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Psychometrically Informed Approach to Integration of Multiple Informant Ratings in Adult ADHD in a Community-Recruited Sample

Michelle M. Martel¹, Joel T. Nigg², and Ulrich Schimmack³

¹University of Kentucky, Lexington, KY, USA

²Oregon Health & Science University, Portland, OR, USA

³University of Toronto, Toronto, Ontario, Canada

Abstract

Although *Diagnostic and Statistical Manual of Mental Disorders–Fifth edition* requires that attention-deficit/hyperactivity disorder (ADHD) symptoms are apparent across settings, assessed by multiple informants, there remains no standardized approach to integration of multiple sources in adult ADHD diagnosis. The goal of the study was to evaluate informant effects on adult ADHD symptom ratings. Participants were 406 adults, ages 18 to 37, and identified second reporters, recruited from the community, and completing a comprehensive diagnostic and cognitive assessment, including a clinician-administered diagnostic interview and self- and other-report questionnaires of ADHD symptoms. Structural equation modeling indicated good fit for a trifactor model of ADHD, including general ADHD, specific inattention and hyperactivity–impulsivity, and self- and other-perspective factors. Yet there were a number of symptoms on the specific hyperactive–impulsive and self-factors that exhibited nonsignificant loadings. Significant differential item functioning across self-ratings and informant ratings was also noted. The external validation indices of laboratory executive function and diagnostic team-rated impairment was significantly correlated with the specific inattentive factor. While executive function was marginally significantly correlated with the other perspective factor, impairment was associated with the self-perspective factor. Overall, inattentive symptoms may be more sensitive measures of adult ADHD, and other and self-ratings may provide different information in relation to external criteria.

Keywords

assessment; diagnosis; adults; structural equation modeling; ADHD

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Corresponding Author: Michelle M. Martel, Psychology Department, University of Kentucky, 207C Kastle Hall, Lexington, KY 40506, USA. michelle.martel@uky.edu.

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The *Diagnostic and Statistical Manual of Mental Disorders–Fifth edition (DSM-5)* continues to operationalize attention-deficit/hyperactivity disorder (ADHD) with a list of nine inattentive and nine hyperactive–impulsive behavioral symptoms, of which diagnosis requires that individuals must manifest six in one of the two symptom domains for children, or five for adults, as well as substantial interference in functioning occurring in two or more settings (e.g., at home and at school or work; American Psychiatric Association [APA], 2013). The *DSM-5* text strongly encourages clinicians to obtain information from more than one informant covering more than one setting. The text (APA, 2013, p. 36) explains that “several inattentive or hyperactive-impulsive symptoms are present in two or more settings (e.g., at home, school, or work; with friends or relative; in other activities)” and further states that “confirmation of substantial symptoms across setting typically cannot be done accurately without consulting informants who have seen the individual in those settings” (pp. 37–38). A key gap in the *DSM* is that it does not specify how the information from the different informants should be combined. This issue is particularly problematic for adults since they may have a more difficult time identifying a second reporter besides themselves depending on their living situation and occupational setting.

Adult ADHD diagnosis is valid and substantially stable from childhood (Faraone & Biederman, 2005; Kessler et al., 2006), now typified in the *DSM-5*, but evidence-based guidelines for diagnosis of ADHD in adulthood are still emerging (APA, 2013). Although prior research, conducted mostly in childhood, has established moderate convergent validity of multiple informant ratings of psychopathology (De Los Reyes, 2013; De Los Reyes et al., 2011; De Los Reyes et al., 2015; Dirks, De Los Reyes, Briggs-Gowan, Cella, & Wakschlag, 2012), there is less work on multiple informant ratings of psychopathology in adulthood. Some work on ADHD symptom report in adulthood suggests similar, moderate convergence across raters of adult ADHD, usually the self and some other, typically a parent or partner (Adler et al., 2006; Barkley, Knouse, & Murphy, 2011; Biederman et al., 2006; Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999; Kessler et al., 2007). However, it should be noted that this remains controversial as some studies question the validity of adult self-report of adult ADHD symptoms, and there is some suggestion that adults with ADHD underreport or overreport on their symptoms in particular (see seminal book chapters by Barkley, Murphy, & Fischer, 2008; see also Barkley, Fischer, Smallish, & Fletcher, 2002; Klein et al., 2012; Mannuzza, Klein, Bessler, Malloy, & LaPadula, 1993, 1998; Molina & Sibley, 2014; Sibley et al., 2012). In all, these prior studies have provided crucial documentation that examining convergence across self-report and other report of ADHD symptoms in adulthood is critically important to advancing clinical practice and diagnosis of ADHD in adulthood.

