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The impact of left and right intracranial tumors on picture and word recognition memory

Bram Goldstein,[a,*] Carol L. Armstrong,[a,b] Edward Modestino,[b,c] George Ledakis,[a] Cameron John,[d] and Jill V. Hunter[e]

[a] *Division of Neurology, Children's Hospital of Philadelphia, Philadelphia, PA, USA*
[b] *Department of Neurology, University of Pennsylvania School of Medicine, PA, USA*
[c] *Functional MRI Research Unit, Children's Hospital of Philadelphia, Philadelphia, PA, USA*
[d] *Department of Behavioral Sciences, Utah Valley State College, 800 West University Parkway, Orem, UT, USA*
[e] *Division of Neuroradiology, Children's Hospital of Philadelphia, Philadelphia, PA, USA*

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Abstract

This study investigated the effects of left and right intracranial tumors on picture and word recognition memory. We hypothesized that left hemispheric (LH) patients would exhibit greater word recognition memory impairment than right hemispheric (RH) patients, with no significant hemispheric group picture recognition memory differences. The LH patient group obtained a significantly slower mean picture recognition reaction time than the RH group. The LH group had a higher proportion of tumors extending into the temporal lobes, possibly accounting for their greater pictorial processing impairments. Dual coding and enhanced visual imagery may have contributed to the patient groups' similar performance on the remainder of the measures.

Keywords: Brain tumors; Laterality; Recognition memory

1. Introduction

Primary brain tumors can compromise neurological systems integral to information processing because of their capacity to invade normal brain tissue (Ojemann, Miller, & Silbergeld, 1996; Skirboll, Ojemann, Berger, Lettich, & Winn, 1996) causing neuronal death, mass effect, or edema (Anderson, Damasio, & Tranel, 1990). Neuropsychological research has provided evidence of these tumor effects on attention, memory, and intellectual processing (Armstrong, Mollman, Corn, & Alavi, 1993; Fisk & Del Dotto, 1990; Mattis, 1995; Meadows & Butler, 1995; Taphoorn et al., 1994). However, the laterality effects of pervasive tumors on cognition have not been extensively investigated. Therefore, examining the impact of hemispheric tumor presence on cognitive factors in a patient population prior to irradiation or chemotherapy may elucidate some of the uncertainty. Picture and word recognition memory are intriguing cognitive factors to study because the hemispheric specialization required to process them is inconclusive.

Several cognitive theories have attempted to explain recognition memory effects through various semantically based picture and word recognition studies. One theory posits that visual (e.g., pictures) recognition tests appear to engage dual hemispheric processing (Gainotto, Capella, Perri, & Silveri, 1994), whereas verbal recognition tests often use real words that appear to be predominantly processed by the left hemisphere (Lieury & Le Nouveau, 1987). Similarly, Gainotto et al. (1994) examined word and picture recognition memory in a right and left neurologically mixed group of patients, requiring them to recognize a previously presented stimulus. They reported a left hemispheric superiority on the verbal memory test with no significant group differences on the picture memory test. Grady, McIntosh, Rajah, Beig, and Craik (1999) presented pictures

* Corresponding author. Present address: Hoag Memorial Presbyterian Hospital, Gynecologic Oncology Associates, 351 Hospital Road, Suite 507, Newport Beach, CA 92663.
E-mail address: bram@gynoncology.com (B. Goldstein).

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or words to a normal control group during different encoding conditions and measured their regional blood flow using PET.

During the multiple conditions, there was bilateral activation throughout the presentations of pictures, although it was more pronounced in the right hemisphere. Although visual field studies by Lupker and Sanders (1982) have suggested that the right and left hemispheres are nearly equal in capacity for processing pictorial stimuli, there have also been specific hemispheric differences illustrated in word and picture recognition studies.

