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The Integrated Visual and Auditory Continuous Performance Test: Does the Comprehension Scale Discriminate ADHD?

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The Integrated Visual and Auditory Continuous Performance Test: Does the Comprehension Scale Discriminate ADHD?

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Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a developmental neuropsychological disorder that usually first appears in early childhood, with symptoms that cause impairment in multiple settings (American Psychiatric Association [DSM-IV-TR], 2000). The disorder has three subtypes: Predominantly Hyperactive/Impulsive Type, Predominantly Inattentive Type, and Combined Type. Individuals with the Predominantly Hyperactive Type exhibit excessive motor activity, experience feelings of restlessness and have problems with impulse control. Individuals with the Predominantly Inattentive Type have problems with memory, organization and sustaining attention to tasks and activities. Individuals with the Combined Type of ADHD exhibit symptoms of both the Hyperactive/Impulsive Type and the Inattentive Type of ADHD.

Approximately three to seven percent of children in the United States meet DSM-IV-TR criteria for ADHD (DSM-IV-TR, 2000). Up to 60% of these children continue to meet criteria into adulthood, for an estimated adult prevalance rate of 4.4% (Kessler et al., 2006). Because ADHD is neurological in origin, comprehensive assessment is crucial for making a differential diagnosis and determining which treatments may be most effective in reducing impairment (Frazier, Demaree, & Youngstrom, 2004; Pliszka, 2007; White, Hutchins, & Lubar, 2005; Educational Testing Service, 2011). This is because ADHD symptoms overlap with other neurological conditions and psychiatric disorders, which typically require different treatment interventions. Furthermore, about 89 percent of adults with ADHD have, have had, or will have a comorbid psychiatric disorder at some time in their life (Adler, Spencer, Stien, & Newcorn, 2008), and it is important to diagnose and treat these additional disorders as well.

Current methods of assessing for ADHD include a clinical interview, current and retrospective self-report of symptoms, collateral report of symptoms from others in order to verify childhood onset and impairment in multiple settings (e.g., home and work, or school), and

administration of a continuous performance test (CPT; Murphy, & Schachar, 2000). Other cognitive, achievement, and/or neuropsychological testing may also be provided based on the referral question (Pliszka, 2007; Educational Testing Service, 2011). Symptom validity testing also is recommended (Quinn, 2003). While the nature of the clinical interview and self and other report of symptoms are subjective, continuous performance tests (CPTs) offer a more objective measure of symptoms to aid diagnosis (Frazier, Demaree, & Youngstrom,2004). CPTs are tests of attentional vigilance that require examinees to respond to various computer-generated stimuli over a period of many minutes. After controlling for effort, individuals who make a significant number of mistakes on CPTs are likely to have attention problems such as those found in individuals with ADHD. Commonly used CPTs include Conner's CPT, the Test of Variables of Attention (TOVA) and the Integrated Visual and Auditory CPT (IVA). Note, both the original version of the IVA and the IVA+Plus, which uses a new operating system, are referred to as IVA in this paper.

The IVA was developed by Sanford and Turner (2004) "in part to measure the ability to inhibit response after a behavioral pattern of responding was established" (p.11). The construction of this test was based on Barkley's theory (1993b) that ADHD reflects a deficit in response inhibition. Furthermore, Sanford and Turner (2004) believed that a dual stimulus model would be more effective than one that requires attention to one infrequent stimulus (an "X-version") or one in which the examinee must respond to a stimulus (X) that follows another stimulus (A-X). To maximize errors in response inhibition, Sanford and Turner decided to make the test stimuli as unpredictable as possible. They included both auditory and visual stimuli to increase the test's sensitivity in distinguishing between ADHD and non-ADHD populations. With respect to the overall construct of attention, the test creators used Sohlberg and Mateer's

theoretical model of attention (1987) which divides attention into five elements: Focused Attention, Sustained Attention, Selective Attention, Alternating Attention, and Divided Attention. Based on this model, Sanford and Turner designed the IVA to simultaneously measure response control and attention processing in the five domains.