There is currently no consensus about how to assess for such convergence or about the optimal way to integrate symptom ratings across multiple informants to diagnosis adult ADHD. At present, researchers and clinicians use a variety of ad hoc approaches. Following the approach taken in the *DSM-IV* field trials (Lahey et al., 1994), the most common approach utilized to date in research studies is the “or” algorithm. The “or” algorithm specifies that a symptom is present if at least one rater endorses a symptom as present. After determining whether a symptom is present, the manifest symptoms are then added up to create a sum score (e.g., five out of nine inattentive symptoms endorsed by either rater). This approach to integration of symptom ratings across multiple informants is simple, easily

standardized, and reasonably easy to utilize in clinical and research settings. Yet this approach also has several problems that may lower the validity of ADHD diagnoses (Solanto & Alvir, 2009; Valo & Tannock, 2010). For example, if one rater overreports or agrees to all symptoms, ratings of the other rater are essentially ignored because it is sufficient for one rater to endorse a symptom. This defeats the intent of demonstrating or confirming that symptoms are substantially present in two or more settings by confirmation of two or more raters. Furthermore, depending on the nature of the second reporter's ratings, underreporting may not be able to be detected. These undesirable limitations of the "or" algorithm thus can undermine the intended benefit of multimethod assessments where adding more data sources should increase validity (Campbell & Fiske, 1959; Connelly & Ones, 2010). Thus, despite its convenience, it is far from clear that the "or" algorithm yields the most valid diagnosis of ADHD. Other methods have their own weaknesses, however, so the question remains as to whether alternatives can do better.

Innovations in advanced modeling approaches have the potential to shed light on the best way to integrate cross-informant ratings, but have been little utilized in this context. A trifactor model provides one example of a viable measurement model with particular relevance to multiple informant ratings of a construct. In this model, use of specific items rated by multiple informants allows simultaneous estimation of common (consensus) views of target behaviors (or trait aspects of behavior), the unique perspectives of each informant, as well as specific variance associated with each symptom domain or individual item (Bauer et al., 2013). In principle, the results, if established, could be converted to a clinical algorithm. In line with the utility of such a model, prior work has established that a related bifactor model may provide the best approximation of ADHD (Martel, von Eye, & Nigg, 2010; Toplak, West, & Stanovich, 2013). A bifactor model allows for individual ADHD symptoms to simultaneously load onto an overall, or "general" ("g"), ADHD factor along with completely or partially distinct ("specific"; "s") inattention and hyperactive-impulsive latent components. A trifactor model builds on that foundation to add individual informant perspectives to the model.

The current study sought to extend prior work by providing, to our knowledge, the first empirical comparison of how to best integrate multiple informant ratings of ADHD through an advanced trifactor model of ADHD that allows for examination of the relatively well-established bifactor model of ADHD with inclusion of informant perspectives. Differential item functioning of symptoms as rated by self and other were examined. External validation of model factors using impairment and laboratory executive function tasks, commonly associated with ADHD, were explored.

Method

Participants

Overview—Participants were 406 adults (197 men), 18 to 37 years old ($M = 23.65$, $SD = 4.53$), recruited from the community via media advertisements and general mailings/flyers for a study of the development of attention abilities and mailings to clinics targeting individuals with and without possible attention problems. Therefore, these are not principally clinic-referred individuals but rather primarily reflect ADHD as it appears in the

community; treatment rates and sex ratios seen in the current sample reflect what is expected in a community, not a clinic, sample. However, we deliberately overenrolled individuals with ADHD or serious attention problems to ensure adequate coverage and representation of the clinical construct.

Volunteering adults were thoroughly evaluated for study eligibility and diagnostic status, based on *DSM-IV-TR* criteria (APA, 2000) as described below (note that *DSM-IV* required six symptoms of either inattention or hyperactivity/impulsivity, whereas *DSM-5* requires only five). After that evaluation, they were either excluded, assigned to one of two groups: ADHD ($n = 145$) and non-ADHD comparison ("controls," $n = 201$), or classified as having situational or subthreshold ADHD ($n = 60$); some of the latter would meet *DSM-5* criteria as having five symptoms. This sampling was intended to achieve the goals of providing full representation of the ADHD syndrome, as well as full representation of the dimensional trait space of ADHD symptoms (Haslam et al., 2006; Marcus & Barry, 2011). Based on their historical and current symptoms, the ADHD group included predominantly inattentive type (ADHD-PI; $n = 64$) defined as met criteria for six or more inattentive symptoms, plus impairment, onset, and duration, and never in the past met criteria for combined type on the basis of self-interview and parent/other interview as detailed below), combined type (ADHD-C; $n = 63$, defined as met criteria for six or more inattentive symptoms and six or more hyperactive-impulsive symptoms, plus impairment, onset, and duration), and hyperactive-impulsive type (ADHD-PHI; i.e., $n = 18$, met criteria for six or more hyperactive-impulsive symptoms, plus impairment, onset, and duration). A total of 6% of the entire sample, including those with and without ADHD, met criteria for major depressive disorder, 11% for generalized anxiety disorder, and 10% for borderline personality disorder.

