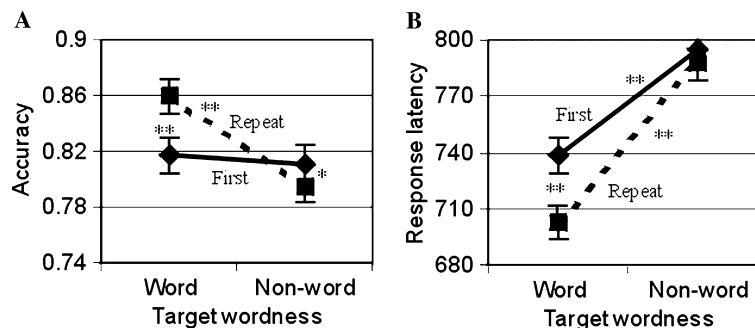


Fig. 3. (A and B) Experiment 1. The effect of target repetition on accuracy (A) and latency (B) performance. Repetition benefited word recognition, leading to both faster and more accurate responses. However, for non-words repetition led to less accurate recognition. * $p < .05$ and ** $p < .0001$.

mark of the lateralized lexical decision task, suggests left hemisphere specialization for the task (Bradshaw & Gates, 1978; Chiarello, 1985; Leiber, 1976). Second, lexicality priming effects were observed for both accuracy and latency performance. Target word trials were responded to faster and more accurately in the presence of distracter words, compared to distracter non-words. This effect of congruous target and distracter lexicality on behavioral performance has been observed elsewhere (Iacoboni & Zaidel, 1996) and is taken as an indication of interhemispheric interaction for word processing. The less reliable effect of distracter wordness on target non-words, in turn, indicates a lack of interhemispheric communication during non-word processing.

Repetition priming effects were observed for target words, with improved accuracy and latency performance for second presentation. As the average inter-stimulus interval was large in the current experiment, the manipulation of the number of items between presentations did not influence behavioral performance. Several different sources of the repetition priming benefit have been observed, with very early repetition (0–2 intervening stimuli) acting independently of later repetition effects (McKone, 1995). Some have advocated different sources for these types of repetition, with the early priming being more lexical in nature and due to residual lexical activation from the first presentation and with later priming being due to episodic recall (McKone, 1995). The choice of long inter-stimulus intervals in the current experiment did not allow for a comparison of repetition types, as all priming occurred at long inter-stimulus lags.

Although latency performance improved for the second presentation of non-words, accuracy decreased from first to second presentation. This results would be expected if the increased familiarity associated with the stimulus was falsely attributed to wordness. Support for this theory was found by Smith and Oscar-Berman (1990) who examined word and non-word repetition priming under divided attention conditions as well as with amnesic patients. They observed that reducing attention during first presentation led non-words to be more often classified as words following repetition. Although the current experiment did not involve additional attention-demanding processes, it is possible that the large number of intervening.

The lack of an interaction between repetition and visual field indicates that the hemispheres did not significantly differ in their degree of repetition priming. As repetition also did not interact with distracter wordness, hemispheric interaction at the time of second presentation did not significantly impact the repetition priming effect either. Distracter lexicality did interact with visual field, a surprising finding that indicates that distracter wordness had a greater impact on the right hemisphere (LVF) than the left. Specifically, distracter non-words led to reduced accuracy, compared to distracter words, for

LVF targets. Other work in this laboratory has shown that increased familiarity of the distracter increases hemispheric interaction (Weems & Zaidel, 2003). It is possible that, in the current experiment, distracter non-words lowered interhemispheric interaction, compared to distracter word trials, due to the absence of familiarity to the observer. This reduced hemispheric interaction should impact the right hemisphere to a greater degree than the left, as the right depends on the specialized left for successful performance.

3. Experiment 2

The goal of the second experiment was to examine if repetition priming is shared asymmetrically between the hemispheres. Whereas Experiment 1 involved stimulus repetition only within the same visual field, the second switched visual field of the second presentation to explore any interhemispheric transfer effects for repetition priming.

