Broad Cognitive Abilities of Children With Mental Retardation: An Analysis of Group and Individual Profiles

Renee Bergeron and Randy G. Floyd
The University of Memphis

Abstract

Group and individual broad ability profiles of children with mental retardation and a matched sample of children with average achievement was investigated through use of the 7 Cattell–Horn–Carroll (CHC) factor clusters from the Woodcock-Johnson III Tests of Cognitive Abilities. Results indicate that, as a group, the ranked performance of the children with mental retardation on the CHC factor clusters was largely consistent with the clusters' *g* loadings. When compared to average-achieving matches, the children with mental retardation scored lower on all CHC factor clusters, but the groups displayed different patterns of performance. Despite normative deficiencies in IQs, children with mental retardation demonstrated a wide range of performance across measures. Implications for assessment and diagnosis are discussed.

A severe deficit in intellectual ability has historically been the pathognomonic sign of mental retardation. Identification of such deficits is generally based on poor performance on norm-referenced intelligence test batteries. Previous research has established the predictive validity of IQs on various outcomes, such as academic achievement, years of education attained, adaptation to environmental demands, and occupational status in adulthood (e.g., Brody, 1997; Neisser et al., 1996; Wagner, 1997). Thus, these measures appear to be effective in identifying deficits in the global cognitive ability that is most closely associated with social and adaptive functioning. However, in recent years, two notable trends in the assessment of cognitive abilities have emerged that have weakened the reliance on a single score representing global cognitive functioning, the IQ. These trends include (a) the growing emphasis during test development and test interpretation on theories of intelligence that include descriptions of specific cognitive abilities and (b) the increasing prominence of part scores during test interpretation and diagnosis of learning difficulties.

The use of IQs is predicated on research indicating that the construct of *general intelligence* represents what is typically called *intellectual ability* or *overall cognitive functioning* (Jensen, 1998; Spearman, 1927). After over 100 years of study and debate, there is agreement that this higher order ability meaningfully represents the positive relations among more specific measures of cognitive abilities, such as the subtests in intelligence test batteries (Carroll, 1993; Jensen, 1998; Spearman, 1927). In fact, many believe that general intelligence is the most important "active ingredient" in all intelligence tests. It is this ability that is represented well by IQs from most test batteries, and, thus, it is the foundation of assessment of mental retardation. Perhaps the most prominent challenges to this reliance on measures of general intelligence stem from the work of Horn and colleagues, who espouse the e*xtended* Gf-Gc theory (e.g., Horn, 1991; Horn & Blankson, 2005; Horn & Noll, 1997). Proponents of this theory depict a hierarchy of abilities describing the different facets of intelligence. These abilities range from elementary capacities to somewhat more general ones.

The most elementary capacities, called *primary mental abilities,* number more than 80. Subsuming these primary mental abilities in the hierarchy are approximately eight semi-independent *second-order abilities:* Acculturation Knowledge, Fluid Reasoning, Short-Term Apprehension and Retrieval or Short-Term Memory, Fluency of Retrieval From Long-Term Storage or Long-Term Memory, Processing Speed, Visual Processing, Auditory Processing, and Quantitative Knowledge. The extended Gf-Gc theory does not include a higher order factor representing general intelligence at the apex of the ability hierarchy.

In his three-stratum theory, Carroll also emphasized the many facets of intelligence and devoted attention to cognitive abilities that are more specific than general intelligence (Carroll, 1993, 1997, 2003). Like extended Gf-Gc theory, the three-stratum theory describes a hierarchical model of abilities that vary according to level of generality. Consistent with extended Gf-Gc theory, it includes abilities at the narrow level (Stratum I) that reflect the highly specialized abilities seen as primary mental abilities as well as abilities at the broad level (Stratum II) that largely reproduce the second-order abilities in name and content. Carroll's broad abilities include Fluid Intelligence, Crystallized Intelligence, General Memory and Learning, Broad Visual Perception, Broad Auditory Perception, Broad Retrieval Ability, Broad Cognitive Speediness, and Processing Speed/Decision Speed. Unlike extended Gf-Gc theory, but consistent with the research supporting the existence and meaningfulness of a higher-order factor at the apex of such a hierarchy, the three-stratum model includes general intelligence at the general level (Stratum III).

In another theory, Detterman (1987, 1999) placed the specific cognitive abilities described by Horn, Carroll, and others in context by focusing on their contributions to overall cognitive functioning, which is represented by general intelligence. Detterman viewed general intelligence as a set of independent cognitive abilities that function as a complex system. Because system parts (e.g., broad or narrow abilities) are interrelated, a deficit in any part will likely affect the functioning of the entire system (i.e., general intelligence). However, not all parts are equally important to overall system functioning. The degree to which an impaired cognitive ability lowers the functioning of the whole system depends on the affected ability's *centrality,* or its relative importance to overall system functioning. To explain general intelligence from a systems perspective, Detterman provided several analogies to other complex systems. For instance, an automobile is a complex system that is made up of several parts (e.g., fuel and exhaust systems) that function as a whole. Each part can be evaluated independently, and the automobile as a whole can be given a global rating in relation to other automobiles. Like specific cognitive abilities, not all automobile parts are weighted equally in an overall rating. Whereas a fuel system is highly central to the automobile's functioning, parts such as the radio or the air conditioner are not and, therefore, have lower centrality. The centrality of specific cognitive abilities may be reflected in the Carroll three-stratum theory by the strength of the relations between the factor at the broad ability level (or Stratum II) and the factor representing general intelligence (i.e., the broad ability factor's *g* loading). In summary, these prominent theories inform those involved in the identification and treatment of individuals with mental retardation that specific cognitive abilities may be important to consider and that some specific cognitive abilities may be more important than others.

Since the inception of multiscore intelligence test batteries (Wechsler, 1939), it has been common for test users to interpret part scores when assessing children and adults with learning difficulties or neuropsychological deficits, and numerous textbooks have been written about these interpretations (e.g., Kaufman, 1994; Kaufman & Lichtenberger, 2002). *Part scores*, which are more specific than the IQs representing global cognitive functioning, include subtest scores, composite scores mirroring the factor structure of the test battery, and more general composite scores reflecting response modalities. For example, the newest version of the Wechsler Adult Intelligence Scale, Third Edition (Wechsler, 1997) provides scores for 14 subtests and four factor indexes as well as the Verbal IQ and the Performance IQ. The newest version of the Wechsler Intelligence Scale for Children, Fourth Edition (Wechsler, 2003) also includes scores for 14 subtests and four factor indexes.

Researchers and theorists focused on cognitive abilities, such as those described above, indicate that important information about an individual's cognitive abilities may be overlooked if the focus is on only a single score, an IQ. Based on this reasoning, test developers and publishers have drawn increasingly on various theories of cognitive abilities. During the past decade, many have focused on the amalgam of the extended Gf-Gc theory and Carroll's three-stratum theory, called the Cattell–Horn–Carroll (CHC) theory, to guide the revisions of several prominent tests batteries (see Alfonso, Flanagan, & Radwan, 2005). These batteries include the Woodcock-Johnson III Tests of Cognitive Abilities (Woodcock et al., 2001), the Stanford-Binet Intelligence Scale, Fifth Edition (Roid, 2003), and the Kaufman Assessment Battery for Children, Second Edition (Kaufman & Kaufman, 2004). The publication of these theory-based test batteries has provided the means to operationalize a number of broad abilities and numerous narrow abilities via part scores at the composite level. Thus, composites stemming from more than one subtest are the focus of interpretation. The focus on theory-based part scores at the composite level overcomes many of the limitations of interpreting atheoretical subtest scores with low reliability as representing specific cognitive abilities (Flanagan & Kaufman, 2004; Flanagan, McGrew, & Ortiz, 2000; Watkins, Glutting, & Youngstrom, 2005).