The IVA manual states that the test was developed to be similar to the then widely used Conners' CPT—2nd Edition (Conners' CPT-II) in format and modality (Sanford & and Turner, 2004). However, the response stimuli were different: The Connors' CPT-II (and the Conners' CPT—3rd Edition now in use) uses the A-X format in only the visual modality, whereas the IVA uses A-X formatting for both visual and auditory stimuli. Furthermore, since it has more clinical scales, the IVA gives more detailed score reports. Specifically, the Connors' CPT-II gave scores for Vigilance, Impulsivity, and Erraticness by measuring reaction time, errors of commission, and errors of omission. The IVA gives Visual and Auditory Response Control Quotients (VRCQ and ARCQ) and Visual and Auditory Attention Quotients (VAQ and AAQ) that are each based on three subscales. The test data also include Attribute scores, and the Symptomatic scales which also have subscales. In addition, the IVA includes a Fine Motor Regulation Scale.

Other than those done by the test developers, few studies have been conducted evaluating the psychometric properties of the IVA. The test developers claim the IVA has adequate reliability and validity (Maddux & Sime, 2007), however there have been few independent peer-reviewed studies evaluating its psychometric properties. Three peer-reviewed studies were found evaluating the clinical utility of the IVA (Corbett & Constantine, 2006; Quinn, 2003; Tinus, 2003). Outside of those three studies, the only other widely available literature on this CPT is the IVA test manual, conference abstracts, and the Mental Measurements Yearbook Review. The Comprehension scale, a subscale of the Symptomatic scale is of particular interest in this study.

The test developers stated that it is intended to "identify random responding by measuring idiopathic errors (Sanford & Turner, 2004, p. 10)." Furthermore, the test developers stated that the "Comprehension Scale is the single most sensitive subscale in discriminating ADHD" (p.10). However, there are no sources apart from the test manual to support this claim; no independent peer-reviewed studies evaluating the psychometric properties of the Comprehension scale exist. Based on a review of the literature, there is a need for further evaluation of its psychometric properties. This study evaluated whether or not there were significant differences between scores for an ADHD group and a non–ADHD clinical group. The sensitivity and specificity of the Comprehension Scale were measured, as well as the ability of this scale to accurately categorize those with ADHD compared to using the Verbal Response Control Quotient (VRCQ) and the Auditory Response Control Quotient (ARCQ) only. The goal of examining these psychometric properties was to evaluate the scale's ability to accurately detect ADHD within a clinical population as well as its ability to detect ADHD compared to using the ARCQ and the VRCQ only.

Test development and construction

The IVA manual (Sandford & Turner, 2004) indicates that test developers investigated 500 test trials and identified seven types of errors. The types of response errors made were used to develop each of the scales. Sanford and Turner found that the rates of these response errors were higher for individuals with ADHD or other attention problems. Measurements of reaction time as well as accuracy and variability under different conditions "gave rise" to 22 raw scale scores (p.26). The test developers did not clearly specify the different conditions used. The scores then were conceptually grouped into the Response Control, Attention, Attribute and Symptomatic scales. Sanford and Turner did not elaborate on how test items were conceptually

grouped. The test developers then standardized the quotient scores to make them analogous to IQ test scores with a mean of 100 and a standard deviation of 15.

Normative sample population

The test developers used a normative sample of 1,700 individuals. They divided the groups by gender, then further grouped the participants by age in groups ranging from ages 6 to 96, with groups including a wider age range of participants as age increased (Turner & Sanford, 1995; http://www.braintrain.com/professionals/adhdtesting/ivaplus_pro.htm). The test developers attempted to have an equal number of males and females in each age group, with about 30 test subjects per group. The normative data was primarily collected in Virginia, Texas, Michigan, California and Florida. According to the IVA website, the sample "included many different ethnic groups." However, data on ethnicity for the normative sample was not included in the manual. Participants were excluded from the study if they "were in therapy, had a history of LD, hyperactivity or attention problems, who were on any type of medication (other than birth control unless >55 years of age), who had a history of neurological problems (e.g., dementia, stroke, or [traumatic brain injury; TBI]) and those who could not validly complete the test." In the Seventeenth Mental Measurements Yearbook (2007), Maddux and Sime restated the available normative data and noted that, while the sample size for each age group is adequate, the lack of available statistics on ethnicity for the normative sample leaves the information about the sample incomplete.