3.1. Methods

3.1.1. Participants

Thirty right-handed undergraduate UCLA students participated in the study for course credit (13 males and 17 females). Each subject had normal or corrected-to-normal vision and no history of neurological illness. Handedness was assessed using a modified version of the Edinburgh Handedness Inventory (Oldfield, 1971). All subjects reported possessing strong right-handed dominance. All reported English as a first language.

3.1.2. Stimuli

The current experiment used the same stimulus list as the first experiment.

3.1.3. Design and procedure

The same design employed in the first experiment was used in the current experiment, with the following exceptions. All stimuli were presented twice for a total of 576 trials per subject. Resting periods were provided every 144 trials and stimuli were repeated either in the same testing block or in the following testing block. Unlike the first experiment, half of the stimuli were repeated in the same visual field as first presentation and half the stimuli were repeated in the opposite visual field. The mean inter-stimulus interval was 83.6 trials. Length and word frequency were counterbalanced between visual field and repetition types.

3.2. Results

3.2.1. Accuracy

A main effect of visual field ($F_{1,29} = 27.65$, $p < .0001$) revealed an overall RVF advantage (84.8 and 77.2%). Visual field interacted with target wordness ($F_{1,29} = 9.01$,

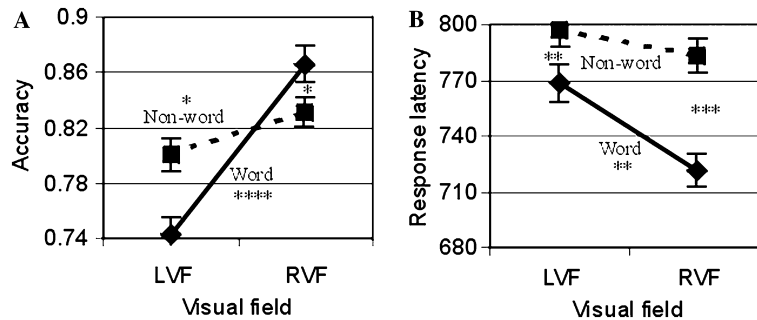


Fig. 4. (A and B) Experiment 2. Visual field by target wordness effects for accuracy and latency. As with Experiment 1, a RVF advantage was observed for word recognition in both accuracy and latency. A smaller, but still significant, RVF advantage also occurred for non-word accuracy. * $p < .05$, ** $p < .005$, *** $p < .001$, and **** $p < .0001$.

$p < .01$), with a RVF advantage for words ($F_{1,29} = 21.40$, $p < .0001$) and less strongly for non-words ($F_{1,29} = 4.44$, $p < .05$, see Fig. 4). Since the RVF advantage was greater for words, this effect was also manifested as a word advantage in the RVF ($F_{1,29} = 6.66$, $p < .05$). A target wordness by distracter wordness by visual field interaction was also observed ($F_{1,29} = 5.62$, $p < .05$). A target wordness by distracter wordness interaction for LVF ($F_{1,29} = 4.59$, $p < .05$) but not the RVF, revealing lexicality priming primarily for right hemisphere targets. Although distracter words led to only a tendency for lower accuracy for LVF target non-words (79.5 and 80.8%), distracter words led to significantly greater accuracy for LVF target words (76.3 and 72.4%; $F_{1,29} = 6.01$, $p < .05$).

3.3. Latency

For latency, target words were identified faster than target non-words (745.1 and 789.8 ms; $F_{1,29} = 56.11$, $p < .0001$). An overall RVF advantage was also observed (752.1 and 782.8 ms; $F_{1,29} = 9.36$, $p < .005$). Target wordness interacted with visual field ($F_{1,29} = 10.62$, $p < .005$). Although words were identified faster than non-words in both the LVF ($F_{1,29} = 9.91$, $p < .005$) and the RVF ($F_{1,29} = 81.30$, $p < .001$), a RVFA advantage was observed only for target words ($F_{1,29} = 12.92$, $p < .005$). A distracter main effect also showed that response was faster in the presence of distracter non-words, compared to distracter words (758.5 and 776.4 ms; $F_{1,29} = 10.23$, $p < .005$).