Only recently have guidelines for the assessment and diagnosis of mental retardation placed greater emphasis on composite part scores. For example, the Social Security Administration (SSA) released new guidelines in 2002 for disability determination for mental retardation that allow certain part scores to be used in place of the IQ in the diagnosis of mental retardation when there is reason to doubt the validity of the IQ (National Research Council, 2002). Moreover, states are increasingly calling on multidisciplinary teams to consider part scores in determining eligibility for special education services for mental retardation under the Individuals With Disabilities Education Act—IDEA (2004). In fact, some states require a child to exhibit normative deficiencies in part scores rather than IQs to satisfy the intellectual deficit criterion for mental retardation.

Improving the understanding of the patterns of performance of individuals with mental retardation across a variety of reliable part scores based on theories describing the structure and relations between cognitive abilities is important for a number of reasons. First, psychologists and other practitioners may be called to examine, in addition to IQs, collections of part scores from individuals with or suspected of having mental retardation. Second, examining these patterns of performance appears to represent the most advanced and sensitive method for gauging the cognitive abilities of individuals. Third, use of part scores may be beneficial for instructional or vocational applications. Thus, consistent with Detterman's systems theory, well-constructed profiles of part scores may provide insight into the functioning of the system parts and their contributions to global system functioning in a manner that is beneficial to the individual being assessed.

According to Cronbach and Gleser (1953), profiles provide three types of information: elevation, scatter, and shape. *Profile elevation* or *level* is defined as the mean of all part scores in the profile. For most intelligence test batteries, profile elevation is reflected in the IQ, which represents global system functioning. *Profile scatter* refers to how widely part scores vary around the profile's mean. Indices of profile scatter include the *SD* and range of part scores in the profile and the degree of deviation of each part score from the overall profile mean. *Profile shape* reflects where the high and low points in the profile occur, and it can be defined by the rank order of part scores within the profile. In a notable body of research with individuals who have mental retardation, investigators have examined the elevation, scatter, and shape of the profiles of cognitive ability measures. These measures have included both published, norm-based measures, such as those from intelligence test batteries, as well as those stemming from experimental cognitive ability tasks developed by researchers.

Elevation. By definition, groups of individuals with mental retardation display profiles with lower elevation (reflecting lower levels of global cognitive functioning) when compared to their same-age peers. Moreover, because there is ample evidence of positive intercorrelations among all types of cognitive ability measures (Jensen, 1998) and because these intercorrelations tend to be higher for mental retardation groups than for other groups (Detterman & Daniel, 1989), it is logical that those with mental retardation would also exhibit lower performance compared to their same-age peers across a number of published and experimental individual cognitive ability measures. Such findings have been consistently demonstrated (e.g., Detterman, 1979, 1987; Detterman et al., 1992; Fletcher, Scott, Deuel, & Jean-Francois, 1999).

Scatter. Because a sizeable portion of the variance in part scores can be attributed to global cognitive functioning, it is also logical that those with mental retardation would display a rather "flat" cognitive profile with consistently low scores and little variation or scatter in performance across part scores. As such, flat part score profiles of both subtest and composite scores from intelligence test batteries have consistently been found in studies of those with mental retardation (e.g., Kaufman & Kaufman, 2004; Roid, 2003; Wechsler, 1991, 2003). Moreover, because the *SD*s around these part scores tend to be smaller for individuals with mental retardation as compared to their same-age peers (Spitz, 1988), it is often assumed that within-group variation across these scores is minimal. However, studies that have included some index of profile variation for individual cases suggest that subtest and composite score scatter is common in all groups of children, including those with mental retardation (Bolen, 1998; Slate, 1995). Although researchers using intelligence test batteries generally report minimal part score variation for mental retardation groups, investigators using experimental measures of cognitive abilities has demonstrated significant variability across measures in group performance of those with mental retardation (Baroody, 1996; Detterman et al., 1992; Joseph & McCachran, 2003; Mervis et al., 2000).

Shape. Most cognitive profile research of those with mental retardation and other disabilities has focused on examining profile shape, or areas of cognitive strengths and weaknesses, because the findings from this research are believed to have the most notable implications for intervention development. In general, researchers examining the profile shape from intelligence test batteries have found that those with mental retardation score lowest on subtests with the highest *g* loadings and that they tend to perform better on subtests with lower *g* loadings (Spitz, 1988). These findings appear consistent across various etiological groups of children with mental retardation. Despite this trend of performance based on *g* loadings, most studies of profile shape reported mean age-based subtest scores that were in the low range across subtests. Thus, although relative strengths and weaknesses across subtests were present, the children with mental retardation still exhibited normative weaknesses on all measures. Because previous researchers have consistently found normative weaknesses across all part scores for groups of individuals with mental retardation, many have argued that part scores from intelligence test batteries yield little information beyond that provided by an IQ (Jensen, 1998; Kubiszyn et al., 2000; Neisser et al., 1996; Watkins, 2003). Other researchers have provided empirical support for this hypothesis (Mueller, Dash, Matheson, & Short, 1984; Mueller, Matheson, & Short, 1983). However, similar to the discrepancy between findings of profile scatter for groups and for individuals with mental retardation, researchers who have included some index of individual case performance have found that many children with mental retardation obtain one or more subtest scores within the normative average range (Bolen, 1998; Scott, Kell, & Salisbury, 1970). Moreover, several researchers have identified typical patterns of group performance for individuals with certain genetic syndromes associated with mental retardation (e.g., Down syndrome and Williams syndrome), but other researchers have highlighted the complexities of these "typical" profiles, such as divergent patterns of performance demonstrated by individuals and that a single cognitive profile should not be assumed for these groups (Jarrold, Baddeley, & Hewes, 1999; Porter & Coltheart, 2005; Purser & Jarrold, 2005; Vallar & Papagno, 1993).

Although consistently low part scores are generally reported in studies of mental retardation group performance, there is some evidence to suggest that this may not be the case for all subgroups. Two lines of cognitive profile research have fueled interest in investigating whether there may be more to the cognitive profiles of those with mental retardation than consistent normative weaknesses across all cognitive abilities. First, several researchers have investigated whether "intact" or "unimpaired" abilities constitute part of an overall phenotype for certain genetic disorders, namely, Williams syndrome. In addition to relative strengths, many researchers have reported mean age-based scores at or near the average range for those with Williams syndrome on measures of language abilities and memory abilities, despite IQs indicating normative deficits in global cognitive functioning (Klein & Mervis, 1999; Mervis et al., 2000). In the second line of profile shape research, investigators have focused on the characteristics of individuals whom Down (1887) called "idiot savants," or individuals who exhibit a remarkable skill (e.g., calendrical counting or musical performance) that is far more advanced than even their same-age peers, despite notable limitations in cognitive and adaptive functioning. Results from studies in which the cognitive characteristics of such individuals were examined suggest that savant skills may occur at all IQ levels and that many individuals with such skills also exhibit normatively average to superior performance on one or more related subtests from intelligence test batteries despite normative deficiencies in overall IQs (Bolte & Poustka, 2004; Miller, 1989; O'Connor & Hermelin, 1988). Nonetheless, several researchers have noted that savant skills tend to be highly specialized and may not contribute in a tangible way to adaptive functioning (Nettelbeck, 1999; Nettelbeck & Young, 1996).

