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the reynolds intellectual assessment scales (RIAS) and assessment of intellectual giftedness

Abstract

The Reynolds Intellectual Assessment Scales (RIAS) (Reynolds & Kamphaus, 2003) is a psychometrically sound, individually administered test of intelligence developed and standardized for ages 3 through 94 years. This article describes the goals for development of the RIAS and its underlying theory, emphasizing its applicability to the identification of intellectually gifted individuals. In addition, an overview of the test's administration and psychometric properties is provided.

The Reynolds Intellectual Assessment Scales (RIAS; Reynolds & Kamphaus, 2003) is a recently published, rapidly administered (25-35 minutes for most school-aged individuals), individually administered test of intelligence. Developed and standardized for ages 3 years to 94 years, the RIAS yields three intelligence scores, a Verbal Intelligence Index (VIX), a Nonverbal Intelligence Index (NIX), and a global Composite Intelligence Index (CIX), derived from the VIX and NIX. Co-normed verbal and nonverbal memory subtests are included as well but are considered to represent a related but separate construct that is not as strongly associated with general intelligence (defined more strongly as representing problem solving skill on the RIAS). The memory scores do not contribute to the calculation of the various intelligence indexes on the RIAS.1

Theory and Goals

The RIAS is based on the consensus findings of Cattell and Horn's (Horn & Cattell, 1966) theory of fluid and crystallized abilities and Carroll's (1993) three-stratum theory of intelligence (Reynolds & Kamphaus, 2005).

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While the indexes are not explicitly divided into fluid and crystallized domains, combinations of the six RIAS subtests were designed to measure four aspects of intelligence, which are related to these concepts. The first, general intelligence, or g, is assessed by the Composite Intelligence Index (CIX) and corresponds to Carroll's (1993) stratum three, which is best represented by fluid abilities. Verbal intelligence is closely related to the concept of crystallized ability, although not identical. Nonverbal intelligence, also referred to as visualization or spatial abilities by some theories, is similar to fluid intelligence. In addition, memory, or learning, may be assessed by the two supplemental subtests.

Most of the variance measured by intelligence tests is accounted for by Carroll's (1993) stratum three, which is solely composed of g (general intelligence). The greater the amount of g measured by an intelligence test, the higher the test's correlation with important outcomes such as academic achievement. Stratum three can be assessed through measures of stratum two traits, which are composed of combinations of subtests, or stratum one measures. These second stratum traits include, in order of relation to g, fluid intelligence, crystallized intelligence, general memory and learning, broad visual perception, broad auditory perception, broad retrieval ability, broad cognitive speed, and processing speed. In other words, fluid and crystallized abilities are the best candidates for quick and accurate assessment of general intelligence (Kamphaus, 2001).

These theories combined with practical considerations led to the primary goals for development as provided in the RIAS professional manual (Reynolds & Kamphaus, 2003) and listed here.

Goal 1: Provide a reliable and valid measurement of g and its two primary components, verbal and nonverbal intelligence, with close correspondence to crystallized and fluid intelligence.

Goal 2: Provide a practical measurement device in terms of efficacies of time, direct costs, and information needed from a measure of intelligence.

Goal 3: Allow continuity of measurement across all developmental levels from ages 3 years through 94 years for both clinical and research purposes.

Goal 4: Substantially reduce or eliminate dependence on motor coordination and visual-motor speed in the measurement of intelligence.

Goal 5: Eliminate dependence on reading in the measurement of intelligence.

Goal 6: Provide for accurate prediction of basic academic achievement at levels that are at least comparable to that of intelligence tests twice its length.

Goal 7: Apply familiar, common concepts that are clear and easy to interpret, coupled with simple administration and scoring.

Goal 8: Eliminate items that show differential item functioning, or DIF, associated with gender or ethnicity.

