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ABSTRACT

The relationship between scores on Raven's Coloured Progressive Matrices (CPM) scores and subtest scores and IQs from the Wechsler Intelligence Scale for Children-III (WISC-III) was studied for 28 children aged 6 to 11 years. Subjects had been referred to a university assessment center because they were believed to have exceptional learning patterns (potential giftedness) or behavioral difficulties. Reading, mathematics, and written language achievement scores were also determined. Correlations indicated a moderate relationship between the Raven CPM percentiles and the WISC-III IQs and certain scaled scores. There were also significant correlations between the Woodcock Johnson Tests of Achievement-Revised and the CPM percentiles. Results also indicate that both verbal and nonverbal abil ties are assessed by Raven's CPM and that the CPM should not be assumed to be a purely nonverbal measure of intelligence. (Contains 3 tables and 25 references.) (SLD)

The WISC-III and Raven Coloured Progressive Matrices Test: A Pilot Study of Relationships

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The WISC-III and Raven Coloured Progressive Matrices Tests: A Pilot Study of Relationships

The Raven's Progressive Matrices tests have a long history of use (since 1949 for the Coloured Progressive Matrices) and an extensive body of literature exists concerning research on the tests. The Raven's Progressive Matrices tests comprise: The Raven's Advanced Progressive Matrices test (APM), the Raven's Standard Progressive test (SPM), and the Raven's Coloured Progressive Matrices test (CPM). The CPM is intended for younger children and the SPM and APM for older individuals. The psychometric characteristics of the tests are impressive (Green & Kluever, 1991, 1992).

Recently, the tests authors (Raven, Raven, & Court, 1991) described the basis for these tests as follows:

> Raven's Progressive Matrices and Vocabulary tests were developed to assess, as simply and unambiguously as possible, the two components of g identified by Spearman as eductive ability and reproductive ability. (p. G1)

They indicated that, "The Matrices measure the ability to educe relationships" (p. G3) and defined eductive ability as, "the process of educing, or squeezing, new insights and information out of that which is perceived or already known" (p. G2).

There is a lengthy history in the United States of non-verbal intelligence testing and this practice has continued to grow over the last 70 years (Kamphaus, 1993; Naglieri & Prewett, 1990). The appraisal of competence by means of human figure drawings (HFD) has been around since the 1800s and became especially popular in the 1920s with work by Florence L. Goodenough (1926). Other early non-verbal measures included manipulative or pictorial items such as Wechsler's (1939) scales, Raven's Progressive Matrices (1938), and the Porteus Maze Test (Porteus, 1959).

Wechsler's (1939) inclusion of the Performance Scale as a major portion of his intelligence test battery further acknowledged the importance of examining non-verbal intelligence. Thereafter, tests were developed that assessed only non-verbal intelligence such as the Raven's Matrices Tests (1939), Hiskey-Nebraska Tests of Learning Aptitude (Hiskey, 1966), and the Leiter International Performance Scale (Leiter, 1979). Currently, many test batteries, such as the Wechsler Scales, include both verbal and non-verbal components. However, there continues to be an interest in batteries with only non-verbal items such as the Leiter International Performance Scales which is currently being restandardized (Leiter, in development).

Non-verbal measures were designed to assess a theoretical construct called "non-verbal intelligence" (Naglieri & Prewett, 1990). Some experts (Glaub & Kamphaus, 1991) do not believed that "non-verbal" describes a construct but rather a unique method of considering intelligence. Other researchers do believe in the non-verbal construct but have chosen different names to describe non-verbal intelligence. For instance, Cattell (1963) developed a theory of Crystallized (Gc) and Fluid (Gf) intelligence. Gc refers to experiential knowledge that is influenced by schooling and acculturation and is further related to verbal ability. On the other hand, Gf is considered to be the biological capacity of a person to acquire knowledge and is viewed as inductive and spatial reasoning abilities (Brody, 1992; Cattell, 1963).