Limitations of previous research. Although previous studies provide some information about the expectations for the cognitive ability profiles of those with mental retardation, there are several notable limitations to this body of research. First, most of these researchers failed to consider the contributions of both general intelligence and more specific cognitive abilities, and thus, they neglected one or more aspects of the functioning of the system. For instance, in many of the aforementioned studies, researchers focused on performance on certain cognitive ability measures (e.g., language abilities) and, thus, did not tap into the full range of specific abilities as specified in recent research and theories. Consequently, little is known about the contribution of some system parts to the workings of the overall system. Although researchers who examined intelligence test battery profiles can provide information about overall system functioning, their results concerning system parts are questionable because of the limited reliability of single subtests used as measures in the profiles (Watkins et al., 2005). In other studies, researchers devised experimental cognitive ability tasks that they used in the analyses. Although these tasks may provide insight into different domains of cognitive abilities than those typically measured with intelligence test batteries, most of these tasks lack the reliability and validity evidence needed to draw strong conclusions (American Educational Research Association, 1999). Because cognitive ability tasks devised by researchers are experimental in nature, they are not widely available to practitioners involved in assessment of individuals with or expected to have mental retardation, and they do not draw on large norming samples needed to compare an individual's performance to that of his or her same-age peers.

Another limitation of existing research involves the composition of the samples of individuals with mental retardation. Although there has been much interest in the cognitive ability profiles of children with mental retardation from organic etiologies, there have been far fewer studies examining the cognitive profiles of children with mild mental retardation whose cognitive limitations cannot be attributed to a specific biological cause (e.g., Down syndrome or birth trauma). Finally, most investigators have focused on the performance of groups of individuals with mental retardation across various cognitive ability measures without sufficient attention to the cognitive abilities of individuals within those groups (Bergman & Magnusson, 1997; Cairns, Bergman, & Kagan, 1998). Results from studies in which researchers included some index of individual performance suggest that the notion of a consistently low profile of cognitive ability scores may hold true for groups of people with mental retardation but not for individuals with mental retardation, per se. As such, Baumeister (1997) noted that, despite empirical findings that individuals with mental retardation exhibit significant within- and between-group variation in performance on cognitive ability measures, there has been an enduring presumption of homogeneity among those with mental retardation. According to Baumeister, this presumption has restricted investigations of individual performance.

In the present study we sought to investigate the cognitive ability profiles of children with mental retardation. In order to address limitations of previous research, we included measures of global cognitive functioning and measures of more specific cognitive abilities described by CHC theory. Thus, we included a full range of abilities as specified in recent research and theories to reveal information about the contribution of some system parts to the workings of the overall system. The cognitive ability profiles include reliable and well-validated part scores in the form of composites that stem from two individual subtests. These part scores were yielded by a published intelligence test battery that is available to practitioners involved in the assessment of individuals with or presumed to have mental retardation, and this test battery produces norm-based standardized scores. The children with mental retardation included in this study were selected only after careful screening to rule out biological and syndromal etiologies as well as sensory or motor deficits and linguistic differences that would likely unduly affect performance on cognitive ability tasks. Finally, we considered the part score profiles of children with mental retardation at both the group and the individual levels. In addition, we compared the profiles of this group to a matched sample of average-achieving children.

Specifically, we investigated the following questions: (a) What is the typical pattern of performance of children with mental retardation on measures of a full range of specific cognitive abilities? (b) Does the group profile of children with mental retardation differ in level, scatter, or shape from the group profile of average-achieving children? (c) Is there a relationship between the *g* loading of part scores and the group- and individual-level performance of those with mental retardation? (d) Are individual children with mental retardation and their average-achieving counterparts adequately represented by their respective group's profile?

Method

Participants

Children with mental retardation were drawn from the population of children attending local urban and suburban school districts and receiving special education services. Specific selection criteria were (a) a psychoeducational assessment conducted within the past 5 years indicated that they met the diagnostic criteria for mental retardation, (b) manifested deficits in global cognitive ability with composite IQs between 40 and 70, (c) manifested deficits in adaptive behavior skills, and (d) cognitive and adaptive behavior deficits that could not be attributed to a medical or neurological condition (e.g., Down syndrome). The sample included 30 children (17 boys, 13 girls) between the ages of 8 and 18 years (M = 11.4, SD = 2.7). Children's mean IQ from previous assessments was 58.5 (SD = 7.3, range = 42 to 70). Only 3 children had IQs below 50. For 28 children, the adaptive behavior deficit criterion was met using an adaptive behavior test composite of 70 or less. The criterion for the remaining 2 children was met by identifying normative deficits in two or more adaptive skill areas. Across all children, the mean adaptive behavior test composite was 61.9. Approximately 80% of the sample were Black (n = 24) and approximately 20% were White (n = 6). Using parent education level as an index of socioeconomic status (SES), we found that 33% did not complete high school (n = 10), 50% graduated from high school (n = 15), and 17% either attended college or obtained a college degree (n = 5). English was the primary language of all participants.

In order to compose a normative comparison group while maintaining independence of selection variables and dependent variables, we matched each child with mental retardation with an average-achieving counterpart based on results from the Woodcock-Johnson III—WJ III (Woodcock et al., 2001) standardization sample based on chronological age (within 6 months), gender, SES, and race. There were 5 children for whom an exact match could not be found on all four variables; thus, these children were matched on all variables except for race. Average achievement was determined based on a Total Achievement composite score from the WJ III Tests of Achievement within one SD of the normative mean (i.e., between 85 and 115). The Total Achievement composite score stems from performance on nine tests and represents one's overall performance across the reading, mathematics, and written language achievement domains, and it has a median reliability of .97 across ages 8 to 18.