The RIAS for Gifted Assessment

There are various definitions of intellectual giftedness and the determination of criteria for eligibility to receive gifted services is typically left to officials at the State, Provincial, or school district level. This situation leads to varying conceptions of what it is to be gifted and how best to identify this population. Many school districts define intellectual giftedness as general intellectual ability or the ability to achieve high academic achievement. Thus, many schools include an intelligence test as one, or sometimes the only, criteria for determining access to services despite the differences in their definitions (McCoach et al, 2001).

According to Reis and Small (2005), intellectually gifted students display several cognitive characteristics that make them unique from their peers. These traits include advanced verbal aptitude, the ability to understand complex and abstract concepts, and advanced thinking, processing, and problem-solving skills. Since these are the traits that characterize gifted individuals, it reasonably follows that the intelligence measure used for gifted identification should assess problem-solving and higher-order skills commonly thought of as general intelligence. The RIAS emphasizes problem-solving and higher order processing skills in assessing intelligence and does not consider visual-motor speed, rote memory, or retrieval of facts (e. g., names of US Presidents, etc.) in determining an individual's general intellectual level.

As discussed previously, the primary goal for development of the RIAS was to assess g and its main components, fluid and crystallized intelligence. Any test of g must measure higher-order cognitive abilities, namely fluid intelligence, such as general sequential reasoning, induction, deduction, analogies, etc (Carroll, 1993). These are the characteristics most important in identifying gifted students, making fluid intelligence key to assessing for giftedness. All of the RIAS subtests have a substantial g saturation, and therefore are suited for gifted identification (Reynolds & Kamphaus, 2003).

Crystallized ability is measured by first-order factors that mainly involve language abilities, which are more commonly referred to as verbal abilities by clinicians (Kamphaus, 2001). Again, this second-order factor is one area of assessment on which the RIAS focuses in order to gain a better measure of g. In the case of gifted identification, gauging verbal abilities not only explains a greater proportion of variation in intelligence, or g, but also assesses a central characteristic of giftedness, and the component that is most highly predictive of success in academic and related learning environments.

Not only does the RIAS mainly assess the primary traits of intellectual giftedness, of equal importance is the fact that the RIAS does not measure domains that are not associated with typical conceptions of the intellectually gifted. As stated in the fourth goal, the RIAS was specifically developed so that its measurement of intelligence would not be confounded with motor coordination and visual-motor speed. Recall that the fourth stratum two trait is broad visual perception, referred to by Carroll as visualization (1993). Tests of this factor require the ability to perceive and transform stimuli accurately, possibly including visual manipulation (Kamphaus, 2001), and also requires motor coordination.

Another trait excluded by the RIAS, visual-motor speed, is best captured by the tail-end of Carroll's (1993) second-stratum – broad cognitive speediness and processing speed. Broad cognitive speediness requires quick responding with little decision-making, while processing speed involves both a quick reaction time and decision-making. The former is well-represented on tests of intelligence in the form of design copying, while the latter is represented by items that require rapid choices (Kamphaus, 2001). These measures typically require rapid motor coordination and are poorly correlated with g.

Because intellectual giftedness is so closely tied to the concept of general intelligence, it would be deleterious to

include measures of traits that are not at least good correlates of g. The assessment of intellectual giftedness would be confounded with domains that are not of interest, possibly decreasing the likelihood of identification. The RIAS avoids this confounding by excluding speed and motor coordination components.

Even mild motor impairments can have significant, deleterious effects on IQ estimation for some of the most popular of intelligence tests. An individual who is highly skilled at problem-solving, deductive and inductive reasoning, and other higher order processing skills, but who has motor problems, will have their overall intelligence level underestimated on tests that include visual-motor skills and processing speed (as typically measured) in the estimation of IQs or related scores.

