

A Comparison of Executive Functioning in Children with Frontal Lobe Epilepsy versus Normal Controls

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INTRODUCTION

Although epilepsy is the most frequently occurring neurological condition of childhood (Williams & Sharp, 2000), questions concerning the associated neuropsychological sequelae remain. Specifically, few studies have focused on the neurocognitive functioning of youth with frontal lobe epilepsy (FLE), particularly related to executive functioning. Clinical descriptions of patients with identifiable frontal lobe ictal foci characteristically include reports of impaired executive functioning (Culhane-Shelburne et al., 2002). Indeed, functional neuroimaging studies have revealed significant activation within the prefrontal cortex in individuals performing executive function tasks. There is now compelling evidence that executive processes emerge in infancy and develop throughout childhood into early adulthood (Anderson, 1998), which is consistent with frontal lobe development.

Given the developmental nature of the frontal lobes throughout childhood and adolescence, it is not surprising that most published, FLE studies have focused on adult populations. Adult FLE research has revealed deficits in such executive functions as planning, working memory, impulse control, and sustained attention (Hernandez et al., 1992). Although it has been postulated that deficits observed in adults with FLE are generalizable to those in FLE youth, the prolonged development of the frontal lobes prevents the extension of such findings to pediatric populations. Further, the few pediatric studies that have been conducted are weakened by methodological weakness (e.g., lack of a control group, use of translated assessment batteries, etc.). Given the paucity of research on executive dysfunction in youth, the methodological weaknesses of those studies that have been conducted, and the inherent developmental difficulties in generalizing findings from adult studies to children, a more focused study on the manifestation of executive dysfunction in youth with FLE is warranted.

METHODS

Participants:

28 participants

- 14 children with FLE (7 males; 7 females)
- 14 age- and gender-matched controls

→ Characteristics of the Clinical Group:

•Ethnicity:

- 57.1% European-American
- 28.6% African-American
- 14.3% Other

•Age of seizure onset:

- 50% ≤ 6 years
- 50% > 6 years

•Medications:

- 50% Monotherapy
- 50% Polytherapy

→ Characteristics of the Control Group:

•Ethnicity:

- 57.1% European-American
- 42.9% African-American

Procedure:

The 28 participants consisted of children and adolescents aged 8 to 18 ($x=12.07$; $SD=2.59$) who were involved in an ongoing project at a large, southeastern children's hospital. Participants were evaluated using an identical battery of neuropsychological tests known to be sensitive to intellectual ability (Wechsler Abbreviated Scale of Intelligence [WASI]) and executive function (Delis-Kaplan Executive Function System [D-KEFS]: Verbal Fluency Test, Trail-Making Test). Additionally, parents of participants were asked to complete a parent-report measure of executive function (Behavior Rating Inventory of Executive Function [BRIEF]).

Statistical Analysis:

Using the SPSS version 12.0 statistics package, a one-way ANOVA was conducted to compare the WISC-IV performance of children with epilepsy to controls. Comparisons were made with index and composite scores from the WASI, and all index and subtest scores from the D-KEFS and BRIEF. An additional one-way ANOVA was conducted to evaluate the impact of medication (i.e., monotherapy versus polytherapy) on the cognitive and executive functioning of FLE children.

RESULTS

Results from a one-way ANOVA evidenced analogous intellectual functioning across FLE and control groups; however, the clinical group performed significantly worse than controls on each of the Verbal Fluency and Trail-Making conditions (See Table 1). Further, parents of FLE children reported significantly more executive impairments than did parents of neurotypical controls, although impulse-control and emotional regulation skills were comparable. Finally, a comparison of FLE participants treated via monotherapy ($n=7$) or polytherapy ($n=7$) revealed a significant, detrimental impact of polytherapy on intelligence, categorical fluency, and parent-reported executive skills, specifically related to shifting ($p=.011$), planning/organization ($p=.012$), and monitoring of behaviors ($p=.039$).

Table 1. Results of FLE and Control Groups

Test Administered	FLE Group		Control Group		ANOVA
	Mean	SD	Mean	SD	
WASI Full Scale IQ	96.79	13.15	105.94	14.67	.105
DKEFS: Verbal Fluency					
Letter Fluency	8.50	2.59	10.71	2.52	.030
Category Fluency	8.93	2.33	11.57	2.02	.004
Total Switching	7.36	2.58	11.36	3.15	.002
Switching Accuracy	9.00	2.84	12.36	2.73	.007
DKEFS: Trail-Making					
Number Sequencing	8.21	3.37	11.50	3.89	.024
Letter Sequencing	6.71	3.33	11.57	1.99	.000
Number-Letter Switch	7.14	3.33	10.21	3.45	.024
BRIEF: Parent Form					
Inhibition	59.29	15.33	50.00	7.29	.051
Shift	59.64	16.40	46.57	8.59	.008
Emotional Control	56.50	15.30	47.64	12.17	.102
Initiation	58.43	11.17	47.43	6.12	.003
Working Memory	67.36	14.31	49.43	7.96	.000
Plan/Organize	65.86	11.87	45.43	6.06	.000
Organization	57.07	8.90	48.57	11.49	.038
Monitor	63.43	13.08	46.07	6.40	.000

DISCUSSION

Results from this study suggest that children with FLE perform significantly worse than neurotypical children on objective measures of executive function, despite sharing similar intellectual skills. Parents of FLE also endorse significantly more executive dysfunction than those of normal controls, with the exception of impulse-control and emotional regulation abilities. Further, those FLE youth who are treated with more than one medication evidence greater difficulty on measures of both intellectual skill and parent-reported executive dysfunction.

Despite the clinical significance of these findings, it is important to also consider the practical utility of the results. Although FLE participants were less adept on all objective measures of executive skills, they still performed within the low average to average range of functioning; thus, while children with FLE may demonstrate significantly less executive ability than their same-aged peers, they nonetheless demonstrate intact executive functioning in structured, one-on-one testing environments. In contrast, results from parent-report measures indicate clinically significant *impairment* in FLE youth rather than simply less well-practiced skills. These findings are inconsistent with adult FLE studies and, assuming that executive functioning is indeed impaired, suggest that parental report may have more utility in describing the deficits associated with FLE in pediatric populations. To further clarify the impact of pediatric FLE on neurocognitive functioning, future research should explore both developmental age and localization of FLE foci as mitigating factors of executive impairments.

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