Measures and Procedure

The WJ III Tests of Cognitive Abilities (Woodcock et al., 2001) was developed based on the CHC theory of cognitive abilities. Seven of the broad abilities specified in CHC theory were operationalized: Comprehension–Knowledge, Long-Term Retrieval, Visual–Spatial Thinking, Auditory Processing, Fluid Reasoning, Processing Speed, and Short-Term Memory. A description of the CHC factor clusters, their median level of reliability, and their *g* loadings appears in Table 1. A network of validity evidence supports the use and interpretation of these clusters. Evidence based on test content, response processes, internal relations, and external relations is apparent (see Floyd, Shaver, & McGrew, 2003; McGrew & Woodcock, 2001). As evident in Table 1, all median reliability coefficients were greater than .85. Only the Visual–Spatial Thinking cluster had a median reliability coefficient of less than .80. Review of the cluster *g* loadings indicates notable variation. For example, using standards typically applied to individual measures (i.e., subtest scores), Comprehension–Knowledge and Fluid Reasoning demonstrated high *g* loadings (.70 and above). Long-Term Retrieval demonstrated a *g* loading in the medium range but near the high range (.69). Auditory Processing, Short-Term Memory, and Processing Speed demonstrated *g*

Table 1. Descriptions and Psychometric Properties of Cattell-Horn-Carroll (CHC) Factor Clusters

CHC factor cluster	Cluster description	Woodcock-Johnson III tests of cognitive abilities	Reliability[a]	*g* loading[b]
Comprehension–Knowledge	Comprehensiveness of acquired knowledge, ability to verbally communicate, and ability to reason by drawing upon previous experiences	Verbal Comprehension General Information	.94	.76
Long-Term Retrieval	Ability to encode, store, and retrieve information for later use	Visual-Auditory Learning Retrieval Fluency	.87	.69
Visual–Spatial Thinking	Ability to perceive, analyze, and synthesize visually presented information and patterns; ability to store and recall visual information	Spatial Relations Picture Recognition	.79	.46
Auditory Processing	Ability to analyze, discriminate, and integrate auditory stimuli	Sound Blending Auditory Attention	.89	.61
Fluid Reasoning	Ability to reason abstractly, form concepts, and solve problems in unfamiliar contexts	Concept Formation Analysis-Synthesis	.95	.78
Processing Speed	Ability to rapidly and efficiently perform simple tasks	Visual Matching Decision Speed	.92	.53
Short-Term Memory	Ability to hold information in immediate awareness and then use it within a few seconds	Numbers Reversed Memory for Words	.87	.60

Note. Descriptions adapted from Mather and Woodcock (2001).
[a]Median reliability estimates are reported for the 6- to 18-year-old age range. According to McGrew and Woodcock (2001), Rasch analysis was used to calculate the reliability of speeded tests (i.e., Visual Matching, Retrieval Fluency, and Decision Speed in this study) and tests that contain multiple-point scored items (i.e., Spatial Relations, Retrieval Fluency, and Picture Recognition in this study). Split-half procedures were used for the remaining tests. Cluster reliabilities were calculated based on the obtained reliability of their component tests. [b]CHC factor cluster *g* loadings were derived from principal axis factoring for the 9- to 13-year-old age range of the WJ III norming sample (Barry & Floyd, 2005).

loadings considered medium, and Visual–Spatial Thinking demonstrated a *g* loading considered low (McGrew & Flanagan, 1998; cf. Kaufman, 1994).

The WJ III Tests of Cognitive Abilities also yields a measure of global cognitive functioning, the General Intellectual Ability–Extended composite that stems from the differential weighting of performance on the 14 tests that contribute to the CHC factor clusters. The median reliability coefficient across ages 8 to 18 is .97. Like the CHC factor clusters, a large body of validity evidence supports its use and interpretation (see Floyd et al., 2003; McGrew & Woodcock, 2001).

Three trained examiners, including both authors, administered 14 tests from the WJ III Tests of Cognitive Abilities according to standardized procedures. All examiners completed coursework and related practica focusing on administration, scoring, and interpretation of such assessment instruments. Children were tested at their home school during regular school hours. Data for the normative comparison group were obtained from data collected during the norming process of the WJ III.

Results

Table 2 presents means, *SD*s, and ranges for the CHC factor clusters as well as the General Intellectual Ability–Extended for the group of children with mental retardation and the average-achieving matches. Data-screening procedures were conducted prior to computing the profile analysis, and assumptions regarding multivariate normality, absence of outliers, linearity, and homogeneity of variance–covariance matrices were met (Tabachnick & Fidell, 2001).

Group-Level Profile Analysis

In general, there was an inverse relationship between the ranked performance of the children with mental retardation on the CHC factor clusters and the factor clusters' *g* loadings, indicating that the children with mental retardation scored lowest on CHC factor clusters that are better measures of global cognitive functioning. Spearman rank-order correlation coefficients revealed that the correlation between the rank ordering of the composite scores means and the rank order of the *g* loadings presented in Table 1 was negative and strong, r = -.75, p = .052, two-tailed test. Thus, children with mental retardation as a group tended to score lower on high *g* loading composites and score higher on low *g* loading composites. In order to investigate possible differences in performance across age levels on the CHC factor clusters, we examined performance across three age groups. Although small sample sizes precluded the use of inferential statistics, results from nonparametric analyses indicated no significant differences across age levels for any of the CHC factor clusters.

In order to compare the group profiles of the children with mental retardation and the average-achieving matches, we computed a repeated-measures analysis of variance using a general linear model procedure to determine (a) whether the children with mental retardation scored significantly lower than did the average-achieving matches on the CHC factor clusters as a set (i.e., levels test), (b) if the pattern of highs and lows across the CHC factor clusters was similar for groups (i.e., parallelism test), and (c) if the combined groups' scores were notably higher or lower on any of the CHC factor clusters (i.e., flatness test). As expected, the children with mental retardation scored significantly below the average-achieving matches on the CHC factor clusters as a set, $F(1, 58) = 280.46$, $p < .001$, partial $\eta^2 = .83$. A one-way ANOVA comparing composite scores between the groups indicated that the children with mental retardation scored significantly below the average-achieving matches on each CHC factor cluster. When averaged across groups, the factor clusters deviated significantly from flatness, $F(6, 53) = 7.80$, $p < .001$, partial $\eta^2 = .47$, indicating the presence of significant

Table 2. Means, *SD*s, and Ranges for Cattell-Horn-Carroll (CHC) Factor Clusters and the General Intellectual Ability-Extended by group

	Children with mental retardation (n = 30)			Matches (n = 30)		
Measure	Mean	*SD*	Range	Mean	*SD*	Range
Comprehension–Knowledge	62.17	11.93	38–83	98.87	11.30	77–121
Long-Term Retrieval	59.10	13.19	32–84	106.97	13.90	89–138
Visual–Spatial Thinking	79.60	11.35	51–97	102.87	11.68	88–136
Auditory Processing	77.47	11.69	50–93	97.63	10.15	79–114
Fluid Reasoning	63.17	9.40	46–82	100.23	10.26	80–123
Processing Speed	63.87	14.88	37–100	105.50	11.46	90–131
Short-Term Memory	66.17	17.43	20–86	100.23	10.17	78–117
GIA[a]-Extended	54.80	12.45	28–77	100.87	8.25	81–113

[a]General Intellectual Ability.

profile scatter. When the cognitive profiles of the groups were compared, the test for parallelism was significant, indicating that the children with mental retardation and the average-achieving matches exhibited different patterns of highs and lows on the factor clusters, $F(6, 53) = 12.44$, $p < .001$, partial $\eta^2 = .58$. In order to determine possible strengths, weaknesses, or both within each group, we performed a priori contrasts to compare each factor cluster to the mean of all scores combined. Within the group of average-achieving matches, no significant differences were found, but the children with mental retardation demonstrated significant relative strengths on the Visual–Spatial Thinking and Auditory Processing clusters, $Fs(1, 29) = 101.05$ and 32.25, respectively, $ps < .001$, and significant relative weaknesses on the Comprehension–Knowledge and Long-Term Retrieval clusters, $Fs(1, 29) = 12.63$ and 36.70, respectively, $ps = .001$.