An illustration of this effect can be found in the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003) manual. In a clinical study, 21 children with significant motor impairments were administered the WISC-IV and compared to a demographically matched control group administered the same test. Compared to the control group, the motor impaired group performed significantly worse on the Processing Speed Index (PSI), which includes tests such as copying symbols based on a given code, scanning for matching symbols, and then marking an answer box (Mean = 78.2 vs Mean = 97.7, $p < .01$). There was also a significant difference between groups' performance on the Perceptual Reasoning Index (PRI), which includes a block design subtest requiring motor coordination (Mean = 83.8 vs Mean = 94.8, $p = .05$). However, the groups performed equally well on stratum two measures of crystallized ability represented by the Verbal Comprehension Index (VCI; Mean = 95.5 vs Mean = 97.9, $p = .62$).

Crystallized ability, as aforementioned, is the second stratum two trait and therefore one of the best measures of g. This well-replicated finding suggests that based on the VCI scores of the motor impaired and control group we should expect the groups to also have similar Full Scale IQs (FSIQ). Yet, this study resulted in a significant difference between the mean FSIQ for the two groups (Mean = 85.7 vs Mean = 96.7, $p = .08$). This difference demonstrates that by measuring constructs poorly related to g, such as motor coordination and visual-motor speed, the overall intelligence measure is not an accurate representation of higher level intellectual ability.

Similarly, the RIAS avoids confounding the Composite Intelligence Index (CIX) with a memory measure, but instead provides two supplementary subtests as a separate memory composite (CMI). Memory loads on the third stratum two factor, general memory and learning. As such, it is not as highly correlated with g as crystallized and fluid intelligence and hence not of great interest in determining whether an individual meets the criteria for intellectual giftedness. The RIAS is rare in that it provides a measure of memory if needed for a specific population, but it is a separate composite and not confounded with the overall measure of general intelligence.

Rote memory, such as represented in tasks like digit or letter recall, remembering symbols associated with single numbers, and the like, require little in the way of mental manipulation and their inclusion in estimates of intellectual ability seems questionable. Although knowledge of memory skills of various sorts is very useful from a diagnostic perspective, - it just should not be confused with higher order information processing when referring to working memory and other forms of rote recall.

Working memory is a lower level skill that does form a basis for intelligence to function well. However, working memory has relatively low correlations with reasoning test scores and while it has some overlap with intelligence (as do all cognitive tasks), it is a different, lower level construct (e. g., see Ackerman, Beier, & Boyle, 2005; Deary, 2000; Kline, 2000). Working memory requires very little manipulation of information and manipulation of information is what is crucial to reasoning. Working memory is a basic building block for cognitive activity but operates with a threshold effect. Clearly a base level of working memory is required to perform reasoning tasks but having a really superb working memory does not make you any more superior at manipulation of information--so a basic level of working memory is a necessary but insufficient skill or ability for good reasoning, i.e., you can not reason very well in the absence of a base level of working memory, but really high levels of working memory do make you reason better past this threshold. The RIAS model notes the importance of having measures of memory conormed with intellectual reasoning tasks and provides them, but relegates them to a separate scale that does not contribute to the intelligence indexes in the proffered model of Reynolds and Kamphaus (2003)..

In evaluating potentially high scoring individuals, the range of possible scores is of importance as well. The RIAS is scaled such that the indexes provide an eight standard deviation score range, from 40 to 160. While floor and ceiling effects occur at some ages, the age range (3 years to 94 years) and associated range of difficulty of the various tasks on the RIAS, provides it with an upper range of IQs (CIX) fully to 160 for ages 3 years to 14 years, 159 at age 15, and 150 or higher at remaining ages. The scaling of the RIAS and its range of difficulty for school-aged individuals should make it particularly useful in the search for intellectually gifted and talented individuals.

In summary, the RIAS was developed with the goal of measuring factors that are closely associated with g. Given the nature of intellectual giftedness, these g-saturated traits are well suited for the assessment of this population. The RIAS is beneficial in evaluating the intellectually gifted because it is not confounded with poor correlates of g, i.e. visual-motor speed, motor coordination, and short-term memory. The score range of the RIAS is also useful across the entire school-age range as well.