In a study presented at the annual Children and Adults with ADHD (CHADD) conference (1995a), Sandford and Turner reported that they found differences in normative data among the 5-7, 8-10, and 11-13 year old age groups. Specifically, reaction speed increased gradually and linearly as the age of test subjects increased. Scores on Vigilance, Prudence,

Consistency and Off Task Behaviors improved markedly between the age of 6 and 9. Scores on Auditory Prudence and Visual Vigilance showed the steepest increases. Overall these improvements tended to level off at the 11-13 year-old age group. Stamina remained stable for all age groups. Lastly, male participants tended to be faster, while female participants tended to be more prudent. Neither the statistical methods used to conduct the statistical analysis nor the raw data for each group were specified in the available conference brief. The Comprehension scale was not mentioned in this study.

Validity of the IVA

Sandford, Fine and Goldman (1995) presented their study of the diagnostic and concurrent validity of the IVA at the American Psychological Association (APA) annual convention. They found that the IVA's overall sensitivity and specificity in differentiating children diagnosed with ADHD from "normals" was 92% and 90%, respectively. They found that the test's positive predictive power was 89% and negative predicative power was 93%. Compared to two other CPTs and two ADHD rating scales that were not specified in the conference brief, the IVA had the lowest rate of false negatives (7.7%) and a low rate of false positives (10%). The authors found the IVA had "excellent concurrent validity with the other instruments used (90%)" (p.1). The authors did not include sample size, demographic information, or criteria for inclusion in the ADHD and non-ADHD groups in the conference brief.

The Seventeenth Mental Measurements Yearbook (2007) provided more information on the original validity study. Maddux and Sime reported that 26 children diagnosed with ADHD were in the ADHD group and 31 children were in the control group. The children ranged between the ages of 7 and 12. Concurrent validity was examined by comparing the percentage of

subjects correctly and incorrectly identified as having ADHD by three different CPTs (including the IVA) with participants' results on two ADHD rating scales. They did not specify which other CPTs and ADHD rating scales were used in the study. The percentage of participants correctly identified by the instruments ranged between 90% and 100% for the different instruments. As noted previously, the IVA had the lowest percent of false negatives (7.7%). There was no information provided on validity of the Comprehension scale. While the initial validity studies appear promising, additional studies using a larger, more diverse sample with a wider range of age groups were recommended to provide a more accurate estimate of the test's validity.

Reliability of the IVA

Seckler, Burns, Montgomery and Sandford (1995) presented a poster on the test-retest reliability of the IVA at the annual convention of CHADD. Seventy individuals without a history of neurological or current psychological, learning, attention or self-control problems participated in the study. The participants ranged from 5 to 70 years of age. Sixty percent were male and forty percent were female. No other information was provided about selection methods or sample demographics. No individuals with ADHD were included in this study. Participants were administered the test one to four weeks apart. All of the IVA composite quotient scores demonstrated "moderate to very strong" test-retest correlations, with r = 0.45 to 0.75. Analysis of the 22 raw scale scores revealed that 20 scales had significant test-retest correlations, with 18 of the 20 scales demonstrating "moderately strong to very strong correlations" (r = 0.46-0.88). Overall, the authors found that individuals without ADHD did not show substantial practice or learning effects. They concluded that changes in IVA scores can be reliably interpreted to reflect real changes due to medication, treatment or environmental effects. However, further peer-reviewed research is needed to support this conclusion.

In The Mental Measurements Yearbook, Maddox and Sime (2007) critiqued this test-retest reliability study and also condensed the information provided by the original study and in the manual. Maddux and Sime noted that there is only one test-retest study available for the IVA. As noted above, that study used a small sample size and some participant demographic data were not specified. The reviewers also pointed out that reliability estimates varied widely, with reliability for composite scale scores ranging from r = .02 to .88. No specific information was included on test-retest reliability of the Comprehension scale. They concluded that more studies that include an ADHD group, larger sample size and more complete demographic information are needed for a more accurate estimate of the instrument's test re-test reliability.

