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An Examination of Clinical Measurements of Verbal Working Memory

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Introduction: Working Memory

- Working memory is the ability to briefly store information in memory while, at the same time, using that information during cognitive processing (e.g., Baddely, 1999).
- Working memory is part of a larger set of skills called executive functions which are related to planning and executing goal-directed behavior.
- Children with language disorders have been shown to have limitations in verbal (phonological) working memory (e.g., Alloway, Rajendran, & Archibald, 2009; Archibald & Gathercole, 2006; Montgomery, 2002; Pickering & Gathercole, 2004).
- Verbal working memory deficits have been implicated in deficits in vocabulary development, language comprehension, language learning, narrative writing, phonological processing, decoding, reading comprehension, curriculum learning, reasoning, problem solving, and even social interaction and behavioral control (Boudreau & Costanza-Smith, 2011; Gathercole & Alloway, 2008; Gathercole, Alloway, Kirkwood, Elliott, Holmes, & Hilton, 2007; Hanten, et al., 2008; Jonsdottir, Bouma, Sergeant, & Scherder, 2005; Kaufman, 2010; Schmeichel, Volokhov, & Demaree, 2008).

Working memory ability has been found to be a better predictor of academic success than I.Q. (Alloway, & Alloway, 2010).

Yet, Speech language pathologists have few tools to measure working memory.

In this study, we aimed to explore the relationships among tests related to working memory that we use in our university clinic. We also endeavored to determine if these working memory scores were strongly related to other scores in the areas of language, social skills, problems behaviors, and executive control.

Working Memory Assessment

- Psychologists typically assess working memory and other cognitive skills using, for example, portions of the WISC-IV, the WRAML2, the WAIT-II, the D-KEFS, the WMRS, the BADS-C, the NEPSY, Working Memory Test Battery for Children, and the BRIEF.
- More available to SLPs are some measures of working memory that are integrated into comprehensive tests of language (e.g., CELF-4) or phonological awareness (e.g., CTOPP).
- Through reviewing records of school age children and adolescents (N=50, mean age 10 yr.) who had been referred to our university clinic for "language and auditory processing assessment" we analyzed different measures related to working memory.
- These were:

- BRIEF (Behavior Rating Inventory of Executive Function)
 - Teacher form
 - Parent form
- CELF-4 Working Memory Index
- CTOPP Phonological Memory Composite

NOTE: One sample t-tests showed that this group of subjects differed significantly (p<.01) from the norm on all measures of language, working memory, and overall executive function (BRIEF composite scores).

NOTE: Not all Ss received the CTOPP (21 did) so we split the file, comparing all CELF-4 and BRIEF composite scores to determine if the 2 groups (those with and without CTOPP) were different in terms of severity. Independent t-tests showed that the two groups did not differ in any measure of language or executive function (p>.05), so the data were pooled. Missing data were deleted pairwise for all analyses.

Are Our Working Memory Measures Related?

If we assume that these are all measuring the same construct (working memory) or a highly related construct (short term memory), these scores should be highly correlated. Using SPSS, a (Pearson) correlation matrix of these scores revealed only a few significant correlations among scores from **different memory composite scores** (p<.05).

Correlations

	BRIEF Parent Wkg Memory	BRIEF Teacher Wkg Memory	CELF-IV Working Memory Index	CTOPP-Phonological Memory Composite
Parent Wkg Memory				
Teacher Wkg Memory	.352(**)			
CELF-IV Working Memory Index	-.282(*)	-.077		
CTOPP-Phonological Memory Composite	-.012	-.363	.264	

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).

Significant correlations were found between:

- Teacher BRIEF Working Memory
- Parent BRIEF Working Memory
- Parent Brief Working Memory and
- CELF-4 Working Memory Index

In general, the relationships among these variables are not strong, as would be expected if they were accurately measuring the same construct or highly related constructs.

Are Our Working Memory Measures Related to Measures of Language, Executive Dysfunction, Social Skills, and Behavior?

- An additional correlation matrix was generated to determine the degree of relationship between the 4 working memory variables, and other clinical measures from the same group of subjects. These other variables were the composite scores from:
 - CELF-4
 - Receptive Language
 - Expressive Language
 - Language Content
 - Social Skills Rating System (SSRS)
 - Social Skills
 - Problem Behaviors
 - BRIEF Global Executive (Dysfunction) Composite
 - Teacher form
 - Parent form