Individual-Level Profile Analysis

At the level of the individual, the cognitive profiles of the children with mental retardation and the average-achieving matches were compared (a) on scatter indexes to determine the amount of variation individual children exhibited across specific cognitive ability measures and (b) on an index of pattern similarity to determine the extent to which individual profiles matched the profile of their respective group.

As indexes of scatter, mean *SD*s calculated for each child on the seven CHC factor clusters were shown to be similar for the children with mental retardation and their average-achieving matches (*M*s = 12.0 and 10.4, respectively). However, the children with mental retardation exhibited significantly larger intra-individual score ranges than did the average-achieving matches (*M*s = 33.2 and 28.7, respectively), $t(58) = 2.08$, $p = .042$. To obtain an index of within-individual cluster variation (i.e., relative strengths and weaknesses), we subtracted each CHC factor cluster score from the individual's mean of all scores (Kaufman, 1994). A score that deviated by one *SD* or more (i.e., ± 15 standard score points or more) from the individual's profile mean was considered significant. Across both groups, many of the children had one or more factor cluster scores that deviated significantly from their profile mean. Approximately 80% ($n = 24$) of the children with mental retardation displayed a significant strength, a significant weakness, or both on at least one factor cluster, whereas 57% ($n = 17$) of the average-achieving matches demonstrated such variability. A chi-square analysis indicated that this difference was not significant. The relative strengths and weaknesses of the children with mental retardation are noted in Table 3. Within the group of children with mental retardation, relative strengths occurred mostly on the Auditory Processing and Visual–Spatial Thinking clusters, and relative weaknesses occurred most frequently on the Long-Term Retrieval cluster. Within the group of average-achieving matches, consistent relative strengths were observed on the Long-Term Retrieval cluster, but there was no discernable pattern of relative weaknesses within this group.

In order to quantify the degree of similarity between individual children's profiles and their respective group's profile, we computed $r_p(k)$ similarity coefficients for correlated variables for each individual (Cattell, 1949; Tatsuoka, 1974; Tatsuoka & Lohnes, 1988). The $r_p(k)$ values are analogous to a correlation coefficient and range from -1 (*complete dissimilarity*) to 1 (*complete similarity*), and values near 0 indicate chance similarity. The $r_p(k)$ values reflect the degree of similarity in terms of shape and level of an individual's profile to that of the group-level profile. Although there is no absolute significance criterion, we used a $r_p(k)$ value of .38 or above to indicate reasonable similarity to the group profile. The probability of obtaining this value by chance is about 10% (Cattell, Coulter, & Tsujioka, 1966), and a similar criterion has been used by other researchers (e.g., Glutting, McGrath, Kamphaus, & McDermott, 1992; Robinson & Harrison, 2005; Watkins & Kush, 1994). Only 3 children with mental retardation and 4 average-achieving matches exhibited cognitive profiles similar to their respective group-level profile. Even when using the more liberal .20 criterion recommended by Cattell et al. (1966) for applied practice, we found that only 6 children in each group exhibited profiles that could be considered similar to their respective group profile. In fact, approximately half of the children in each group had negative $r_p(k)$ values, indicating dissimilar patterns of performance from that of their group.

The normative classifications (e.g., average, low average, low, very low) of scores for each child with mental retardation were also examined to determine the extent to which individual children exhibited one or more "nonimpaired" abilities on the CHC factor clusters. To put children's per-

Table 3. Normative Ranges for the Cattell-Horn-Carroll (CHC) Factor Cluster Scores and the General Intellectual Ability-Extended Scores for Individual Children With Mental Retardation

Case no.	Gc	Glr	Gv	Ga	Gf	Gs	Gsm	GIA[a]-Ext
1	L	L	A	A	L	A	LA	L
2	VL	VL−	LA+	L	VL	VL	L	VL
3	L	L	A	LA	LA	L	L	L
4	VL	VL	L	LA+	VL	VL−	VL	VL
5	VL−	VL−	VL	VL	VL	VL	VL	VL
6	VL	VL	L	LA	L	VL−	LA−	VL
7	VL−	VL	LA+	L	VL	L	LA	VL
8	VL+	VL	VL	LA+	VL	VL−	VL	VL
9	LA	L	LA	LA	L	VL	L	L
10	VL−	VL	LA	A+	VL	L	L	VL
11	L	VL	A+	VL	VL−	L	VL−	VL
12	VL	VL	LA	LA+	L	VL	VL	VL
13	VL	VL	L	VL	VL	L	VL	VL
14	VL	L	A+	VL	L	VL	VL	VL
15	VL	VL	VL	VL+	VL	VL	VL	VL
16	VL	VL	LA+	A+	VL−	VL	L	VL
17	VL	VL	L	A+	VL	VL	LA	VL
18	VL	VL−	LA	L	L	VL	VL	VL
19	VL	VL	L	L	VL	VL	VL	VL
20	VL	VL	L+	VL	VL	VL	VL	VL
21	VL	VL	VL	LA+	VL	VL	L	VL
22	VL	VL−	LA	A+	VL	L	LA	VL
23	LA	LA	A+	L	L	VL	L	L
24	VL	VL	LA+	VL	VL	VL−	LA	VL
25	VL	VL	LA	L	VL	A+	VL	VL
26	LA	LA	LA	LA	VL	L	LA	L
27	VL	VL	LA	A+	VL	VL	L	VL
28	L	VL−	LA	LA	VL	L	LA	VL
29	VL	VL	VL	VL+	VL	VL	VL−	VL
30	VL	VL−	L+	VL+	VL	VL	VL	VL

Note. Gc = Comprehension–Knowledge; Glr = Long-Term Retrieval; Gv = Visual–Spatial Thinking; Ga = Auditory Processing; Gf = Fluid Reasoning; Gs = Processing Speed; Gsm = short-term memory; A = average; LA = low average; L = low; VL = very low. + Denotes within-individual strength. − Denotes within-individual weakness.
[a]General Intellectual Ability–Extended.

formance across the CHC factor clusters in perspective, we also examined the General Intellectual Ability–Extended obtained by each child. Table 3 presents the normative classifications of the CHC factor cluster scores and the General Intellectual Ability–Extended in the cognitive profiles of the 30 children with mental retardation. Although the group means on all seven factor clusters for the children with mental retardation were within the normative low to very low range, there was considerable variation in scores for each cluster. Across individual children, 11 of the 30 children (36.6%) obtained at least one factor cluster score within the average range (i.e., standard score ≥ 90), 18 children (60%) obtained at least one factor cluster score that was within one *SD* of the population mean (i.e., standard score ≥ 85), and 23 children (76.6%) obtained at least one factor cluster score that was not within the low range (i.e., standard score ≥ 80). Thus, although the children demonstrated global cognitive functioning within the low range, over one third of these children exhibited at least one broad cognitive ability that was within the average range, and most displayed at least one broad cognitive ability not within the low range. Many children obtained several broad cognitive ability scores within the average or low average range. As evident in Table 3, average and low average scores were mostly obtained on the Visual–Spatial Thinking and Auditory Processing clusters. Nonetheless, despite unimpaired performance on some of the CHC factor clusters, all of the children with mental retardation obtained a General Intellectual Ability–Extended within the low or very low range. As evident in Tables 2 and 3, the mean General Intellectual Ability–Extended was 54.8, and no child obtained a General Intellectual Ability–Extended score over 77.