RIAS Overview

Before employing a test for the assessment of any population it is important to understand its administration, development, and psychometric properties. A brief description of these aspects of the RIAS follows. The goals and theory on which the creation of the RIAS was based have been discussed previously (for a more in depth discussion of these issues see Reynolds & Kamphaus, 2003, and Reynolds & Kamphaus, 2005, which also includes a case study application).

The RIAS includes six subtests that are based on formats common in intellectual assessment providing an instant familiarity for the user. There are four intelligence subtests requiring integration of several intellectual functions and two memory subtests. The intelligence subtests are further subdivided into a Verbal Intelligence Index (VIX) and a Nonverbal Intelligence Index (NIX).

The VIX includes the Guess What (GWH) and Verbal Reasoning (VRZ) subtests. Guess What requires verbal reasoning, vocabulary,

language development, and verbal knowledge base. It consists of questions beginning with "What is…" followed typically by three clues (occasionally more are given) describing the target object, person, place, or concept and requires only a one or two word response from the examinee. The Verbal Reasoning subtest measures verbal-analytical reasoning ability but with fewer vocabulary and general knowledge demands than GWH. The examinee is required to supply one or two words that complete a complex analogy.

The NIX scale includes the Odd-Item Out (OIO) and What's Missing (WHM) subtests. The examinee has two opportunities to generate the correct response on both subtests, receiving two points if correct the first time and one point for the second. Odd-Item Out measures nonverbal reasoning skills and also requires the subject to use spatial ability and visualization. It is a reverse matrix analogies task. The examinee is presented with a card containing several figures that complete a form of matrix analogy but with one extra item. The examinee must identify the one that is different from the others, the item that does not belong. What's Missing requires nonverbal reasoning where the individual must conceptualize a picture, analyze its gestalt, and deduce the essential missing element, indicating the response verbally or by simply pointing to the location of the missing elements. It is not necessary to give a verbal response or to know the "name" of the missing essential element.

The Composite Memory Index (CMI) includes the Verbal Memory (VRM) and Nonverbal Memory (NVM) subtests. Verbal Memory assesses the ability to encode, store, and recall verbal material in a meaningful context. Sentences or stories with lengths determined by the examinee's age are read aloud by the examiner and the examinee must repeat the words verbatim. Nonverbal Memory requires the ability to encode, store, and recall pictorial stimuli that are concrete or abstract. The examinee is presented with the target picture for 5 seconds and then asked to identify the target within a set of pictures presented on the following card.

The RIAS is easy to administer and objectively scored. Judgments are seldom required in scoring, with the exception of the Verbal Memory subtest, and interrater reliability exceeds the recommended value of .90 for all 6 subtests with a median value of 1.00 (Reynolds & Kamphaus, 2003). After the examiner has become familiar with the administration, the entire RIAS requires an average of 25 to 35 minutes, including the memory tasks. The intelligence subtests alone can be administered in about 20 to 25 minutes, although it may take longer for bright individuals such as those who are assessed for being potentially gifted. Basal and ceiling rules as well as age designated starting points were determined based on responses of the standardization sample in order to control administration time. In addition, administration is made more efficient by the presence of all necessary instructions on the RIAS record form.

The RIAS was normed on a representative sample of 2,438 participants based on the demographic characteristics of the U.S. population as defined by the 2001 U.S. Bureau of the Census Report (Reynolds & Kamphaus, 2003). Stratification variables included age, gender, ethnicity, educational level, and region. Oversampling of the South region and minority ethnic groups were corrected for using a weighting procedure. The resulting norms represent a nearly perfect match to the population statistics.