ADHD and malingering

Quinn (2003) conducted a study comparing the sensitivity and specificity of the ADHD Behavior Checklist to the IVA for diagnosing ADHD in a college population. She hypothesized that the IVA would be more sensitive to simulated malingering than would the ADHD Behavior Checklist, a self-report measure of hyperactive and inattentive symptoms. Furthermore, she hypothesized that malingerers' scores would be more deviant than scores for both participants with ADHD and the control group. Forty-four undergraduates recruited from psychology classes were randomly assigned to either a control group (n = 19) or a feigned malingerer group (n = 23). Also, 16 students with ADHD diagnoses were recruited from the university's Office for Students with Disabilities. No information was collected regarding psychiatric disorders for participants. All participants completed both the ADHD rating scale and the IVA. Quinn used a one-way analysis of variance (ANOVA) with a Tukey HSD post hoc test to assess the ability of IVA scales (including the Comprehension subscale) to distinguish between the 3 groups. The IVA was found to have a sensitivity of .81 and a specificity of .91, while the sensitivity and specificity of the ADHD Behavior Checklist was found to be .69 and .43, respectively. As

predicted, the malingering group scored significantly lower on the IVA than did the ADHD or control group. Quinn found no significant differences in scores between the ADHD and malingering group on the ADHD Behavior Checklist. Quinn concluded that the IVA has greater sensitivity and specificity than the ADHD Behavior Checklist and is more sensitive to malingering than is the ADHD Behavior Checklist. Quinn noted that using a larger sample size and including a community sample and an ADHD group with proportions of the ADHD subtypes more representative of those found in the general population would enhance this study's generalizability.

Other Criticisms

Tinus (2003) conducted a study to determine the relationship between a self-report measure and performance on the IVA in adults with ADHD or mild TBI (mTBI). He hypothesized that there would be a different pattern of deficits on the IVA for these two groups. Specifically, individuals with mTBI were expected to report more impairment on the self-report scale and to demonstrate a positive association between self-report symptoms and performance on the IVA. Participants were 38 adults diagnosed with ADHD, 41 participants with a history of mTBI, and a healthy control group comprised of 41 individuals. The ADHD and mTBI group participants were recruited among individuals referred for a psychological or neuropsychological evaluation. All groups completed the IVA and the Neuropsychological Impairment Scale (NIS), a self-report scale of neuropsychological impairment. The Full Scale Visual and Auditory Attention, Full Scale Visual and Auditory Response Accuracy, Secondary Visual and Auditory Attention, and Secondary Visual and Auditory Response Accuracy scales were found to reflect impairment for both the mTBI and ADHD groups but not for the control group. A multivariate analysis of variance (MANOVA) between-group design was used for statistical analysis. A

follow-up t-test was used to analyze significant univariate analyses. There were no statistically significant differences in the mTBI and ADHD groups' response patterns. In contrast, the self-report scale (NIS) differentiated between the ADHD and mTBI groups on the Frustration Tolerance, Verbal Language Learning and Academic Activities scales. Tinus concluded that the IVA and the NIS tap into different but relevant constructs.

Corbett and Constantine (2006) investigated the utility of the IVA as a tool to aid differential diagnosis and constructing profiles of attentional abilities for children with high functioning autism spectrum disorders (ASD) and ADHD. Three groups of 15 children each (an ADHD group, an ASD group, and a healthy control group), balanced for age, gender and ethnicity, were given the Autism Diagnostic Observation Schedule (ADOS), the Conners' Parent Rating Scale-Revised (Short Form) and the IVA. Participants also were administered the Weschler Abbreviated Scale of Intelligence (WASI) to ensure they met inclusion criteria of a Full Scale Intelligence Quotient (FSIQ) ≥ 70. The authors hypothesized that children with ASD would show attention and response control deficits similar to children with ADHD. Furthermore, they hypothesized that the IVA would adequately discriminate between children with and without attentional symptoms. The authors performed multivariate analyses of covariance (MANCOVA) using age and FSIQ as covariates. They also performed discriminant functional analyses to determine the contribution of IVA scores in predicting ADHD classification. Lastly, Corbett and Constantine calculated Pearson product moment correlation coefficients between the four IVA quotients and the attention and hyperactivity domain scores from the parent report measure. The results revealed the IVA successfully identified attention deficits in each group. The authors found that the participants in both clinical groups had impaired performance on the IVA. Most of the children in the ASD group fell within the IVA's ADHD-Combined Type

category. The only measure that discriminated between the two clinical groups was the Visual Response Control Quotient, with the ADHD group scoring lower than the ASD group. Corbett and Constantine noted that a larger sample size, matching participants for IQ, and including more participants without ADHD symptoms could help improve the generalizability of this study.