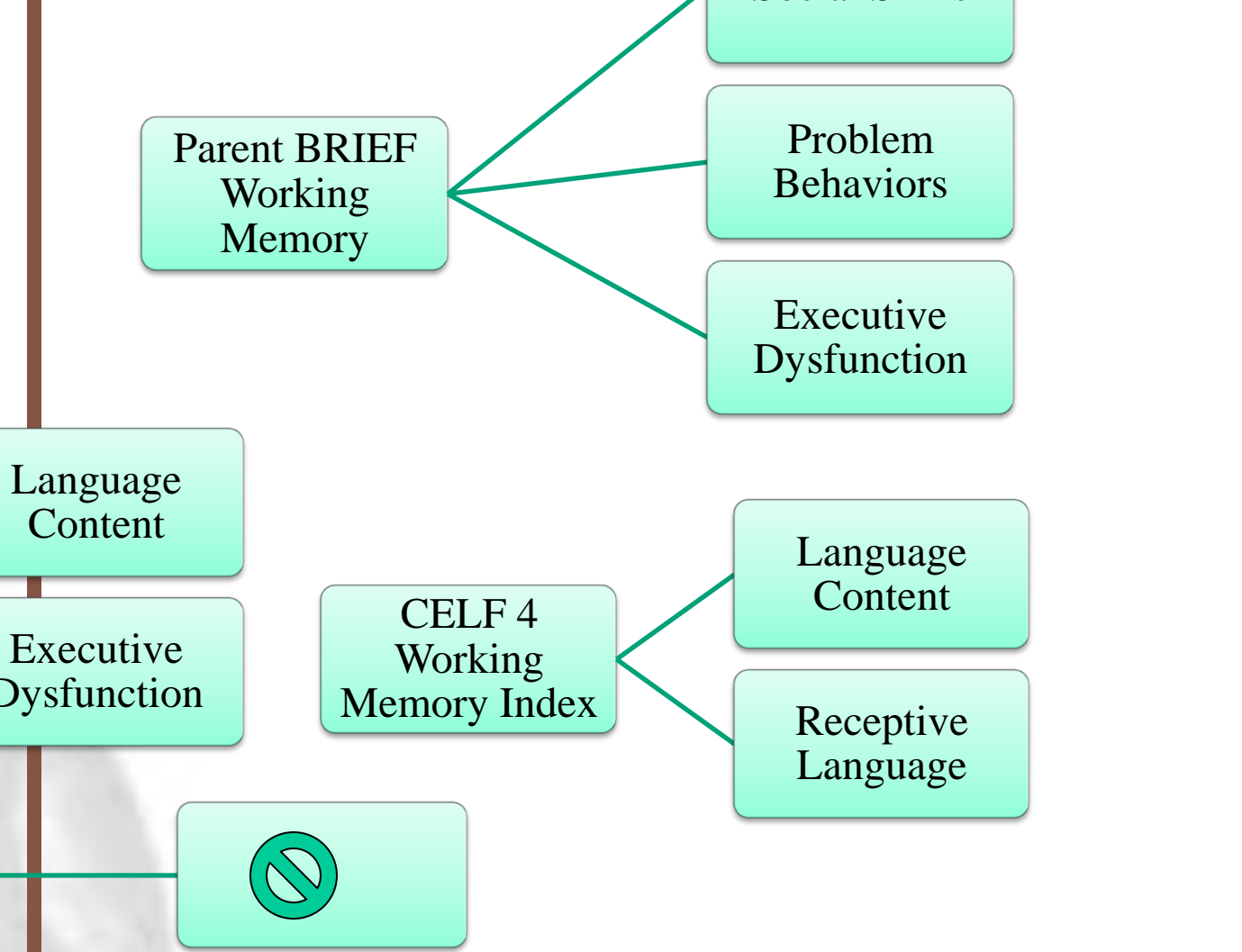
Correlations

	BRIEF Parent Wkg Memory	BRIEF Teacher Wkg Memory	CELF-IV Working Memory Index	CTOPP-Phonological Memory Composite	SSRS Social Skills	SSRS Problem Behaviors	CELF-IV Receptive Language Index	CELF-IV Expressive Language Index	CELF-IV Language Content Index	BRIEF Parent Global Executive	BRIEF Teacher Global Executive
BRIEF Parent Wkg Memory											
BRIEF Teacher Wkg Memory	.352(**)										
CELF-IV Working Memory Index	-.282(*)	-.077									
CTOPP-Phonological Memory Composite	-.012	-.363	.264								
SSRS Social Skills	-.315(*)	.023	-.143	-.141							
SSRS Problem Behaviors	.273(*)	.175	.017	.161	-.459(**)						
CELF-IV Receptive Language Index	-.073	-.266	.294(*)	.005	-.064	.128					
CELF-IV Expressive Language Index	-.083	-.278	.248	.096	.066	-.255	.632(**)				
CELF-IV Language Content Index	-.200	-.474(**)	-.406(**)	.234	.088	-.443(**)	.533(**)	.526(**)			
BRIEF Parent Global Executive	.771(**)	.303(*)	-.203	.064	-.526(**)	.472(**)	-.091	-.161	-.227		
BRIEF Teacher Global Executive	.212	.804(**)	-.183	-.262	-.196	.302(*)	-.266	-.290(*)	-.502(**)	.362(**)	

** Correlation is significant at the 0.01 level (1-tailed).
* Correlation is significant at the 0.05 level (1-tailed).

Results and Implications

Interestingly, the working memory subtest from the parent form of the BRIEF showed the most significant relationships with other variables.



Each working memory assessment was correlated with a different set of tests measuring language, executive impairment, social skills, or problem behaviors, indicating that each is unique. The uniqueness of these tests is supported by the fact that they are not highly correlated with each other.

SLPs should be aware that not all working memory tests at our disposal are measuring the same thing.

The validity and predictive value of our working memory measures should be explored further. The relationships among our working memory tests and those typically used by psychologists should also be investigated.