All standard scores for the RIAS were obtained using continuous norming, a regression procedure that stabilizes parameter estimation and minimizes the effects of sampling irregularities across the 52 age groups in the normative sample. For the subtests, T scores with a mean of 50 and a standard deviation of 10 were chosen over the traditional scaled score due to the higher reliability coefficients for RIAS subtest scores thus allowing finer discriminations. For the intelligence indexes (VIX, NIX, CIX) as well as the memory index (CMX), the traditional IQ-metric is used (Mean=100, SD=15). For those who are interested, percentiles, T scores, z scores, normal curve equivalents (NCE's), age equivalents, and stanines are provided in the RIAS Manual (Reynolds & Kamphaus, 2003).

Internal consistency reliability of the RIAS was assessed using Cronbach's coefficient alpha, as is commonly done for such tests. The lowest alpha reliability for the RIAS subtests scores is .84 across all age groups, with the medians across age for the subtests equaling .90 or greater. Similarly high alpha coefficients were obtained for the indexes, with the lowest median coefficient equal to .94. These reliability estimates are quite strong and exceed values of composite indexes of some tests considerably longer than the RIAS and are as high as or higher than most popular IQ tests which are significantly longer to administer and score. This is partly due to the focus of the RIAS on g and excluding extraneous variables, making the items and subtests more homogenous and therefore more reliable.

The RIAS manual also reports the reliability of the test's scores across gender and by ethnicity. No significant differences were found for any age level as a function of gender. Additionally, no significant differences in reliability were found for whites versus African Americans, although at some age levels the absolute value of the differences was greater than for gender.
Error due to time sampling, or test score stability, was examined using the test-retest method for 86 individuals with a median time interval of 21 days. Test-retest reliability correlations and corrected coefficients for the subtests and indexes are provided in the RIAS Manual (Reynolds & Kamphaus, 2003). The corrected coefficients range from .76 to .91 for the 3- to 4-year-olds, .76 to .92 for the 5- to 8-year-olds, .77 to .99 for the 9- to 12-year-olds, .73 to .99 for the 13- to 82-year-olds, and .76 to .91 for the entire test-retest sample. Based on these reliabilities, examiners may expect small practice effects when using the RIAS. In addition, as previously mentioned, all subtests have more than sufficient interrater reliabilities, with the lowest being .95 for Verbal Memory. Given that the RIAS is a relatively new intelligence scale, the RIAS Manual (Reynolds & Kamphaus, 2003) is the main source of validity evidence. Theory-based evidence, content evidence, response processes evidence, internal structure evidence, external relations evidence, and consequential evidence are provided as recommended by the Standards (AERA, APA, & NCME, 1999). Theory will not be discussed here as it was discussed previously, and an explanation of consequential validity will be omitted due to its controversial nature.

Content evidence of validity is provided by direct examination of the RIAS items and format. Items were reviewed by experts for cultural bias and appropriateness, with questionable items being eliminated or modified. Response process evidence is based on fit between what the subtests propose to measure and the tasks employed. In this respect, all subtests are devoid of contamination from nonintellectual processes, such as motor coordination, speed, and acuity. The verbal subtests measure vocabulary and language comprehension, not simply acquired skills and little expressive language is required.

The nonverbal subtests are designed to require primarily spatial encoding, and avoid verbal strategies.

Evidence based on internal structure was supplied by confirmatory and exploratory factor analyses, in addition to internal consistency as noted above. To enhance stability and generalizability of the results for the factor analysis of subtest intercorrelations without masking developmental shifts, the sample was divided into five age groups: early childhood (3 to 5 years), childhood (6 to 11 years), adolescence (12 to 18 years), adulthood (19 to 54 years), and senior adulthood (55 to 94 years).