Hypotheses

Sandford and Turner (2004) stated in the IVA test manual that the Comprehension scale is the "single most sensitive subscale in discriminating ADHD" (p. 10). Based on a review of the literature no peer-reviewed studies exist that specifically evaluate the ability of the Comprehension scale to discriminate ADHD. Thus there is a clear need to evaluate the psychometric properties of the Comprehension Scale of the IVA to determine its sensitivity in discriminating ADHD, as well as specificity to the disorder.

1. It was hypothesized that there would be significant differences between scores of the ADHD group and the non-ADHD group on the Comprehension Scale. Specifically, the ADHD group was expected to score significantly lower than the non-ADHD group on both Visual and Auditory modalities of the Comprehension Scale.
2. Furthermore, based on the test developers' assertions and initial study it was hypothesized that the Comprehension scale would have adequate sensitivity and specificity.
3. Furthermore, based on the test developers' assertions it also was hypothesized that the Comprehension scale would have better sensitivity and specificity than the VRCQ and the ARCQ.

Method

Participants and Setting

IVA Comprehension scores from an archival database were examined, along with diagnostic and demographic information. One hundred and fifty-one records were extracted. Participants ranged from 17 to 60 years of age referred to a university clinical psychology training clinic for neuropsychological evaluation, primarily to seek college accommodations. Individuals were administered a comprehensive battery of neuropsychological tests. The sample included 52 (34%) males and 99 (66%) females, with a range of 4 to 20 years of education. In the overall sample, 53 (35%) were given an ADHD diagnosis based on DSM-IV-TR criteria; of these, 20 (38%) had a comorbid learning disorder and 19 (37%) had one or more comorbid psychiatric disorders (e.g., anxiety or mood disorder). In the overall sample, 60 (40%) individuals were diagnosed with a learning disorder without ADHD; of these, 11 (7%) had a comorbid psychiatric disorder. See Table 1 for demographic characteristics of the sample. Data from individuals diagnosed with Cognitive Disorder NOS were not analyzed in this study.

Table 1

Demographic characteristics of participant sample

Variable	Number	Percent of sample
Males	52	34
Females	99	66
ADHD diagnosis	53	35
ADHD and comorbid learning disorder	20	38
ADHD and >1 comorbid psychiatric disorder	19	37
Learning disorder only	60	40
Learning disorder and comorbid psychiatric disorder	11	7

For an ADHD diagnosis, the IVA manual suggests that a cutoff score of 85 on the Comprehension subscale is the most useful. In this study, the specificity and sensitivity of additional cutoff scores were explored: ≤ 75 (reflecting moderate impairment), ≤ 79 (reflecting mild to moderate impairment,), and ≤ 82 (reflecting mild impairment).

Results

Using SPSS, independent samples t-tests were performed on visual and auditory Comprehension Scores for the ADHD and non-ADHD groups. Even if using a Bonferroni adjustment for multiple analyses, t-tests revealed significant differences between means of the two groups for both visual $t(149) = -2.73$, $p < .007$ and auditory subscales $t(149) = -2.32$, $p < .021$. However, there was significant overlap between the means and standard deviations for the two groups (see Table 2).

Sensitivity and specificity also were calculated based on Visual or Auditory Comprehension scores that fell below the cutoff point. This analysis of sensitivity and specificity was also intended to help determine the most appropriate cutoff score for an accurate diagnosis. When a cutoff point of 75 was used, the sensitivity, or the test's ability to correctly identify a participant with an ADHD diagnosis, was .38, and the specificity, or the test's ability to correctly identify participants without ADHD, was .76. When a cutoff point of 79 was used, the sensitivity was .42 and specificity was .78. When a cutoff 82 was used, the sensitivity was .50 and specificity was .74. Lastly, when a cutoff point of 85 was used as suggested by test developers, the sensitivity was .51 and specificity was .68.