Discussion

Because groups of individuals with mental retardation are usually found to obtain consistently low part scores across cognitive ability measures, some may presume that individual children with mental retardation will also obtain low scores with minimal variation in performance. In light of this presumption, we sought to investigate the group and individual performance of children with mental retardation using well-validated measures of specific cognitive abilities.

As a group, the ranked performance on the CHC factor clusters of the children with mental retardation was broadly consistent with the clusters' *g* loadings. This finding is consistent with results of previous researchers who examined the ranked subtest performance of groups of children with mental retardation on intelligence test batteries (Spitz, 1988). When compared to the average-achieving matches as a group, the children with mental retardation scored lower on the seven CHC factor clusters as a set and on each factor cluster. However, the groups displayed different patterns of highs and lows across part scores representing broad cognitive abilities.

The group-level performance of the children with mental retardation yielded relative strengths on the Visual–Spatial Thinking and Auditory Processing clusters and relative weaknesses on the Comprehension–Knowledge and Long-Term Retrieval clusters. Results of previous research suggest that children with Down syndrome demonstrate relative strengths in visual-processing abilities and weaknesses in language and memory abilities, whereas children with Williams syndrome typically demonstrate strengths in language and memory abilities and marked weaknesses in motor skills and visual-processing abilities (Carlesimo, Marotta, & Vicari, 1997; Jarrold et al., 1999; Purser & Jarrold, 2005; Wang, Doherty, Rourke, & Bellugi, 1995). However, the *g* loadings of most of the measures used in this research are not known.

Consistent with previous studies of individual variability in performance, our analyses revealed that between-cluster scatter was common for individual children in both groups and that only a handful of children demonstrated cognitive profiles that were reasonably similar to their respective group profile. Notably, individual children with mental retardation demonstrated a rather wide range of performance across the CHC broad abilities, even though their IQs were within the low to very low range.

The individual cognitive profiles of the children with mental retardation appear to support Detterman's (1987, 1999) hypothesis that this disorder arises from one or more impaired cognitive abilities with high centrality that lower the functioning of the whole system. In the present study, all children with mental retardation exhibited impairments on at least one of the two CHC factor clusters with the highest *g* loadings (i.e., the Comprehension–Knowledge and Fluid Reasoning clusters), and many children exhibited impairments on both. Using *g* loadings to indicate centrality, we found that these findings are consistent with the importance or centrality of these abilities to the functioning of the system. Likewise, the children with mental retardation were most likely to score in the average or low average range on the Visual–Spatial Thinking and Auditory Processing clusters, which have low and moderate *g* loadings, respectively, at this age level and, thus, may be considered less central. Our results suggest that low global cognitive functioning does not necessarily imply a general impairment across all cognitive abilities and that impaired abilities are not necessarily consistent across individuals with mental retardation. Thus, children with similar IQs may have very different profiles of strengths and weaknesses across part scores. However, it must also be recognized that some children in the mental retardation group scored in the average or low average range on either the Comprehension–Knowledge or Fluid Reasoning cluster. Because more than 4 out of 5 children in this group demonstrated global cognitive functioning within the very low range, it is important for practitioners to remember that an average or low average part score does not necessarily mean that the overall system or other cognitive abilities in the system are functioning adequately when compared to age mates.

Although both the group and individual profiles of the children with mental retardation behaved in ways that were generally consistent with the CHC factor cluster *g* loadings, there were several notable differences between the group profile and the profiles of individual children in this group. First, all seven part scores fell in the low to very low range for the group profile, but over one third of the individual children in this group exhibited one or more part scores that fell within the average range, and many exhibited at least one part score that was not within the low range. Moreover, only 3 of the 30 children with mental retardation demonstrated cognitive profiles that could be considered reasonably similar to the group profile, whereas over half of the children exhibited dissimilar cognitive profiles.

Limitations

Although the findings from this study provide insight into both group-level and individual-level performance across cognitive ability measures, these results are limited in several ways. First, although the sample size is comparable or higher than that of many other studies in which researchers examined the cognitive abilities of children with mental retardation (e.g., Bolte & Poustka, 2004; Klein & Mervis, 1999), our sample included only 30 children with mental retardation. There is no doubt that our stringent selection criteria, which included selecting only children whose mental retardation could not be traced to a biological or syndromal etiology, led to a smaller sample size than if no etiological subtype had been sought. Furthermore, increasing the IQ cutoff for eligibility to 75 would also have doubled the number of possible participants (National Research Council, 2002). Additional research is needed with larger and more diverse samples in order to evaluate our findings. Second, as a result of our selection criteria for children with mental retardation, the results may not be applicable to those whose mental retardation can be attributed to organic causes. Finally, although the results indicating that many children with mental retardation have "intact" or "unimpaired" cognitive abilities when compared to their age mates, additional research is needed to determine what, if any, instructional and vocational implications these findings have for children with mental retardation.

Implications for Practice

Results of this study provide several implications for psychologists and other professionals called to examine the cognitive abilities of children with low IQs during diagnosis or eligibility determination for mental retardation following guidelines from the SSA (National Research Council, 2002) and several state criteria under IDEA (Individuals, 2004). Rather than conceptualizing mental retardation as a generalized cognitive impairment due to a deficit in "intelligence," evaluators' interpretation of measures of general and specific cognitive abilities can be considered from a systems perspective.

Results from this study suggest that some existing assumptions about the profiles of individuals with mental retardation should be altered. First, individual children with mental retardation will not likely display a flat cognitive profile on comprehensive assessments of CHC broad cognitive abilities—especially when measures vary widely in *g* loadings—regardless of the information presented in test manuals for mental retardation groups. As such, part scores in the normative average and low average range may be common. Second, practitioners should be aware that group-based *g* loadings for part scores provide only a rough set of expectations for performance. These measurement properties may indicate which cognitive measures are most sensitive to mental retardation (i.e., those with the highest *g* loadings) and which are likely to vary into higher levels of normative performance. However, practitioners should note that children with mental retardation may not necessarily display part scores that vary uniformly from the normative mean in a manner consistent with the *g* loadings and that part scores with high *g* loadings may emerge in the average or low average range. Finally, it is likely that the increasing number of specific cognitive abilities measured by intelligence test batteries and the variation of these scores in individual profiles inadvertently muddies the waters of mental retardation diagnosis. As a result, when faced with IQs in the range described in the diagnostic criteria for the disorder and part scores that are much higher, practitioners may believe that an individual cannot be diagnosed with mental retardation because of evidence of "intact" or "unimpaired" abilities. However, practitioners should consider the systems perspective, in which the interrelated specific cognitive abilities and their contribution to overall system functioning are described.

