One Cheer for Digit Span: Alternate Administration & Scoring Methods May Improve Working Memory Measurement

Erica L. Wells, Sherrle L. Harmon, Elia F. Soto, Nicole Ferretti, Matthew Casarico, Briana Francis, Brian Menard, Kayla Saunders, & Michael J. Koeller, Ph.D.
Department of Psychology, Florida State University

Introduction

* Working memory (WM) is a limited capacity system for temporarily storing and processing internally held information for use in guiding behavior (1).
* Children with ADHD exhibit large magnitude WM deficits (d ≥ 2.0; 4) but do not perform comparatively worse than non-ADHD children on digits backward relative to digits forward (6).
* Digit span backward is frequently interpreted as a measure of WM, but decades of evidence from cognitive psychology indicate that digits backward is better characterized as a measure of verbal short-term memory (STM; cf. 3).
* STM and WM constructs predict non-overlapping variance in outcomes such as IQ (10).
* Performance on simple span tasks (e.g. digit span forward & backward) appears to predict WM only at list lengths that exceed STM capacity (i.e. during the trials omitted by standardized administration; 9).

Participants

* Thirty-six children with ADHD (13 female, 23 male), ages 8-13
* M age = 10.35, SD = 1.42
* Final N = 33 (three excluded due to administration error)

Methods

Measures

* WISC-IV Digit Span (DS) Backward
* PH and VS WM tasks, as described by (7) and depicted in the Figure below.

Administration & Scoring Procedures

* Participants completed all trials of WISC-IV digit span backward (i.e. no discontinue rule).
* Performance on DS was evaluated using both traditional (discontinue rule; all-or-nothing scoring) and recommended (no discontinue; partial-credit unit scoring) methods (9).
* A latent index of central executive WM served as the criterion as recommended, to reflect shared variance between PH and VS WM (cf. 8).

Visuospatial (VS) and Phonological (PH) WM Tasks

Results

* Traditional DS Backward scores were not related significantly to the WM criterion (r = 0.005, 95% CI = .45 to .56).
* A significant relation between DS Backward and WM emerged when using non-discontinue, partial-credit scoring methods (r = 0.47, 95% CI = .15 to .78).
* The improved correlation appeared specific to trials above span: Performance at the lowest list lengths failed to predict WM (2-4 digits; r = .09, 95% CI = -.32 to .56), whereas the highest list lengths showed strong association with WM (6-8 digits; r = .60, 95% CI = .35 to .83).
* The hierarchical regression was significant (R² = .62, p = .001). High-list performance (ΔR² = .39; β = .64, p = .001) and SES (ΔR² = .23; β = .47, p = .006) uniquely predicted WM. Traditional and low-list scores failed to account for additional variance (all p > .05).

Discussion

* Our results extend findings from healthy populations to clinical sample, and they further challenge traditional interpretations of digit span backward as a measure of WM.
* WM performance predicts constructs as varied as academic achievement, IQ, and social functioning (e.g., 3, 5).
* Firm conclusions regarding digit span’s construct validity are limited by the lack of a typically developing (TD) comparison group; however, results were highly consistent with findings from healthy populations (3, 9).
* Future research that includes larger samples of TD and clinical comparison groups is needed to determine the extent to which DS Backward measures WM across groups.
* Accurate measurement of WM is useful in both research and clinical settings. This may be particularly relevant for clinical assessment of children with ADHD and other populations that exhibit impairments in working memory.

References