Table 2

Means, Standard Deviations, and t–scores for ADHD and Control Groups on Comprehension Scales

	ADHD (n = 53)	No ADHD (n = 98)	t - score	Sig (two - tailed
Visual Comprehension	78.87 (31.15)	91.21(23.73)	t(149)= -2.73	0.007*
Auditory Comprehension	81.17 (29.97)	91.65(24.37)	t(149)= -2.32	0.021*

*p< .025

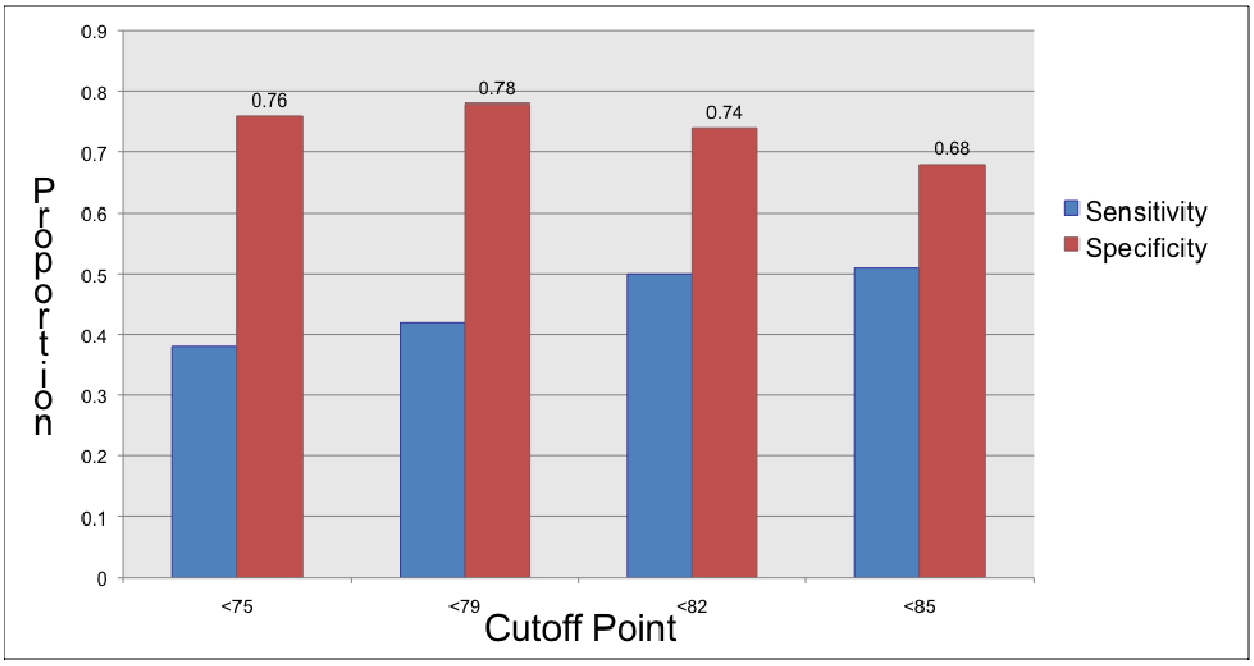

Figure 1. Sensitivity and specificity for various clinical cut off points for the IVA Comprehension Scale.

Overall, as more stringent cutoff points were used, specificity increased while sensitivity decreased (see Figure 1). However, it should be noted while this trend was observable, using different cutoff points resulted in only minimal changes in sensitivity and specificity.

One hundred and thirty-three records were analyzed further (the remainder could not be located due to a physical move of the data). Of these 133, participants also ranged from 17 to 60 years of age. This sample included 67 (50%) males and 66 (50%) females, with a range of 4 to 20 years of education. In the overall sample, 43 (32%) were given an ADHD diagnosis; of these, 12 (9%) had a comorbid learning disorder and 12 (9%) had one or more comorbid psychiatric disorders. In this sample, 53 (40%) individuals were diagnosed with a learning disorder without ADHD; of these, 7 (5%) had a comorbid psychiatric disorder. See Table 3 for demographic characteristics of this sample.

Table 3

Demographic characteristics of sample for further analysis

Variable	Number	Percent of sample
Males	67	50
Females	66	50
ADHD diagnosis	43	32
ADHD and comorbid learning disorder	12	9
ADHD and >1 comorbid psychiatric disorder	12	9
Learning disorder only	53	40
Learning disorder and comorbid psychiatric disorder	7	5

In this sample, we further analyzed sensitivity and specificity for primary and other scales using a cutoff of 85 as recommended by test publishers. Lastly, we analyzed positive predictive power (PPP), or the ability to accurately categorize those with scores below the cutoff, and negative predictive power (NPP), or the ability to accurate classify those with scores above the cutoff, for the Comprehension Scale as well as other scales. See Table 4.