Gardner (1983) introduced a theory of multiple intelligences which included 7 types of intelligence (Verbal/Linguistic, Musical, Logical/Mathematical, Visual/Spatial, Bodily/Kinesthetic, Interpersonal, and Intrapersonal). The Visual/Spatial intelligence of Gardner's theory conforms to the non-verbal abilities considered in other theories. Process theory driven tests such as the Kaufman Assessment Battery for Children (K-ABC; Kaufman, 1983) consider simultaneous and sequential intelligences, wherein simultaneous relates primarily to non-verbal processes and sequential to verbal processes. Although the terms differ, the cognitive tasks are similar.

According to Sattler (1988), non-verbal ability measures typically have both non-verbal and verbal elements but the subject's response does not usually necessitate spoken language.

Nonverbal tests differ in regard to the degree of motor involvement, structure of the task, nature of the nonverbal content (abstract versus concrete), and time limits. However, according to Naglieri and Prewett (1990), all of them should be devised so that there is a minimum of verbal directions and responses are required.

Is there a need for non-verbal measures of intelligence? The answer would appear to be yes, especially when a language barrier exists, since the minimal need for verbal directions and responses is less likely to influence the test score (Naglieri & Prewett,1990). Therefore, non-verbal tests may give a better indication of ability than would a verbal assessment for those individuals who have a language deficit or are unwilling to interact verbally. Non-motor non-verbal tests are available for individuals who have significant motor difficulties which are likely to inhibit performance time.

The Raven's matrices have advantages for individuals with either verbal or motor difficulties. Such advantages include the figural format which does not require physical action in response to the brief directions that are consistent throughout the test. Sattler (1988) and Jensen (1974) view the Raven's as less culturally loaded than verbal tests and as a good choice for use with minorities.

Although the CPM has a non-verbal format, responses to the CPM items can be verbally mediated. Sattler (1990) stated:

> The rule or principle required to solve each item can either be formulated in verbal terms or be derived from a visual perceptual discovery of the internal structure of the stimulus. In the former case, an analytic approach is used in which logical operations are applied to features contained within the elements of the problem matrix. In the latter case, a Gestalt approach involving visual perception is used to solve problems (p. 309)

Because responses to the CPM items can be verbally mediated, the CPM should not be regarded as a pure measure of non-verbal or visual-spatial intelligence.

Gardner's (1983) Multiple Intelligences theory proposes that Visual/Spatial intelligence and Verbal/Linguistic intelligence are two of seven independent types of intelligence. Because the CPM items can be solved through verbal mediation of visual-spatial information, Multiple Intelligences theory would not consider the CPM a "direct" or "intelligence fair" measure of Visual/Spatial intelligence. Gardner & Hatch (1990) stated:

> Although spatial problems can be approached to some degree through linguistic media (like verbal directions or word problems), intelligence-fair methods place a premium on the abilities to perceive and manipulate visual-spatial information in a direct manner. For example, the spatial intelligence of children can be assessed through a mechanical activity in which they are asked to take apart and reassemble a meat grinder. The activity requires them to "puzzle out" the structure of the object and then discern or remember the spatial information that will allow reassembly of the pieces. Although linguistically inclined children may produce a running report about the actions they are taking, little verbal skill is necessary (or helpful) for successful performance on such a task (p. 7)

Thus, as stated by Raven, Raven, and Court (1991), the CPM measures "the ability to deduce relationships" (p. G3) by means of visually presented problem solving tasks. According to Multiple Intelligences theory, CPM scores can be thought to reflect several independent intelligences functioning in concert. But, according to more traditional conceptions of intelligence, CPM scores can be thought to reflect a general intelligence or g factor.

In a review of the validity studies of the CPM, Raven, Court, and Raven (1986) summarized a number of studies of the correlation of the CPM with the Wechsler Intelligence Scale for Children (WISC). The studies included children from many countries and of different cultural and ethnic backgrounds. These studies found significant correlations between the CPM score and the WISC Full Scale IQ, the WISC Performance IQ, and WISC subtest scores.