The sample was broadly representative of the community from which they were recruited, approximately 15% ethnic or racial minority and a wide range of socioeconomic status. Approximately 10% of the ADHD group were currently prescribed psychostimulant medication. All participants completed written informed consent, and study procedures were approved by the university institutional review board.

Identification and Recruitment—As described in prior studies of this sample (Nigg et al., 2005; Stavro, Ettenhofer, & Nigg, 2007), recruitment and ascertainment was conducted using a diverse set of recruitment strategies including radio, newspaper, and movie theater advertisements and general mailings/flyers targeting individuals who think they might have attention problems and/or advertising a study of the development of attention, as well as mailings to local clinics (although less than 10% of the sample came from clinic advertisements), in order to recruit a sample of community volunteers with and without attention problems with deliberate oversampling of attention problems and true ADHD compared with the general population.

Prospective participants then underwent a standard multi-gate screening process. At Stage 1, participants completed a telephone screen to assess eligibility. To be eligible to participate in the study, participants had to be a native English speaker and not have a sensorimotor disability, neurological illness, or be on a current prescription for antidepressant, antipsychotic, or anticonvulsant medication. These eligibility criteria were chosen to ensure

study participants could adequately understand task instructions and to eliminate the confounds of comorbid conditions and medication use that could affect cognitive performance. Participants who passed this stage of screening went on to a second stage of screening.

At Stage 2, eligible participants completed semistructured interviews and standardized normative rating scales, described below, to ascertain *DSM-IV-TR* ADHD and comorbid psychopathology. Participants completed a retrospective Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS-E; Puig-Antich & Ryan, 1986) to assess current and past ADHD symptoms. Adult participants also completed the Barkley and Murphy's (1998) Current ADHD Symptoms Rating Scale, the Conners, Erhardt, and Sparrow's (1999) Adult ADHD Rating Scale, the Achenbach's (1991) Young Adult Self-Report, and the Brown's (1996) Adult ADHD Rating Scale (all measures were the most current available at the time of data collection).

Crucially given concerns with veridicality of adults self-report of ADHD symptoms, and as recommended by best practices and expert recommendations (Barkley et al., 2011), two other informants also reported on every participant's ADHD symptoms, as well as their potential mood symptoms, impairment, and drug use. One informant who knew the participant well when they were a child (usually a parent) reported on childhood ADHD symptoms via a structured interview (retrospective K-SADS ADHD module) and a standardized rating scale (the ADHD Rating Scale). The second informant knew the participant well currently, usually a partner or friend, that is, whoever the participant identified as having the most knowledge of their daily behavior. This informant completed a structured clinical interview (K-SADS ADHD module) on current symptoms, and a standardized rating scale (Conners Adult ADHD Rating Scale), and the Barkley and Murphy (1998) scale. They also completed a brief screen of antisocial behavior and drug and alcohol use.

A clinical diagnostic team consisting of a board-certified child psychiatrist and licensed clinical child psychologist, each with more than 10 years of experience, then used this information to arrive at a "best estimate" diagnosis (Faraone, 2000). Each member reviewed ADHD symptom counts from the semistructured interviews, interviewer observation notes, and raw scores and *T* scores from the rating scales, and independently judged whether ADHD was present or absent, ADHD subtype (if applicable), and comorbid disorders. Each member reviewed information individually to reach a diagnostic decision based on aggregation of all aforementioned information, and then these decisions were compared. In the case of disagreement, consensus was reached by discussion. Interrater agreement prior to conference was satisfactory on presence or absence of ADHD ($\kappa = .80$) and ADHD subtype (κ ranged from .74 to .89). The diagnostic team also came up with a Global Assessment of Functioning (GAF) impairment rating (described below).

Measures

For the analytic models, the following measures were abstracted and used.

ADHD Symptom Counts—Current ADHD symptoms were obtained via self-report and other report on the Barkley and Murphy (1998) ADHD Rating Scale. Individual symptoms were coded on a 1 (*absent*) to 3 (*present*) rating scale. These individual symptom scores were utilized in structural equation modeling analyses.

Impairment—The diagnostic team generated a GAF estimate of individual impairment after reviewing all diagnostic data. Such estimates ranged from 1 to 100, as described and anchored in *DSM-IV-TR* (APA, 2000). Lower scores indicate worse impairment. This index was reliable in the current sample.

