4-2006

An Analysis of Executive Functions in Children Referred for Auditory Processing Evaluation

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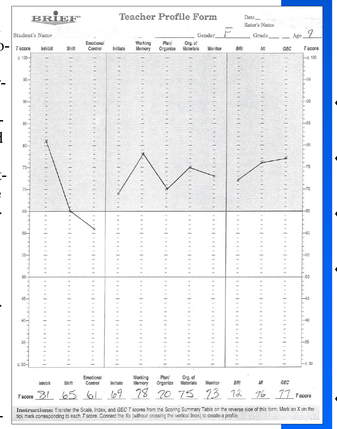
Plattsburgh STATE UNIVERSITY OF NEW YORK

46th Annual New York State Speech Language Hearing Association Convention

Introduction

- It is well known that attention deficits and language disabilities frequently co-occur with auditory processing disorder (APD) (e.g., Chermak & Musiek, 1997).
- Attention is currently thought of as part of a larger set of cognitive variables called executive functions. **Executive functions (or executive skills) "allow us to organize our behavior over time and override immediate demands in favor of longer-term goals" (Dawson and Guare, 2004).**
- These skills include task initiation and follow through, working memory, sustained attention, performance monitoring, inhibition of impulses, and goal-directed assistance (Dawson & Guare, 2004).
- Disorders of executive functioning are "executive dysfunction" (ED). ED has been studied in a number of adult patient populations with neuropsychiatric disorders such as Parkinson's disease, schizophrenia, and depression; however, there is very little information on ED in developmental disorders such as language disorder and auditory processing disorder.
- The assessment of executive dysfunction is an important contributor to the comprehensive assessment of children with difficulties processing spoken language. In fact, ASHA has recently underscored the importance of considering cognitive factors in the assessment and treatment of many communication disorders, stating that **speech-language pathologists "play a primary role in the screening, assessment, diagnosis, and treatment of … children … with cognitive-communication disorders…(ASHA, 2005).**



- We present a preliminary analysis of the executive functioning in school-age children referred for auditory processing and language assessment. These children typically have difficulty listening and understanding in the classroom, difficulty reading, and are often experiencing academic failure.

Methods

- The *Behavior Rating Inventory of Executive Functions* (*BRIEF*; Gioia, Isquith, Guy, & Kenworthy, 2000) was used as the assessment instrument. The BRIEF is a norm-referenced tool with both teacher and parent report forms.

T-scores are derived for the following executive functions scales:

- **inhibiting impulses** → ability to inhibit, resist, or not act on an impulse;
- **shifting attention** → ability to shift attention, make transitions, problems-solving flexibility, change mindset;
- **maintaining emotional control** → ability to control emotional responses, inhibit emotional outbursts;
- **initiating actions** → ability to begin a task, generate ideas, responses, or problem-solving strategies;
- **working memory** → capacity to hold information in mind for the purpose of completing a task;
- **planning/organization** → ability to manage current and future-oriented task demands, set goals, make plans;
- **organization of materials** → orderliness of work, play, and storage spaces (e.g., desks, lockers, bedroom);
- **self-monitoring** → ability to monitor one's own behavior during or after an activity (quoted from Gioia, Isquith, Guy & Kenworthy, 2000).

T-scores are also derived for three composite scores:

- **Behavioral Regulation Index** → based on the subscales Inhibit, Shift, and Emotional Control);
- **Metacognitive Index** → based on the subscales Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor;
- **Global Executive Composite** → a summary score derived from all subscales.
- For the purposes of this study, BRIEF subscale and composite T-scores were recorded from clinical files of children, ten boys and five girls, who had been referred for assessment of auditory/language processing (a multidisciplinary assessment clinic). Children were, on the average 8.34 years of age (minimum = 5 yr., maximum = 12 years).
- The goals of the study were to describe the executive functions of these children, to determine if their scores are significantly different from the scores of the normative population of the BRIEF, and to compare teachers' ratings with parents' ratings.
- SPSS for Windows 10.0 (SPSS Inc., 1999) was used for statistical analysis in this study. Alpha level was set at .05.

Results

- A one-sample t-test, using 50 as the test value (the mean T-score for the normative population), showed that the Parent BRIEF Metacognitive Index scores and Global Executive Scores were significantly different than normal ($t = 1.141$, $df = 14$, $p = 0.03$; $t = 3.580$, $df = 14$, $p = 0.005$, respectively). See below.