The principal factors solution with two-factors makes the most sense for both the four intelligence subtests and all six subtests as a set. The g factor for the RIAS is the strongest with all but one of the loadings on g being .60 or higher. The two verbal subtests have the highest loadings on g, but the nonverbal subtests are also good measures of the unrotated factor. Two components of g, verbal and nonverbal, were clearly delineated for every age group. The six-subtest solution also followed these two dimensions, with Verbal Memory on the first factor with the verbal subtests and Nonverbal memory on the second factor with nonverbal subtests. Despite these loadings, the authors contend that the memory subtests are best presented as a separate memory index. The four-subtest and six-subtest solutions demonstrate the same factor structure across gender and ethnic groups based on factorial similarity requirements and coefficients of congruence. Confirmatory factor analyses were conducted to compare the chosen two factor model (Model 2) of the RIAS to a single factor model consisting simply of g (Model 1) and a three factor model (Model 3) consisting of verbal, nonverbal, and memory components. Model 1 fit better when only the four intelligence subtests were included and the results suggest that the RIAS has a large first factor, yet inspection of Model 2 and Model 3 was still necessary. Model 2 provided a good fit for the four subtests as well with chi-square values between .22 and 1.49 and small RMSEA values. Model 3 for six subtests did not demonstrate as good a fit, but there were indications that Model 2 for the six subtests was a possibility for individuals 19 years of age and older. While the use of all six subtests for assessing nonverbal and verbal intelligence in adults may be plausible, Reynolds and Kamphaus (2003) recommend the use of the four-subtest two-factor model based on the factor analysis results and the theories discussed previously.

The RIAS shows evidence of external validity based on developmental trends, relations to other measures, and performance of clinical groups. To obtain a measure of relationship between performance on the RIAS and age, correlations were calculated for ages 3 through 18 years. The correlations were then examined to determine whether they followed the hypothesized early and rapid increase, plateau in the teen years, and decline in the older years of the intelligence composite. The correlations were large (greater than .80) for the sample as well as for gender and ethnicity showing that raw scores increase with age across subtests with common stimuli. In addition, polynomial curves were constructed to illustrate that the expected developmental trend was evident for the entire age range from 3 to 94 years.

To demonstrate external validity with other measures, each RIAS index was correlated with the three IQs provided by the WISC-III (Wechsler, 1991). All of the RIAS indexes correlated highly with the WISC-III Full Scale IQ (FSIQ), ranging from .60 for the NIX to .78 for the VIX. This pattern is expected because the VIX and FSIQ are most associated with g based on their factor analyses. Additionally, differences are to be expected between the NIX and WISC-III IQs due to the WISC-III's Performance IQ, which incorporates the motor and language skills, and speed components that are purposely absent from the RIAS nonverbal scale. Additionally, the RIAS was shown to be predictive of educational achievement based on correlations in the .60s and .70s with the Wechsler Individual Achievement Test (WIAT; The Psychological Corporation, 1992).

The RIAS scores for clinical samples identified during standardization were obtained to provide evidence of validity based on the match between observed performance and hypothesized performance for a given disorder. The clinical groups included five organic syndromes, such as deafness and mental retardation, five psychiatric groups, such as depression and polysubstance abuse, and learning disabilities and attention deficit hyperactivity disorder groups. The scores for these samples displayed the expected patterns of mild cognitive impairment with greater impairment for more severe disorders, providing further proof of validity for the RIAS.

Conclusion

The RIAS is a quick and easy to administer (25 –35 minutes) measure of intelligence that provides a highly reliable and valid measurement of general intelligence and its two main components, verbal and nonverbal abilities. Its focus on tasks most related to higher-order conceptions of intelligence makes it a prime candidate for use with intellectually gifted populations. Further, its exclusion of confounding factors such as motor ability and speed provides an even more accurate picture of intellectual functions related to intellectual giftedness than other currently available measures. The range of intelligence index scores available (up to 160 through age 14 years and above 150 thereafter) coupled with their reliability should make the RIAS maximally useful with high IQ populations. A brief version of the RIAS, the Reynolds Intellectual Screening Test (RIST; Reynolds & Kamphaus, 2003) is also available although not specifically reviewed here.

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