Whitehouse (1981) demonstrated that left hemisphere brain-damaged patients were impaired on verbal memory and right hemisphere patients were impaired on pictorial memory tasks. Additional studies have found greater right hemisphere activation associated with picture, but not word, encoding in the medial temporal lobe (Kohler, Moscovitch, Winocurm, & Mclntosh, 2000; Martin, Wiggs, & Weisberg, 1997). These studies suggest that verbal recognition memory is almost exclusively associated with the left hemisphere because of its association with linguistic processing, whereas picture memory is processed bilaterally.

Based on the findings of prior research, our study attempted to address the primary question: Can we identify specific hemispheric processing differences for pictures and words? From this, we have formulated two hypotheses: (1) since picture encoding may require bilateral processing (both verbal and visual), there will be no hemispheric differences on picture recognition memory in brain tumor patients; (2) since word recognition requires greater linguistic encoding (verbal or lexical representation), left hemispheric lesions will disrupt word recognition memory more than right hemispheric lesions.

2. Method

2.1. Participants

All subjects (males = 14, females = 15) were right-handed adults, who were being treated for primary low-grade gliomas at the University of Pennsylvania Cancer Center or the Thomas Jefferson University Bodine Cancer Center. Patients were administered both recognition memory tests approximately 6 weeks post-surgery (although not all patients had surgery) and prior to irradiation and chemotherapy. The extent of edema is less pronounced in low-grade brain tumors compared to malignant brain tumors (Greenberg, Chandler, & Sandier, 1999), so the impact from edema was presumably mitigated by delaying the testing 6 weeks to accommodate post-surgical recovery. Surgery consisted of gross total resection (42%), partial resection (0%), biopsy (16%), or none (42%) for the left hemisphere group and gross total resection (76%), partial resection (12%), biopsy (6%), or none (6%) for the right hemisphere group. None of the patients had tumor growth for at least 6 months following their evaluation, as demonstrated by MRI. The mean age of the patients was 41.20 years ($SD = 12.85$) and mean educational attainment was 16.10 years ($SD = 2.38$). Twenty-two normal controls (NC; males = 8, females = 14) were compared to the patient population. The NC consisted of patient's family members and volunteers from the two hospitals. They were grouped together and used throughout all of the analyses. The mean age of the NC group was 39.45 ($SD = 16.29$) and mean educational attainment was 16.23 ($SD = 2.49$). On major demographic variables (education and age), the two samples appear to be similar.

The tumor characteristics of the patients are illustrated in Table 1. Inclusion criteria were age between 18 and 69 years, low tumor grade, and supratentorial location. Tumor grading was based on pathology reports or neuroradiologic findings. Exclusionary criteria were extensive neuropsychological impairment, major

Table 1
Clinical characteristics of brain tumor patients

Tumor location	Tumor type
Left hemispheric tumors (n = 12)	
Temporal	Non-specific glioma
Temporal	Astrocytoma
Temporo-parietal	Astrocytoma
Temporo-parietal	Non-specific glioma
Frontal	Mixed glioma
Frontal	Astrocytoma
Fronto-temporal	Astrocytoma
Fronto-temporal	Oligodendroglioma
Parietal	Astrocytoma
Parietal	Non-specific glioma
Parietal	Ependymoma
Parieto-occipital	Oligodendroglioma
Right hemispheric tumors (n = 17)	
Temporal	Ganglioglioma
Temporal	Non-specific glioma
Temporo-parietal	Pleomorphic Xanthoastrocytoma
Temporo-parietal	Pleomorphic Xanthoastrocytoma
Frontal	Astrocytoma
Frontal	Astrocytoma
Frontal	Astrocytoma
Frontal	Astrocytoma
Frontal	Oligodendroglioma
Frontal	Non-specific glioma
Frontal	Oligodendroglioma
Frontal	Oligodendroglioma
Fronto-parietal	Oligodendroglioma
Parietal	Oligodendroglioma
Parietal	Astrocytoma
Parietal	Ependymoma
Parietal	Astrocytoma