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Increased interhemispheric interaction is associated with decreased false memories in a verbal converging semantic associates paradigm

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Abstract

Recent evidence indicates that task and subject variables that are associated with increased interaction between the left and right cerebral hemispheres result in enhanced performance on tests of episodic memory. The current study looked at the effects of increased interhemispheric interaction on false memories using a verbal converging semantic associates paradigm. In Experiment 1, strong right-handedness (which is associated with decreased interhemispheric interaction) was associated with higher rates of false memories. In Experiment 2, bilateral saccadic eye movements (which are associated with increases in interhemispheric interaction) were associated with fewer false memories. The results provide further support for an interhemispheric basis for episodic/explicit memory.

1. Introduction

A growing body of evidence indicates that the cerebral hemispheres are differentially involved in the encoding and retrieval of episodic versus semantic memories. In particular, brain imaging and behavioral evidence both point to a bilateral, interhemispheric basis for episodic memories and a unilateral, intrahemispheric basis for semantic memories. In an extensive review of 275 studies comparing brain activity during episodic versus semantic memory tasks, Cabeza & Nyberg (2000) concluded that encoding and retrieval operations in episodic memory tasks led to bilateral patterns of brain activation, whereas brain activation during semantic memory tasks was almost always confined to the left hemisphere.

Behavioral studies provide converging evidence. Christman & Propper (2001) reported that task and participant variables associated with increased interhemispheric interaction were associated with enhanced episodic recall. When encoding and retrieval were handled by different hemispheres, episodic memory was superior relative to when the same hemisphere handled both encoding and retrieval. In contrast, semantic memory was superior when encoding and retrieval took place within the same hemisphere. Also, familial left-handedness, which serves as a marker for increased interhemispheric interaction (e.g., Gorynia & Egenter, 2000), was associated with superior performance on tests of episodic, but not semantic, memory.

Propper, Christman, & Phaneuf (in press) extended these findings to personal handedness, reporting that non-right handers exhibit superior episodic memory for lab-based and real-world memories. Similarly, while there are not handedness differences in recognition memory, strong right- versus mixed-handers are biased towards basing recognition memory on familiarity-based "know" judgments versus episodic-based "remember" judgments, respectively (Propper & Christman, in press).

These reports that familial and personal right-handedness is associated with inferior performance on tests

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of episodic memory are hypothesized to reflect the presence of lesser interhemispheric interaction in right-handers. This assumption is based on both physiological and behavioral evidence. First, strength of handedness preference is associated with individual differences in corpus callosum size, with right-handers having smaller callosal sizes than non-right-handers (Clarke & Zaidel, 1994; Witelson, 1985, 1989). For example, Witelson reported that the correlation between strength of right hand preference and callosal size was −0.67. Second, right-handedness is associated with decreased interhemispheric EEG coherence (Nielsen, Abel, Lorrain, & Montplaisir, 1990), an electrophysiological correlate of interhemispheric interaction. Finally, there is behavioral evidence that right-handedness is associated with lesser interaction between left and right hemisphere processing (e.g., Christman, 1993, 2001; Hellige, 1993). Given the evidence reviewed above that brain activity during episodic memory tasks involves both cerebral hemispheres, it is therefore hypothesized that the lesser degree of interhemispheric interaction in right-handers will be associated with poorer performance on tests of episodic memory.

Further support for the hypothesis that episodic memory involves interhemispheric processing comes from a study looking at the effects of eye movements (Christman, Garvey, Propper, & Phaneuf, 2003). When subjects engaged in bilateral, horizontal saccadic eye movements for 30 s immediately prior to memory testing, performance was enhanced on tests of episodic, but not semantic, memory. Pursuit eye movements and vertical eye movements had no effects on either type of memory test and were equivalent to a no eye movement control condition. As (i) horizontal lateral eye movement activate the contralateral hemisphere (Bakan & Svorad, 1969) and (ii) saccadic eye movements generate greater cortical activity than pursuit eye movements (O'Driscoll et al., 1998), it was hypothesized that bilateral saccadic eye movements led to increased bihemispheric activation, which led to increased interhemispheric interaction, which in turn led to enhanced episodic memory performance.

It should be emphasized here that there is no direct evidence that bilateral eye movements enhance interhemispheric interaction, as the link rests on a number of indirect inferences. However, tentative support for the assumptions that (i) bilateral eye movements lead to bihemispheric activation and (ii) bilateral eye movements lead to increased interhemispheric interaction is available. First, Christman & Garvey (2001) reported that the bilateral eye movement procedure used in the current study equalized left and right hemisphere activation levels as measured by perceptual asymmetries in a free vision chimeric face task (Levy, Heller, Banich, & Burton, 1983). Second, Christman (2001) showed that non-right-handedness was associated with increased Stroop interference, and Christman & Garvey (2003) showed that the bilateral eye movement procedure used in the current study also was associated with increased Stroop interference. While this does not directly show that the bilateral eye movements increased interhemispheric interaction, the facts that bilateral eye movements result in right-handers' performance looking more like non-right-handers' provides converging support for the assumption that such eye movements do enhance interhemispheric interaction. Finally, it is worth pointing out that increases in interhemispheric EEG coherence (a marker for increased interhemispheric interaction) during REM sleep are specifically associated with the presence of eye movements (Dionne, 1986), and the majority of eye movements during REM sleep are horizontal saccades (Hansotia et al., 1990).

The purpose of the present paper is to report two experiments that extend the above findings to the issue of false memories. Given evidence that task (i.e., eye movements) and subject (i.e., non-right-handedness) factors that increase interhemispheric interaction result in improved episodic memory for previously encountered items, will these same factors result in a decrease in the likelihood that people will falsely recall items that had not been encountered previously?

This question was addressed via the false-memory paradigm developed by Roediger & McDermott (1995), which in turn was modeled after a procedure created by Deese (1959). The Deese–Roediger–McDermott (DRM) technique involves the presentation of lists of words that are all close semantic associates of a target word that is *not* included in the list. The associates converge on, and lead people to think of, the target word. During recall, a failure of source memory causes people to often falsely recall that the target word had been presented in the list (e.g., Hicks & Marsh, 1999). For example, individuals presented with the semantically related words 'bed', 'rest', 'awake', 'tired', 'dream', 'snooze', et cetera, tend to falsely recall the critical lure word 'sleep'. Experiment 1 looked at the effects of strength of personal handedness on performance on the DRM paradigm, while Experiment 2 looked at the effects of bilateral saccadic eye movements.

2. Experiment 1

2.1. Method

2.1.1. Participants

Participants were 63 college students, without first degree left-handed relatives, participating either as part of a course requirement or for extra-credit in a Psychology class. The median score for the sample on the Edinburgh Handedness Inventory (EHI; Oldfield, 1971) was 80;