When those involved in the assessment of children suspected of having mental retardation can rule out construct-irrelevant influences that may have undermined performance during testing (e.g., sensory or motor skill deficits, linguistic and cultural differences, and noncompliance), it is likely that children who obtain low IQs from tests with strong psychometric properties meet the severe deficit in intellectual ability criterion for the diagnosis of mental retardation, regardless of the variation of the part scores in the profile. Although knowledge of children's strengths and weaknesses gleaned from part scores measuring specific cognitive abilities may inform educational interventions or curriculum adjustments, denying special education eligibility or failing to make a diagnosis of mental retardation based on significant part score variability may do these children disservice when other ecologically valid evidence of mental retardation (e.g., adaptive behavior skill deficits) indicates genuine need. We urge continued consideration of these matters by practitioners, educators, and politicians.

References

Alfonso, V. C., Flanagan, D. P., & Radwan, S. (2005). The impact of the Cattell-Horn-Carroll theory on test development and interpretation of cognitive and academic abilities. In D. P. Flanagan & P. Harrison (Eds.), *Contemporary intellectual assessment* (2nd ed., pp. 185–202). New York: Guilford Press.

American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. (1999). *Standards for educational and psychological testing.* Washington, DC: American Educational Research Association.

Baroody, A. J. (1996). Self-invented addition strategies by children with mental retardation. *American Journal on Mental Retardation, 101,* 72–89.

Barry, A., & Floyd, R. G. (2005, August). *Woodcock-Johnson III CHC factor clusters: g loadings and specificity estimates.* Poster session presented at the annual meeting of the American Psychological Association, Washington, DC.

Baumeister, A. A. (1997). Behavioral research: Boom or bust? In W. E. MacLean, Jr. (Ed.), *Ellis' handbook of mental deficiency, psychological theory and research* (3rd ed., pp. 3–45). Mahwah, NJ: Erlbaum.

Bergman, L. R., & Magnusson, D. (1997). A person-oriented approach in research on developmental psychopathology. *Development and Psychopathology, 9,* 291–319.

Bolen, L. M. (1998). WISC–III score changes for EMH students. *Psychology in the Schools, 35,* 327–332.

Bolte, S., & Poustka, F. (2004). Comparing the intelligence profiles of savant and nonsavant individuals with autistic disorder. *Intelligence, 32,* 121–131.

Brody, N. (1997). Intelligence, schooling, and society. *American Psychologist, 52,* 1046–1050.

Cairns, R. B., Bergman, L. R., & Kagan, J. (1998). Lawfulness in individual development. In R. B. Cairns, L. R. Bergman, & J. Kagan (Eds.), *Methods and models for studying the individual* (pp. 1–9). Thousand Oaks, CA: Sage.

Carlesimo, G. A., Marotta, L., & Vicari, S. (1997). Long-term memory in mental retardation: Evidence for a specific impairment in subjects with Down's syndrome. *Neuropsychologia, 35,* 71–79.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor analytic studies.* New York: Cambridge University.

Carroll, J. B. (1997). The three-stratum theory of cognitive abilities. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 122–130). New York: Guilford.

Carroll, J. B. (2003). The higher stratum structure of cognitive abilities: Current evidence supports *g* and about ten broad factors. In H. Nyborg (Ed.), *The scientific study of general intelligence: Tribute to Arthur R. Jensen* (pp. 5–21). New York: Pergamon.

Cattell, R. B. (1949). r_p and other coefficients of pattern similarity. *Psychometrika, 14,* 279–298.

Cattell, R. B., Coulter, M. A., & Tsujioka, B. (1966). The taxonometric recognition of types and functional emergents. In R. B. Cattell (Ed.), *Handbook of multivariate experimental psychology* (pp. 288–329). Chicago: Rand McNally.

Cronbach, L. J., & Gleser, G. C. (1953). Assessing similarity between profiles. *Psychological Bulletin, 50,* 456–473.

Detterman, D. K. (1979). Memory in the mentally retarded. In N. R. Ellis (Ed.), *Handbook of men-*

tal deficiency (2nd ed., pp. 727–760). Hillsdale, NJ: Erlbaum.

Detterman, D. K. (1987). Theoretical notions of intelligence and mental retardation. *American Journal of Mental Deficiency, 92,* 2–11.

Detterman, D. K. (1999). The psychology of mental retardation. *International Review of Psychiatry, 11,* 26–33.

Detterman, D. K., & Daniel, M. H. (1989). Correlations of mental tests with each other and with cognitive variables are highest for low IQ groups. *Intelligence, 13,* 349–359.

Detterman, D. K., Mayer, J. D., Caruso, D. R., Legree, P. J., Conners, F. A., & Taylor, R. (1992). Assessment of basic cognitive abilities in relation to cognitive deficits. *American Journal on Mental Retardation, 97,* 251–286.

Down, J. L. (1887). *On some of the mental afflictions of childhood and youth.* London: Churchill.

Flanagan, D. P., & Kaufman, A. S. (2004). *Essentials of WISC-IV assessment.* New York: Wiley.

Flanagan, D. P., McGrew, K. S., & Ortiz, S. (2000). *The Wechsler intelligence scales and* GNf–Gc *theory: A contemporary approach to interpretation.* Needham Heights, MA: Allyn & Bacon.

Fletcher, K. L., Scott, M. S., Deuel, L. S., & Jean-Francois, B. (1999). A comparison of the cognitive capabilities of young children with mild mental retardation or learning disabilities. In T. E. Scruggs & M. A. Mastropieri (Eds.), *Advances in learning and behavioral disabilities* (Vol. 13, pp. 65–93). Stamford, CT: JAI.

Floyd, R. G., Shaver, R. B., & McGrew, K. S. (2003). Interpretation of the Woodcock-Johnson III Tests of Cognitive Abilities: Acting on evidence. In F. A. Schrank & D. P. Flanagan (Eds.), *WJ III clinical use and interpretation* (pp. 1–46, 403–408). New York: Academic Press.

Glutting, J. J., McGrath, E. A., Kamphaus, R. W., & McDermott, P. A. (1992). Taxonomy and validity of subtest profiles on the Kaufman Assessment Battery for Children. *Journal of Special Education, 26,* 85–115.

Horn, J. L. (1991). Measurement of intellectual capabilities: A review of theory. In K. S. McGrew, J. K. Werder, & R. W. Woodcock, *WJ–R technical manual* (pp. 197–232). Itasca, IL: Riverside.

Horn, J. L., & Blankson, N. (2005). Foundation for better understanding cognitive abilities. In D. P. Flanagan & P. Harrison (Eds.), *Contemporary intellectual assessment* (2nd ed., pp. 41–68). New York: Guilford Press.

Horn, J. L., & Noll, J. (1997). Human cognitive capabilities: *Gf-Gc* theory. In D. P. Flanagan, J. L. Genshaft, & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (pp. 53–91). New York: Guilford Press.

Individuals With Disabilities Education Act, Pub.L. 108–446 (2004).

Jarrold, C., Baddeley, A. D., & Hewes, A. K. (1999). Genetically dissociated components of working memory: Evidence from Down's and Williams syndrome. *Neuropsychologia, 37,* 637–651.

Jensen, A. R. (1998). *The g factor.* Westport, CT: Praeger.

Joseph, L. M., & McCachran, M. (2003). Comparison of a word study phonics technique between students with moderate to mild mental retardation and struggling readers without disabilities. *Education and Training in Developmental Disabilities, 38,* 192–199.