One-Sample Test

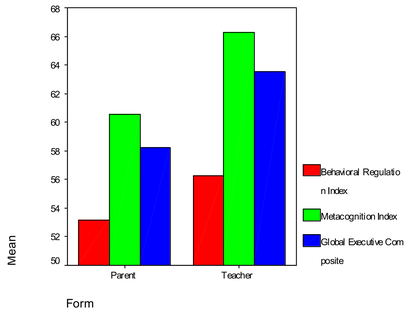
	Test Value = 50					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Behavioral Regulation Index	1.141	14	.273	3.13	-2.76	9.02
Metacognition Index	3.580	14	.003	10.53	4.22	16.84
Global Executive Composite	3.329	14	.005	8.20	2.92	13.48

- Additionally, all composite scores from the Teacher BRIEFs were significantly different than normal ($t = 2.290$, $df = 13$, $p = 0.039$; $t = 7.076$, $df = 14$, $p < 0.001$; $t = 5.529$, $df = 14$, $p < 0.001$). See below.

One-Sample Test

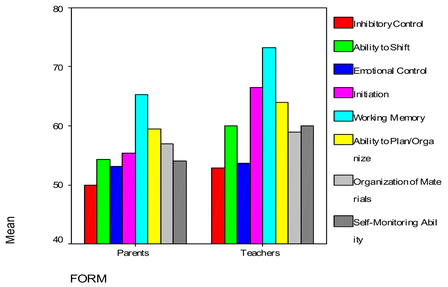
	Test Value = 50					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Behavioral Regulation Index	2.290	13	.039	6.29	.36	12.21
Metacognition Index	7.076	14	.000	16.13	11.24	21.02
Global Executive Composite	5.529	14	.000	13.27	8.12	18.41

- Descriptive statistics show that all composite scores are elevated above the normal. As a group, the mean Metacognitive Index from the Teacher Forms is in the range of clinical significance (1.5 standard deviations above the mean).

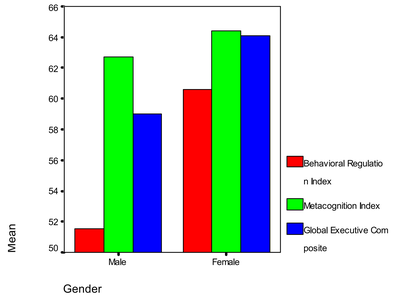


Results

- The graph, below, shows the scores of the individual subscales for both Parent and Teacher Forms. Note that for both Parent and Teacher Forms, the subscale **Working Memory** is rated as the most impaired. Additionally, the relative distribution of scores across the subscales appears similar for parents and teachers, but the teacher-derived scores are generally higher.



- Additionally, there appear to be gender differences in the composite scores, particularly in the area of Behavioral Regulation. Caution is warranted, however, because of the small number of female subjects in the study.



Conclusions

- Parents and teachers rated children referred for auditory processing assessment as having more executive dysfunction than the normative population. Working memory, in particular, appeared to be relatively more impaired than other executive functions.
- Baddeley (1986) proposed that working memory includes a temporary phonological or "articulatory loop" that works to keep language in memory as it is linguistically or cognitively processed. It has been conceptualized as a mechanism for "short-term storage as well as processing, manipulation, and transformation of stored information" (Westby & Watson, 2004, p. 244). Working memory is believed to be central to executive functioning (Gioia et al. 2005; Westby & Watson, 2004).
- On-line processing of both oral and written language is dependent on working memory (Westby & Watson, 2004). Additionally, working memory appears to play a critical role in both reading and mathematical ability (Gathercole et al., 2006), which may explain the high incidence of reading/learning disabilities in children with ADHD and in those referred for auditory processing testing.
- Gioia et al. (2005) report that children with working memory have difficulty remembering verbal material such as word lists and multi-step directions. Symptoms such as these often prompt referrals for auditory processing assessment. In fact, Keith (1995) and others include such items on checklists that are designed to identify children in need of auditory processing assessment.
- Gioia et al. (2005) also report that children with deficits in working memory have difficulty "sticking to" an activity, and present with deficits in sustained attention; thus, they consider clinically significant scores in working memory on the BRIEF to be diagnostically significant for ADHD-type I (predominantly inattentive type). Barkley (2006) views working memory deficits and ADHD as separate, but highly related, problems. The relationship between ADHD and auditory processing disorder has been long debated, and some researchers believe that these are, in fact, not really distinct disorders (e.g., Burd & Fisher, 1986).
- The role of working memory and other executive functions in both ADHD and auditory processing disorder should be further investigated. Working memory may be a unifying concept that ties together and best predicts attention deficits, higher level language processing disorders, learning and reading disabilities, as well as auditory processing deficits.

References on handout.