

Exploratory Factor Analysis of the Cognitive Facilitators/Inhibitors Domain of the Integrated SNP/CHC Model

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Abstract:

The purpose of this study was to examine the factor structure of the cognitive facilitators/inhibitors domain of the Integrated School Neuropsychological (SNP)/Cattell-Horn-Carroll (CHC) model. The data utilized produced six components with one variable exhibiting cross loadings.

Introduction:

The Integrated SNP/CHC model (Miller, 2013) is a novel model of pediatric neuropsychological functioning that hypothesizes the existence of four, broad domains within which children may be assessed. These domains include sensorimotor functions, cognitive facilitators/inhibitors, basic cognitive processes, and acquired knowledge. The cognitive facilitators/inhibitors domain is hypothesized to be comprised of three constructs including allocation and maintenance of attention, processing speed (PS), and working memory (WM). Each of these constructs is made up of second- and third-order constructs. Specifically, attention includes selective/focused and sustained attention and attentional capacity as second-order constructs while third-order constructs include auditory and visual distinctions among second-order constructs. Second-order classifications of PS include performance, retrieval, and acquired knowledge fluency, and fluency and accuracy. There are numerous third-order constructs associated with PS. The label WM is used both broadly and secondarily with third-order constructs making verbal and visual distinctions. In contrast, traditional models of pediatric neuropsychological functioning conceptualize all facets of attention as existing within one domain (Baron, 2004; Kozial & Budding, 2011). In addition, WM is typically conceptualized as existing within the domain of memory, while PS usually represents its own domain. Despite these classic conceptualizations, research has demonstrated an overlap between attention, PS, and WM (Cowan, 2010; Fry & Hale, 2000; Kail, 2007; Nettelbeck & Burns, 2010; Oberauer & Bialkova, 2009) that the Integrated SNP/CHC model appears to recognize. Given the novel nature of the Integrated SNP/CHC model, it becomes important to systematically validate aspects of this model.

Method:

The data utilized were archival and culled from a national database of neuropsychological case studies of a mixed-clinical sample (N = 591) that had been subjected to multiple imputation. Clinical populations included school-age boys and girls diagnosed with attention-deficit/hyperactivity disorder, specific learning disabilities, autism spectrum disorders, speech/language impairment, and general neurological impairments including traumatic/acquired brain injuries, seizure disorders, and brain tumors. The measures utilized included the *Wechsler Intelligence Scale for Children, Fourth Edition* (WISC-IV), *Woodcock-Johnson Tests of Cognitive Abilities, Third Edition, Normative Update* (WJ-III Cog), *Wide Range Assessment of Memory and Learning, Second Edition* (WRAML2), and *NEPSY: A Developmental Neuropsychological Assessment, Second Edition* (NEPSY-II). Specific subtests were selected from these measures to represent cognitive facilitators/inhibitors as outlined in the Integrated SNP/CHC model. Subtests used to measure attention included WJ-III Cog Memory for Words and Pair Cancellation; NEPSY-II Auditory Attention; and, WRAML2 Finger Windows and Number/Letter. Measures of PS included WISC-IV Cancellation, Coding, and Symbol Search; and, WJ-III Cog Retrieval Fluency and Visual Matching. Subtests presumed to measure WM included WISC-IV Digit Span Backward and Letter-Number Sequencing; WJ-III Cog Auditory Working Memory and Numbers Reversed; and, WRAML2 Symbolic Working Memory and Verbal Working Memory. Subtest selections were based on nature of the dataset and reliability and validity data related to each subtest.

Results:

A factor analysis was conducted to determine the underlying structure of the 16 aforementioned variables. Preliminary analyses indicated the linearity and normality of each variable. Principal components analysis was conducted utilizing a varimax rotation with Kaiser normalization. Six components emerged with eigenvalues greater than one. Examination of the scree plot further indicated these six components should be retained. The six components explained 59.4% of the observed variance with Speeded WM explaining the majority of the variance. Each variable had a factor coefficient of at least .4. Digit Span Backward loaded on both Attentional Capacity and Verbal WM; however, it was dropped from Attentional Capacity given higher loadings on Verbal WM..

Conclusions:

The Speeded WM component represents the Processing Speed Index from the WISC-IV along with a task of WM from this measure (Wechsler, 2003). Collectively, this component may represent the ability to hold rules or information in mind in order to quickly complete a cognitive task. The Immediate Memory component is made up of subtests tapping short-term memory (*Gsm*) on the WJ-III Cog (McGrew, Shrank, & Woodcock, 2007); and, the Speeded Attention component is reflective of cognitive efficiency in CHC theory (Schneider & McGrew, 2012). In line with this construct, Speeded Attention may represent the ability to engage and maintain attention in order to successfully complete a timed cognitive task. The Attentional Capacity component is consistent with the Integrated SNP/CHC model in that subtests making up this component are hypothesized to represent verbal and visual attentional capacity; however, WJ-III Cog Memory for Words would have ideally loaded here as well (Miller, 2013). Also consistent with the Integrated SNP/CHC model is the Verbal WM component. Finally, the Sustained Attention component may represent the ability to engage attention for prolonged periods of time in order to complete a task. In summary, aspects of the cognitive facilitators/inhibitors domain were supported; however, additional research on this model using additional or different subtests is necessary.

Subtests	Component 1: Speeded WM	Component 2: Immediate Memory	Component 3: Speeded Attention	Component 4: Attentional Capacity	Component 5: Verbal WM	Component 6: Sustained Attention	Communalities
WISC-IV Symbol Search	.777						.677
WISC-IV Coding	.770						.606
WISC-IV Cancellation	.610						.480
WISC-IV Letter-Number Sequencing	.576						.506
WJ-III Cog Auditory Working Memory		.750					.587
WJ-III Cog Memory for Words		.710					.562
WJ-III Cog Numbers Reversed		.696					.580
WJ-III Cog Visual Matching			.802				.693
WJ-III Cog Pair Cancellation			.800				.674
WJ-III Cog Retrieval Fluency			.520				.435
WRAML2 Number/Letter				.719			.654
WRAML2 Finger Windows				.592			.454
WISC-IV Digit Span Backward					.447		.699
WRAML2 Verbal Working Memory					.853		.771
NEPSY-II Auditory Attention						.715	.577
WRAML2 Symbolic Working Memory						.593	.552
% of Variance Explained	16.5	11.9	9.9	7.9	6.6	6.3	
Cumulative % of Variance Explained	16.5	28.4	38.4	46.3	53.0	59.4	