However, the Wechsler scales have undergone a number of revisions since these earlier studies. The initial Wechsler scale led to the development of the WISC which was revised as the WISC-R. And recently, the WISC-R was revised and became the WISC-III. These revisions resulted in updated items, modifications in scoring, revised norms, and additional technical data. Among these Wechsler scales, the WISC-III is the instrument most often used today. Sattler (1992) reported that the description of the abilities associated with the WISC-R subtests also apply to the WISC-III subtests. However, the test differs sufficiently from earlier versions that it is appropriate to compare the present WISC-III and CPM relationship with the earlier Wechsler scale - CPM validity studies.

The purpose of this study was to examine the relationship between Raven CPM scores and WISC-III subtest scores and IQs. The relationship of these scores to children's achievement was also of interest.

Method

Data for this study were gathered from University Assessment Center files. Children were referred to the Center by their parents at the recommendation of their teachers or pediatricians because they were believed to have exceptional learning patterns (often accelerated learners) or behavioral difficulties. A battery of educational and psychological tests was used to assess these children and a written summary of the results was provided to parents at a summary session.

Instruments

The CPM consists of 36 items which are in the form of designs with a missing piece. The subject selects one of six choices which will complete the design correctly. The tasks involve attending to the stimulus figure followed by a series of analyses of the choices leading to selection of the appropriate response. Raven, Court, and Raven (1986) indicated that the "CPM has a high g loading, with the visual-spatial k factor involved to some degree." (p.CMP22) The Wechsler Intelligence Scale for Children - Third Edition (WISC-III) includes 13 subtests that consider verbal and nonverbal abilities. Six of the subtests form the Verbal Scale (Information, Similarities, Arithmetic, Vocabulary, Comprehension, and Digit Span) and the other seven make up the Performance Scale (Picture Comprehension, Picture Arrangement, Coding, Block Design, Object Assembly, Symbol Search, and Picture Completion). The Woodcock-Johnson Tests of Achievement - Revised (WJ-R) is a comprehensive achievement battery which consists of 10 subtests covering five general areas (Reading, Mathematics, Written Language, Knowledge and Skills). The main areas of achievement assessed in this study were Reading, Mathematics, and Written Language.

Sample

Twenty-eight children who were referred to a university assessment center for psycho-educational evaluations by their parents were the subjects of this study. Of the twenty-eight children in the study, 16 were male and 12 were female. The children ranged in ages from 6 to 11(mean age was 7.6 years) and attended kindergarten through 5th grade. The distribution by grades was 7% kindergartners, 36% 1st-graders, 25% 2nd-graders, 14% 3rd-graders, 11% 4th-graders, and 7% 5th-graders. Eighteen of the children were Caucasian, two African American, four Hispanic, and four Asian. All of them resided in the Denver, Colorado metropolitan area. The children were referred for several reasons, with the greatest proportion being referred for potential giftedness. A few children were referred for academic/learning difficulties, behavioral problems, or a mix of learning and behavioral issues. Forty-six percent of the children's parents held a graduate degree.

Results

IQs, scaled scores, standard scores, and percentiles were recorded from the files. The relationship of the WISC-III IQs, scaled score, and CPM percentiles are reported in Table 1. As expected, there were moderate to high correlations among the 3 IQs. Furthermore, the verbal subtests correlated significantly with the Verbal IQ and the performance subtests with the Performance IQ. The CPM percentiles were moderately correlated with the WISC-III 3 IQs and with some of the performance as well as verbal subtests. The highest correlations with the CPM percentiles were found for the Block Design (which seemed to resemble the CPM tasks), Picture Arrangement, and Picture Completion performance subtests. Four verbal subtests were significantly related to the CPM percentile (Vocabulary, Arithmetic, Similarities, and Information). Mazes, Coding, and Symbol Search showed the least relationship to the CPM percentile.

In a further analysis of the WISC-III and CPM relationship, a stepwise multiple regression analysis was computed (Table 2). The WISC-III full Scale IQ and two verbal subtests (Digit Span and Arithmetic) were found to be the best predictors of the Raven CPM percentile. None of the WISC-III performance subtests entered the equation.

And finally, the correlation of the WISC-III scores, Raven CPM percentiles, and Woodcock-Johnson Tests of Achievement - Revised (WJ-R) scores for Reading, Mathematics, and Written Language were computed (Table 3). The Raven percentiles were moderately correlated to WJ-R Mathematics (.55) and Written Language (.38) but were not significantly related to reading.