3.4. Repetition effects

An overall main effect of repetition was observed in target accuracy, with repeated targets identified more accurately than during the first presentation (79.7 and 82.2%; $F_{1,29} = 20.22$, $p < .0001$). Repetition effects interacted with target wordness ($F_{1,29} = 19.50$, $p < .0001$). While repetition provided no benefit for target non-word accuracy, it significantly improved target word performance ($F_{1,29} = 36.45$, $p < .0001$, see Fig. 5). This also led to a non-word advantage for first-presented words ($F_{1,29} = 36.45$, $p < .0001$) but not for repeated words. The

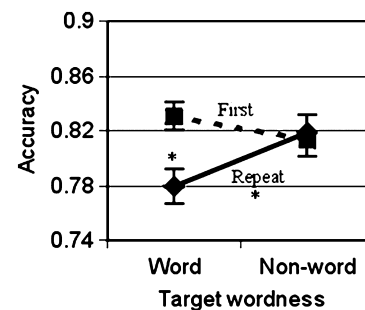


Fig. 5. Experiment 2. The effect of word repetition on target wordness accuracy. Repetition led to an improvement in response accuracy for words, but had no impact on non-word recognition. * $p < .0001$.

only repetition effect to reach significance for response latency was a main effect of faster responses for repeated targets compared to during first presentation (758.3 and 776.6 ms; $F_{1,29} = 15.40$, $p < .0005$).

A separate analysis was conducted on repeated targets to examine the effect of repetition visual field on performance. Consequently, a four-way ANOVA (target wordness, distracter wordness, visual field, repetition: same VF, different VF) was performed. The visual field of repetition had no significant impact on accuracy, but it did affect response latency. Targets repeated in the same visual field as first presentation were identified earlier than those repeated in the contralateral visual field (753.3 and 766.7 ms; $F_{1,29} = 10.68$, $p < .005$). This effect also interacted with current trial visual field ($F_{1,29} = 4.01$, $p = .05$, see Fig. 6). For LVF target trials it made no difference if prior presentation was in the LVF or RVF, but for RVF target trials response was faster for those cases in which previous presentation was also to the RVF ($F_{1,29} = 9.92$, $p < .005$). This difference was also observed as a RVF advantage for targets repeated in the same visual field ($F_{1,29} = 11.66$, $p < .005$) but not targets repeated in the opposite visual field.

3.5. Discussion

As in the first experiment, a RVF advantage for words confirmed left hemisphere specialization for the

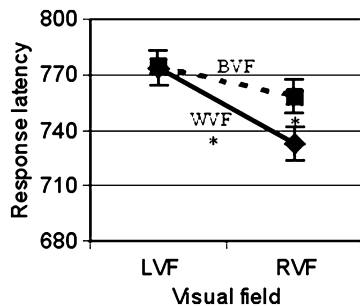


Fig. 6. Experiment 2. Within visual field (WVF) versus between visual field (BVF) repetition effects on target latency. Although visual field of previous presentation had no impact on LVF trials, RVF performance was fastest when the prior presentation was also in the RVF. $*p < .005$.

lexical decision task. This, combined with the lexicality priming effects observed in both experiments, suggest that subjects performed consistently across tasks. However, the second experiment did uncover an asymmetry in lexicality priming not observed in Experiment 1. Lexicality priming was strongest for the right hemisphere, and did not reach significance for the left. This result has been observed elsewhere (Iacoboni & Zaidel, 1996), suggesting that left to right hemisphere transfer plays a more significant role than that in the opposite direction. Some indication of this asymmetry was seen in the first experiment, as distracter wordness had the greatest impact on LVF trials, although it was not influenced by target lexicality. The current results further support a greater reliance of the right hemisphere on left hemisphere resources, i.e., greater left-to-right transfer, than in the opposite direction.