Table 4

Sensitivity, Specificity, Positive Predictive Power, and Negative Predictive Power

	Sensitivity (n = 133)	Specificity (n = 133)	Positive Predictive Power (n = 133)	Negative Predictive Power (n = 133)
Auditory and Visual Comprehension Scales (combined)	0.51	0.69	0.440	0.747
Full Attention Scale	0.40	0.54	0.293	0.653
Auditory and Visual Attention Scales (combined)	0.44	0.41	0.264	0.607
Full Response Control Quotient	0.47	0.62	0.364	0.709
Auditory and Visual Response Control Quotients (combined)	0.60	0.49	0.361	0.721

Discussion

The results of an independent samples t-test supported the first hypothesis that there would be significant differences between the IVA Comprehension Scale scores for the ADHD group and the non-ADHD group, with the ADHD group scoring significantly lower than the non-ADHD group. However, there was considerable overlap between the mean scores for the two groups due to the relatively large standard deviations.

The second hypothesis, that the IVA Comprehension Scale would have adequate sensitivity and specificity, was partially supported. While the acceptability of sensitivity and specificity will differ across clinical groups, it can be argued that the scale has adequate specificity across cutoff scores of 75, 79, and 82 (.76, .78, and .74, respectively). However, in this clinical population the Comprehension Scale did not correctly classify participants with ADHD at better than chance levels. In this study, a cutoff point of 85 had the highest sensitivity (.51) and did the best job of identifying individuals in this study with ADHD compared to the other cutoff points used. This finding supported the test developers' assertion that a cutoff point of .85 was the most useful for classification purposes.

The additional analyses of sensitivity and specificity for the Full Attention Scale, combined Visual and Auditory Attention Scale and the Full Response Control Quotient produced similar results. That is, sensitivity (.40 to .51) was considerably lower than specificity (.41 to .62) for each of the scales. In line with this, PPP and NPP of all scales demonstrated lower PPP than the NPP. Sensitivity of the combined Visual and Auditory Response Control Quotient (.60) was higher than was sensitivity of the Comprehension scale (0.51); however, the PPP of the combined Response Control Quotient (.361) was lower than for the Comprehension scale (.44). Thus, these results are inconclusive as to whether or not the Comprehension Scale is the single

most sensitive score for classifying ADHD as asserted by test publishers. However, this study would need to be replicated using a larger data set before more definite conclusions could be drawn.

In this study the IVA Comprehension scale correctly identified individuals without ADHD better than individuals with ADHD. Because the Comprehension Scale of the IVA may only correctly identify individuals with ADHD 51 percent of the time using the recommended clinical cutoff score of 85, the scale alone should not be used alone for ADHD diagnosis. Instead, as recommended by test publishers, results from the entire IVA should be considered in conjunction with a clinical interview and self-report as well as collateral data. This is consistent with the fact that ADHD presents as a very heterogeneous disorder (APA, 2000).

Only four studies found analyzed the IVA, and most of the information available is from test developers. Alhough the test had an adequate sized normative sample, the ADHD group in the validation study was small (n = 31). No peer-reviewed research has been done on the Comprehension scale using a community sample referred for neuropsychological assessment. This may be why sensitivity and specificity in this study were lower than what was found in the available published literature.

This study was done using archival data from individuals referred to a psychology training clinic for a cognitive assessment. Many individuals chose this clinic because of its reduced cost. Because of this, this sample was self-limiting to individuals with a low to moderate income. Including data across more diverse settings could help improve the generalizability of this study. Future studies could use a larger sample from multiple databases. Lastly, this study focused on only the Comprehension Scale of the IVA. Future studies could examine other scales

to investigate the overall ability of the IVA to discriminate ADHD compared to the Comprehension scale and to determine the most useful score profile

In conclusion, this study calls into question the Comprehension Scale's clinical utility in 'the real world' as "the single most sensitive subscale in discriminating ADHD" (Sanford & Turner, 2004, p.10). Further studies will be needed to confirm this and should investigate clinical utility of the IVA's other scales using a larger and more inclusive sample.

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