These correlations indicate a moderate relationship between the Raven CPM percentiles and WISC-III IQ's and certain scaled scores. The correlation of each of these measures with the WJ-R achievement measures was also in the moderate range but with the WISC-III correlations higher than the Raven CPM correlations for each achievement area.

Discussion

In this study, the highest correlations were found between the CPM percentile and Full Scale IQ, Performance IQ, and Block Design. This finding is consistent with a previous validity study (Raven, Court, & Raven, 1986) which revealed a significant correlation between the CPM and both the Full-Scale and the Performance Scale IQs. Furthermore, these findings would seem to support Raven, Court, Raven's (1986) idea that the CPM is a measure of g because the Full Scale IQ, Performance Scale IQ, and Block Design subtest all have high g loadings (Sattler, 1992). It is particularly noteworthy that the WISC-III Full-Scale IQ, which showed the highest correlation with the CPM, is described by Sattler (1992) as being the highest measure of g on the Wechsler Scale.

The results of the step-wise regression analysis revealed three Wechsler scores as being significant predictors of the CPM percentile: Full-Scale IQ, Digit Span, and Arithmetic. It is interesting to note that the three WISC-III scores which correlated most highly with the CPM in the correlation analysis (Full-Scale, Performance Scale, and Block Design) were not the same as the three best predictors of the CPM percentile (Full-Scale, Digit Span, and Arithmetic). This discrepancy can be explained by the high degree of variance accounted for by the WISC-III Full-Scale IQ. As indicated on Table 1, the Full-Scale IQ, Performance IQ, and Block Design subtest were highly inter-correlated, thus the three scores were multicollinear. Therefore, it would be expected that the shared variance would result in Performance IQ, and Block Design to fall out of the regression analysis and cause scores sharing unique variance to emerge.

The regression analysis results appear to support the idea that the CPM is measuring both verbal and nonverbal abilities (Sattler, 1990, 1992). The Full-scale IQ is a composite measure of both verbal comprehension and perceptual organization factors. Interestingly, Digit Span only loaded on the Verbal Comprehension factor (average loading = .34; Sattler, 1992). Finally, the Arithmetic subtests had a moderate loading on the Verbal Comprehension factor (average loading = .55; Sattler, 1992) and a minimal loading on the Perceptual Organization factor (average loading = .37; Sattler, 1992). Thus, the results of this regression analysis would provide further evidence that "nonverbal tests" such as the CPM actually have both verbal and nonverbal components and would suggest the possibility that the CPM items can be verbally mediated tasks.

There were also significant correlations between the Woodcock-Johnson Tests of Achievement-Revised (WJ-R) and the CPM percentile. The Mathematics and Written Language portions of the WJ-R correlated significantly with the CPM percentile. However, with one exception, the WISC-III Full-Scale, Verbal, and Performance IQs were all more highly correlated with the WJ-R Broad scores in Reading, Math, and Writing. The exception was that the Raven's percentile was more highly correlated with the WJ-R Math Cluster score than was the WISC-III Performance IQ. Still, the WISC-III Full-Scale and Verbal IQs were more highly correlated with the WJ-R Mathematics Cluster score than was the CPM percentile. Therefore, the results of this study would suggest that the CPM (a visually presented measure) is related to achievement (a verbal task) but not as highly as is the WISC-III which has both verbal and visual items. It is also noteworthy that the CPM percentile appears generally more highly related to the WISC-III IQ scores than to the WJ-R Cluster scores.

This study has several limitations that should be considered in interpreting and using the results. First, the small sample size of the study did not allow data analysis by sex, age, or SES. Next, the children in the sample were representative of diverse cultural backgrounds, but were predominately from a high SES background. The gifted population was over-represented in this study. Thus, these results apply essentially to children whose characteristics are similar to this sample.