Kaufman, A. S. (1994). *Intelligent testing with the WISC–III.* New York: Wiley.

Kaufman, A. S., & Kaufman, N. L. (2004). *Kaufman Assessment Battery for Children, Second edition manual.* Circle Pines, MN: American Guidance Service.

Kaufman, A. S., & Lichtenberger, E. O. (2002). *Assessing adolescent and adult intelligence* (2nd ed.). Boston: Allyn & Bacon.

Klein, B. P., & Mervis, C. B. (1999). Contrasting patterns of cognitive abilities of 9- and 10-year-olds with Williams syndrome or Down syndrome. *Developmental Neuropsychology, 16,* 177–196.

Kubiszyn, T. W., Meyer, G. J., Finn, S. E., Eyde, L. D., Kay, G. G., Moreland, K. L., Dies, R. R., & Eisman, E. J. (2000). Empirical support for psychological assessment in clinical health care settings. *Professional Psychology: Research and Practice, 31,* 119–130.

Mather, N., & Woodcock, W. (2001). *Examiner's manual. Woodcock-Johnson III Tests of Cognitive Abilities.* Itasca, IL: Riverside.

McGrew, K. S., & Flanagan, D. P. (1998). *The intelligence test desk reference (ITDR): Gf-Gc Cross-Battery assessment.* Boston: Allyn & Bacon.

McGrew, K. S., & Woodcock, R. W. (2001). *Technical manual. Woodcock-Johnson III.* Itasca, IL: Riverside.

Mervis, C. B., Robinson, B. F., Bertrand, J., Morris, C. A., Klein-Tasman, B. P., & Armstrong,

S. C. (2000). The Williams syndrome cognitive profile. *Brain and Cognition, 44,* 604–628.

Miller, L. K. (1989). *Musical savants: Exceptional skill in the mentally retarded.* Hillside, NJ: Erlbaum.

Mueller, H. H., Dash, U. N., Matheson, D. W., & Short, R. H. (1984). WISC-R subtest patterning of below average, average, and above average IQ children: A meta-analysis. *Alberta Journal of Educational Research, 30,* 68–85.

Mueller, H. H., Matheson, D. W., & Short, R. H. (1983). Bannatyne recategorized WISC-R patterns of mentally retarded, learning disabled, normal, and intellectually superior children: A meta-analysis. *Mental Retardation and Learning Disability Bulletin, 11,* 60–78.

Neisser, U., Boodoo, G., Bouchard, T. J., Boykin, A. W., Brody, N., Ceci, S. J., Halpern, D. F., Loehlin, J. C., Perloff, R., Sternberg, R. J. et al. (1996). Intelligence: Knowns and unknowns. *American Psychologist, 51,* 77–101.

Nettelbeck, T. (1999). Savant syndrome—Rhyme without reason. In M. Anderson (Ed.), *The development of intelligence* (pp. 247–273). East Sussex, England: Psychology Press.

Nettelbeck, T., & Young, R. (1996). Intelligence and savant syndrome: Is the whole greater than the sum of the fragments? *Intelligence, 22,* 49–68.

O'Connor, N., & Hermelin, B. (1988). Low intelligence and special abilities. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 29,* 391–396.

Porter, M. A., & Coltheart, M. (2005). Cognitive heterogeneity in Williams syndrome. *Developmental Neuropsychology, 27,* 275–306.

Purser, H. R. M., & Jarrold, C. (2005). Impaired verbal short-term memory in Down syndrome reflects a capacity limitation rather than atypically rapid forgetting. *Journal of Experimental Child Psychology, 91,* 1–23.

Reschly, D. J., Myers, T. G., & Hartel, C. R. (Eds.). (2002). *Mental retardation: Determining eligibility for social security benefits.* Washington, DC: Committee on Disability Determination for Mental Retardation, Division of Behavioral and Social Sciences and Education. National Research Council, National Academy Press.

Robinson, B. R., & Harrison, P. L. (2005). WISC-III core profiles for students referred or found eligible for special education and gifted programs. *School Psychology Quarterly, 20,* 51–65.

Roid, G. H. (2003). *Stanford-Binet Intelligence Scale, Fifth Edition.* Itasca, IL: Riverside.

Scott, R., Kell, E. R., & Salisbury, D. L. (1970). Cognitive profiles of "retarded" children: A survey of inter- and intra-child differences. *Psychology in the Schools, 7,* 288–292.

Slate, J. R. (1995). Discrepancies between IQ and index scores for a clinical sample of students: Useful diagnostic indicators? *Psychology in the Schools, 12,* 103–108.

Spearman, C. (1927). *The abilities of man: Their nature and measurement.* New York: Macmillan.

Spitz, H. H. (1988). Wechsler subtest patterns of mentally retarded groups: Relationship to *g* and to estimates of heritability. *Intelligence, 12,* 279–297.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). Needham Heights, MA: Allyn & Bacon.

Tatsuoka, M. M. (1974). *Selected topics in advanced statistics: An elementary approach: III. Classification procedures: Profile similarity.* Oxford, England: Institute for Personality and Ability Testing.

Tatsuoka, M. M., & Lohnes, P. R. (1988). *Multivariate analysis: Techniques for educational and psychological research* (2nd ed.). New York: Macmillan.

Vallar, G., & Papagno, C. (1993). Preserved vocabulary acquisition in Down's syndrome: The role of phonological short-term memory. *Cortex, 29,* 467–483.

Wagner, R. K. (1997). Intelligence, training, and employment. *American Psychologist, 52,* 1059–1069.

Wang, P. P., Doherty, S., Rourke, S. B., & Bellugi, U. (1995). Unique profile of visuo-perceptual skills in a genetic syndrome. *Brain and Cognition, 29,* 54–65.

Watkins, M. W. (2003). IQ subtest analysis: Clinical acumen or clinical illusion? *Scientific Review of Mental Health Practice, 2,* 118–141.

Watkins, M. W., Glutting, J. J., & Youngstrom, E. A. (2005). Issues in subtest profile analysis. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary intellectual assessment: Theories, tests, and issues* (2nd ed., pp. 251–268). New York: Guilford Press.

Watkins, M. W., & Kush, J. C. (1994). Wechsler subtest analysis: The right way, the wrong way, or no way? *School Psychology Review, 23,* 640–651.

Wechsler, D. (1939). *The measurement of adult intelligence*. Baltimore: Williams & Wilkins.
Wechsler, D. (1991). *The Wechsler Intelligence Scale for Children-Third Edition*. San Antonio, TX: Psychological Corp.
Wechsler, D. (1997). *Wechsler Adult Intelligence Scale-Third Edition*. San Antonio, TX: Psychological Corp.
Wechsler, D. (2003). *The Wechsler Intelligence Scale for Children-Fourth Edition*. San Antonio, TX: Psychological Corp.
Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock-Johnson III Tests of Cognitive Abilities*. Itasca, IL: Riverside.

Received 7/28/05, accepted l/21/06.
Editor-in-charge: Frances Conners

Requests for reprints should be sent to Randy Floyd, Department of Psychology, 202 Psychology Building, The University of Memphis, Memphis, TN 38120. E-mail: rgfloyd@memphis.edu