The second experiment also found unique repetition effects not observed in the first. Although words benefited from multiple presentations in the both experiments, unlike in the first experiment non-word repetition had no influence over either accuracy or latency performance. One reason for the differing results may be the switching of visual fields between presentations which may have reduced the repetition priming effects. Indeed, it was predicted that non-words should receive less benefit from repetition priming from the contralateral hemisphere since they are probably processed in a direct access manner. It is disappointing that this result did not reach significance (i.e., a significant previous visual field by target interaction), as this result should have been observed. Perhaps the negative priming for non-words is not robust, and further exploration of the possibility is needed.

Switching visual fields of presentation between repetitions decreased priming benefits. However, one surprising result was an asymmetry in decrement due to switching of visual fields. When repeated targets were presented to the RVF, the visual field of previous presentation became significant, with slower responses for prior LVF presentation compared to prior RVF presentation. This provides some indication that the priming

benefits travel between the hemispheres more easily from left-to-right than in the contralateral direction, just as greater left-to-right transfer was observed for the lexicality priming. Thus, our evidence suggests directional asymmetries in interhemispheric repetition priming, although such asymmetries have not been previously observed to our knowledge.

It is difficult to explain repetition priming asymmetries as being a result of hemispheric specialization, since it is the specialized left hemisphere that appears to be most influenced by the visual field of prior presentation. Indeed, one might predict the exact opposite outcome: a lack of repetition priming from contralateral previous presentation for LVF targets. This is the only case in which the hemisphere supposedly making the response (right hemisphere) did not likely receive stimulus information from the previous presentation, since the prior RVF presentation would not require any involvement from the right hemisphere. However, repetition priming asymmetry may be explained by a consistent greater relative left-to-right interhemispheric transfer, regardless to which visual field a stimulus is presented. Perhaps the current results suggest that such asymmetric transfer occurs for both LVF and RVF trials, thereby leading the right hemisphere to consistently show repetition priming results regardless of visual field. This raises interesting questions regarding the functional role of such transfer, as well as the role of cognitive control during the lexical decision task.

4. General discussion

The two experiments each verified standard findings common to lexical decision research. First, a RVF advantage was observed for words but not for non-words, indicating hemispheric specialization and independence for these stimuli. Second, lexicality priming was observed in the form of an effect of distracter wordness on target word accuracy and latency. Whereas the first finding indicates hemispheric specialization, the lexicality priming result provides support for hemispheric interaction. As target words are more affected by distracter wordness than target non-words, it follows that greater inter-hemispheric communication occurs for processing of target word stimuli. When combined, these two results provide strong support for a joint hemispheric processing model of word recognition, with the predominance of resources existing in the left hemisphere.

Some new findings include negative effects of repetition on non-word stimuli (Experiment 1). This result provides support for a non-lexical source of repetition priming since it is likely the decrease in accuracy for repeated non-words is due to misplaced familiarity for these stimuli. Switching visual fields between first and

second presentation also diminished the repetition priming effect (Experiment 2), primarily for the left hemisphere. Perhaps greater transfer from the left to the right hemisphere might explain later repetition priming effects. We observed greater left-to-right hemisphere transfer in both experiments, manifested as greater influence of RVF distracters on LVF targets and greater lexicality priming for LVF targets. It is often assumed that the left hemisphere is specialized for lexical decision, and that this specialization leads to a RVF advantage. Rather, the current results suggest that such a model may be overly simplified, and that the RVF advantage may also be due to greater relative left-to-right information transfer between the hemispheres. Right visual field trials may allow for greater bi-hemispheric involvement in the lexical decision due to the stronger interhemispheric transfer, as the left hemisphere initially receives the stimulus information and can easily transfer such information to the right. In contrast, LVF trials do not foster such interhemispheric communication, thereby leading to reduced performance.

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