This present study extends past research on the characteristics of the Raven, thus facilitating more informed decisions concerning appropriate use of the Raven's CPM for specific assessment purposes. For instance, as the results indicate that both nonverbal and verbal abilities are accessed by the Raven's CPM, it should not be assumed that the CPM is a pure nonverbal measure of intelligence. Also, because of the significant correlations with the WISC-III IQ scores, the results suggest that the CPM may be tapping similar intellectual abilities.

There are several possible directions for future research on the Ravens CPM. First of all, it would be useful to repeat the present study with a large, diverse sample. Such a study could also consider variations by gender, age, and SES. Furthermore, the realization that verbal abilities are utilized on the Raven's CPM indicates a need for a Raven's study that examines the role of verbal mediation in responding to Raven's CPM items.

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Table 1

Correlations of WISC-III IQ's, Scaled Scores, and Raven CPM Percentiles

Var	VIQ	PIQ	FSIQ	PC	PA	COD	BD	OA	SYM	MAZ	INF	SIM	ARIT	VOC	COM	DS	PCT
VIQ		.48*	.89**	.10	.44*	.20	.37	.35	.52*	-.42	.78**	.79**	.66**	.79**	.78**	-.08	.55**
PIQ			.82**	.43*	.73**	.38*	.82**	.70**	.23	.13	.24	.41*	.48**	.50	.22	.02	.62**
FSIQ				.28	.67**	.33	.66**	.58**	.52*	-.29	.62**	.73**	.68**	.77**	.61**	-.06	.67**
PC					.31	-.15	.16	.28	.23	-.15	.09	-.04	.10	.13	.14	.15	.44*
PA						-.05	.69**	.30	-.04	.09	.20	.47*	.38*	.37	.29	.14	.54**
COD							.17	.19	.23	.00	.17	.16	.17	.31	-.03	-.14	.04
BD								.36	-.09	.12	.21	.35	.37	.35	.17	.15	.62**
OA									.33	.30	.07	.28	.44*	.41*	.16	-.18	.30
SYM										-.31	.45*	.06	.11	.63**	.41	-.02	.16
MAZ											-.34	-.33	.29	-.49	-.47	.48	-.10
INF												.55**	.52**	.49**	.45*	.08	.41*
SIM													.34	.61**	.44*	-.22	.47*
ARIT														.32	.48**	.29	.40*
VOC															.58**	-.20	.49**
COM																-.11	.33
DS																	.38
PCT																	

* Signif. LE .05
** Signif. LE .01

VIQ = WISC-III Verbal IQ
PIQ = WISC-III Performance IQ
FSIQ = WISC-III Full Scale IQ
PC = WISC-III Picture Completion Subtest
PA = WISC-III Picture Arrangement Subtest
COD = WISC-III Coding Subtest
BD = WISC-III Block Design Subtest
OA = WISC-III Object Assembly Subtest
SYM = WISC-III Symbol Search Subtest

MAZ = WISC-III Mazes Subtest
INF = WISC-III Information Subtest
SIM = WISC-III Similarities Subtest
ARITH = WISC-III Arithmetic Subtest
VOC = WISC-III Vocabulary Subtest
COM = WISC-III Comprehension Subtest
DS = WISC-III Digit Span Subtest
PCT = Raven CPM Percentile

Table 2

Stepwise Multiple Regression Analysis Using the Raven's CPM Percentile as the Dependent Variable

Step	Variable Entered	R	R sq. Adj.
1	WISC-III Full Scale IQ	.67**	.43
2	WISC-III Digit Span	.79**	.59
3	WISC-III Arithmetic	.85**	.67

* Signif. LE .05
** Signif. LE .01

Table 3

Correlations of WISC-III IQ's, Raven's CPM Percentiles, and Woodcock Johnson Achievement Broad Scores

Var	FSIQ	VIQ	PIQ	PCT	READ	MATH	WRITE
FSIQ		.89**	.82**	.67**	.42*	.69**	.56**
VIQ			.48*	.55**	.47*	.63**	.51**
PIQ				.62**	.23	.53**	.48**
PCT					.16	.55**	.38*
READ						.36	.67**
MATH							.44*
WRITE							

* Signif. LE .05
** Signif. LE .01