



The Woodcock-Muñoz Foundation

Research Brief

Woodcock-Johnson III Factor Clusters: *g* Loadings and Specificity

Amberly Barry
University of Memphis

Randy G. Floyd
University of Memphis

Copyright © 2005, Randy G. Floyd

Downloaded from www.woodcock-munoz-foundation.org

Correspondence concerning this research brief should be addressed to Randy G. Floyd at the University of Memphis; email: rgfloyd@memphis.edu

Woodcock-Johnson III CHC Factor Clusters: *g* Loadings and Specificity Estimates

Amberly Barry and Randy G. Floyd

The University of Memphis

Introduction

The Cattell–Horn–Carroll (CHC) theory describes a hierarchical model of cognitive abilities that vary according to level of generality: narrow abilities, broad abilities, and general intelligence (*g*). Narrow abilities include approximately 70 abilities that are generally marked by specific types of tasks and standard response processes. Broad abilities include Fluid Reasoning, Crystallized Intelligence, Short-Term Memory, Visual Processing, Auditory Processing, Long-Term Retrieval, Processing Speed, Reading and Writing Ability, Quantitative Knowledge, and Reaction Time/Decision Speed. At the apex of this hierarchical model is *g*. Many recognize the sources of this model, the Cattell–Horn *Gf-Gc* theory (Horn & Noll, 1997) and the Carroll three-stratum theory (Carroll, 1993, 2003), as the most complete and empirically supported descriptions of the structure of human cognitive abilities.

The purpose of this study is to investigate the *g* loadings and specificity estimates for seven composites scores designed to operationalize CHC broad abilities. These composite scores are the CHC factor clusters from the Woodcock–Johnson III (WJ III) Tests of Cognitive Abilities (COG; Woodcock, McGrew, & Mather, 2001).

Method

Participants

All participants were drawn from the WJ III United States standardization sample (McGrew & Woodcock, 2001). For this study, three age-differentiated samples were formed from the total standardization sample. These samples included 262 participants from ages 6-8, 498 participants from ages 9-13, and 554 participants from ages 14-18.

Measures

The seven WJ III COG CHC factor clusters were the focus of this study: Comprehension–Knowledge, Long-Term Retrieval, Visual–Spatial Thinking, Fluid Reasoning, Auditory Processing, Processing Speed, and Short-Term Memory (Woodcock et al., 2001). See Table 1.

Analyses

To obtain the *g* loadings for each cluster, scores from all seven clusters at each age level were entered into a principal factor analysis in which one factor was extracted. The *g* loadings represent the correlation between the cluster score and the factor presumed to be *g*.

Specificity estimates for each cluster were obtained by following three steps. First, multiple regression was used at each age level to obtain the squared multiple correlations (SMC) between each individual cluster and all of the remaining clusters. Second, the average split-half reliability coefficient for each cluster was obtained at each age level using the reliability coefficients presented by McGrew and Woodcock (2001). Third, the SMC for each cluster was subtracted from its average reliability coefficient to obtain an estimate of reliable variance that is unique. Estimates of error variance were obtained by subtracting the average reliability from 1. These estimates represent the amount of variance in a cluster attributed to unsystematic error.

Results

g Loadings

Comprehension–Knowledge, Long-Term Retrieval, and Fluid Reasoning had the highest *g* loadings (see Table 1). However, the single highest *g* loading for each age group varied. Long-Term Retrieval had the highest loading with ages 6-8. Fluid Reasoning had the highest loading with ages 9-13 and tied with Comprehension–Knowledge for the highest loading with ages 14-18.

According to the standard rules-of-thumb for interpreting *g* loadings (e.g., McGrew & Flanagan, 1998), Comprehension–Knowledge is a *high* measure of *g* across all age groups. Long-Term Retrieval is a *medium* measure of *g* at ages 9-13 and a *high* measure of *g* for the 6-8 and 14-18 age groups. Fluid Reasoning is a *medium* measure of *g* at ages 6-8 but a *high* measure with the older age groups. Auditory Processing and Short-Term Memory are *medium* measures of *g* across all age groups. Processing Speed is a *low* measure of *g* at ages 6-8 and a *medium* measure of *g* at ages 9-13 and 14-18. Visual–Spatial Thinking is a *medium* measure at ages 14-18 and a *low* measure of *g* for ages 6-8 and 9-13. For all clusters except Long-Term Retrieval, the sizes of the *g* loadings tended to increase with age.

Table 1. The *g* Loadings for Each CHC Factor Cluster at Three Age Groups

CHC Factor Cluster	Age Group		
	6-8	9-13	14-18
Comprehension-Knowledge	.70	.76	.77
Long-Term Retrieval	.75	.69	.70
Visual-Spatial Thinking	.26	.46	.54
Auditory Processing	.54	.61	.64
Fluid Reasoning	.68	.78	.77
Processing Speed	.45	.53	.52
Short-Term Memory	.52	.60	.63

Specific and Error Variance

The specific and error variances are presented in Table 2. All clusters have well more than ample specificity based on the standard rule-of-thumb indicating that to have ample specificity a score must be greater than error variance and have more than 25% specific variance (e.g., Kaufman, 1994). Processing Speed has the highest specificity across all age groups. Long-Term Retrieval has the lowest specificity for the 6-8 age group, Comprehension–Knowledge and Fluid Reasoning tie for the lowest specificity for the 9-13 age group, and Comprehension–Knowledge has the lowest specificity for the 14-18 age group. Specificity is notably greater than the variance attributed to *g* across all age groups for Processing Speed and Visual–Spatial Thinking. For all clusters except Long-Term Retrieval, the sizes of the specific variance estimates tended to decrease with age.

Table 2. The Specificity for Each CHC Factor Cluster at Three Age Groups

CHC Factor Cluster	Age Groups					
	6-8		9-13		14-18	
	S	E	S	E	S	E
Comprehension Knowledge	49	8	44	6	41	5
Long-Term Retrieval	46	12	47	13	45	11
Visual-Spatial Thinking	67	26	60	21	55	19
Auditory Processing	61	13	55	12	50	10
Fluid Reasoning	60	4	44	5	43	5
Processing Speed	75	6	67	9	68	8
Short-Term Memory	64	13	55	14	53	12

Note. S = Specific Variance, E = Error Variance.

Discussion

The WJ III CHC factor clusters vary greatly in their measurement of *g*, and their measurement of *g* varies notably with age. Regardless of the levels of *g* measured by these clusters, all possess ample specificity. These results have notable implications for the interpretation of the CHC factor clusters as measures of general, broad, and narrow abilities described by CHC theory.

The *g* loadings, specificity estimates, and error estimates aid psychologists in explaining why the CHC factor cluster scores may deviate from a global ability composite score and from each other. For example, when interpreting the CHC factor cluster scores of a child age eight, the Visual-Spatial Thinking cluster, which has an extremely low *g* loading as well as sizeable specificity and error estimates at this age, would be expected to be notably higher or lower than the child's score on the global ability composite score and notably higher or lower than the Long-Term Retrieval cluster, which has a high *g* loading and lower specificity and error estimates. Knowledge of *g* loadings also prompts psychologists to look for environmental reasons for scores with high *g* loadings to deviate notably from global ability composite scores (Kaufman, 1994).