

Relationship of Temporal Lobe Volume to Neuropsychological Test Performance in Healthy Children and Adolescents

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INTRODUCTION

Ecological validity of pediatric neuropsychological assessment is considered to be related to the ability of tests to predict real world adaptive functioning, and covary with underlying brain structures. Although a few studies have examined the relationship between adaptive skills and intelligence,¹ attention,² and, executive functions,³ there has been less focus on the relationship between adaptive functioning and skills considered to be dependent on temporal lobe integrity (e.g., visual perceptual and receptive language skills). Further, while studying patients with known brain lesions has led to advances in neuropsychological assessment, fewer studies have documented an association between regional brain volumes and neurobehavioral function in healthy children. Studies involving patients with lesions of the left temporal lobe,⁴ specifically the superior temporal cortex, have documented language comprehension deficits. Thus the left temporal lobe appears to be specialized for language processing, and is thus considered crucial in a variety of school-related skills. Traditionally, the right superior temporal cortex is thought to process the 'what' in object-space relationships,⁵ although there is increasing yet inconsistent evidence supporting a relationship with other brain regions.⁶ In healthy individuals, while some studies have documented a modest relationship between total brain volume and intellectual functioning,⁷⁻¹⁰ correlations between specific neuropsychological tests and regional brain volumes have been more limited.¹¹ The focus of the present study was to determine whether left and right temporal lobe volumes would predict performance on two neuropsychological tests hypothesized to measure left temporal lobe (Peabody Picture Vocabulary Test – Third Edition/PPVT-III)¹² and right temporal lobe (Beery Visual Perception)¹³ functioning in a sample of healthy children.

MATERIALS AND METHODS

The present study examined the association among neuroanatomic structure volume and performance-based measures of temporal lobe functioning in 37 typically developing children ages 5-18 years (20 males; mean age 12.6 years \pm 3.6 years). Children were excluded if there was a history of neurological disorder, mental retardation, learning disability, or psychiatric disorder. High-resolution three-dimensional volumetric MRI (3D-SPGR, TI/TR/TE=300/17/1.6 ms, 256x128x124 matrix, 1.5 mm partitions) was performed at 1.5 T. *BrainImage* (<http://spnl.stanford.edu/tools/brainimage.htm>)¹⁴ was used for visualization, processing and quantification of MRI data (see Figure 1). Isolated brain tissue was subdivided using the revised Talairach atlas¹⁵ into cerebral lobes, subcortical regions, and cerebellum, and was segmented to delineate and measure lobar volumes of gray, white, and ventricular compartments using a constrained fuzzy algorithm. All study participants completed a neuropsychological assessment that included measures of attention, memory, language, visual, and motor skills. Four hierarchical regression analyses were used to predict neuropsychological test scores from brain regions of interest (left temporal, left frontal, right temporal, right frontal), controlling for total cranial volume in each analysis.



Figure 1: Volumetric MRI analysis of the temporal lobe using *BrainImage*.

RESULTS

Results of regression analyses are detailed in Table 1. After controlling for total cranial gray matter volume, left temporal lobe gray matter volume ($p = .002$), but not left frontal gray matter volume ($p = .922$) was a significant predictor of the PPVT-III total score (considered to be a measure of *left* temporal lobe function). Similarly, right temporal gray matter volume ($p = .012$), but not right frontal gray matter volume ($p = .149$) was a significant predictor of the Beery Visual Perception total score (considered to be a measure of *right* temporal lobe function).

Table 1: Correlations of Neuropsychological Tests with Temporal and Frontal MRI Volumes

Neuropsychological Test - DV ^a	ROI (Gray Matter) - Predictor	B	R ² Change	Sig.
PPVT-III	Total Cranial Volume	-0.117	0.144	.164
	Temporal Lobe-Left	2.633	0.207	.002
	Total Cranial Volume	0.103	0.144	.456
Visual Perception	Frontal Lobe-Left	0.082	0.000	.922
	Total Cranial Volume	-0.015	0.090	.207
	Temporal Lobe-Right	0.283	0.157	.012
	Total Cranial Volume	0.047	0.090	.071
	Frontal Lobe-Right	-0.210	0.055	.149

^aDV = Dependent Variable

DISCUSSION

These results provide initial convergent and discriminant validity supporting the PPVT-III as a measure of left temporal lobe function and the Beery Visual Perception test as a measure of right temporal lobe function. This study is one of the first to document a relationship between specific behavioral measures of temporal lobe function (i.e., receptive vocabulary and visual perception) and volumetric MRI analyses of the temporal lobes. As such, these findings support the use of volumetric MRI analysis in healthy children for establishing the ecological validity of specific neuropsychological tests. Future research involving patient populations and measures of adaptive functioning are needed to further support the identified relationship between brain, behavior, and functional outcome.

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