Executive Function—For external validation purposes, we utilized neuropsychological testing scores that were available on this sample. All testing was done after a minimum medication washout period of ~ 7 half lives (i.e., 24 hours for short-acting preparations and 48 hours for long-acting preparations). The testing battery included measures of response inhibition, set shifting, and working memory (see Nigg et al., 2005, for details; also Huang-Pollock, Nigg, & Carr, 2005). They were administered in a fixed order as follows.

Response suppression/inhibition: Go-Stop task—The Go-Stop task (Logan, 1994) was administered to assess response inhibition; it requires the suppression of a prepotent motor response. During this Choice Reaction time task, participants see an X or an O on a computer screen and respond rapidly with one of two keys to indicate which letter they had seen (called Go Response trials). On 25% of trials, a tone sounds shortly after the X or the O is displayed, indicating that participants are to withhold their response. A stochastic tracking procedure was used; stop signal reaction time was computed as an index of how much warning each participant needs to interrupt a response. Trials are presented across eight blocks. Stop signal reaction time was calculated by subtracting the average stop signal delay from the average Go Response time (Logan, 1994) after cleaning the data to remove anticipations (<100 ms), excessive slow responses (>1,500 ms), or blocks in which the participant appeared not to be doing the task (X/O accuracy <80% or probability of stopping <20% or >80% on average for a block of trials).

Reaction time variability: Go-Stop task—The within-person variability of the reaction time on the Go Response trials from the Go-Stop task was retained as a measure of response variability, again after removing responses <100 ms or >1,500 ms.

Set shifting: Trail Making Test—The Trail Making Test is a widely used timed paper-and-pencil test consisting of two parts (Reitan, 1958). Part A requires the participant to draw a line connecting numbered circles in sequential order. Part B requires the participant to draw a line connecting numbered and lettered circles in alternating sequential–alphabetical order. Time taken to complete Part B was utilized as the outcome measure of set shifting (Arbuthnott & Frank, 2000).

Perseveration: Wisconsin Card Sorting Task—The Wisconsin Card Sorting Task is a widely used, computer-administered task assessing working memory and set shifting (Heaton, Chelune, Talley, Kay, & Curtiss, 1993). Up to 64 trials were administered in which the participants sorted cards on the basis of shifting criteria of color, shape, and numbers.

The participant is not told how to sort, but receives feedback from the computers regarding whether they sort correctly or incorrectly. Number of perseverative errors was the outcome variable.

Data Reduction and Analysis

Confirmatory factor analysis was conducted on all executive function summary scores described above to form a single latent factor we termed *executive function* for purposes of this report (root mean square error of approximation [RMSEA] = .11; comparative fit index [CFI] = .82). All executive function measures loaded significantly on this factor (all $p < .05$) with set shifting exhibiting the highest loading of .82. This executive function latent factor was used as an external validation for latent factors.

To fit the trifactor model of ADHD ratings, structural equation modeling was conducted in *Mplus* (version 6.11) using theta parameterization and weighted least squares means and variance adjusted estimation, as recommended for ordinal items (Muthen & Muthen, 2013). As a data analytic check, a fully constrained and freely estimated trifactor model was fit across ADHD and non-ADHD groups to examine invariance across diagnostic groups. Based on power concerns (each diagnostic group comprised slightly over 100 individuals), main analyses focus on the full group, but differences in results based on meaningful ADHD and non-ADHD variance are noted where relevant.

Results

Utilizing self-ratings and other ratings of ADHD symptoms, a trifactor CFA model was fit. This model, shown in simplified form in Figure 1, separates general ADHD trait variance from inattentive and hyperactive–impulsive symptom domain variance and informant (i.e., self and other) perspective variance. The initial model exhibited good model fit to the data (Hu & Bentler, 1999; McDonald & Ho, 2002) with $\chi^2(525) = 607.51$ ($p < .01$), an RMSEA of .021 (90% confidence interval [CI] [.012, .028]) and CFI of .99, suggesting that—once the unique perspectives of each informant and variance unique to each individual symptom domain are accounted for—all individual informant reports on individual items contributed significantly to the general ADHD construct. A fully constrained, or invariant, trifactor model based on ADHD diagnostic status fit reasonably well with $\chi^2(1186) = 2119.02$ ($p < .01$), an RMSEA of .075, and CFI of .64. The freely estimated trifactor model across both diagnostic groups fit slightly better with $\chi^2(1081) = 1867.40$ ($p < .01$), an RMSEA of .072, and CFI of .69.

Across the full group and as shown in Table 1, factor loadings across raters were uniformly statistically significant on the general ADHD factor with self-rated item loadings slightly higher (.51–.88) than other-rated item loadings (.18–.67). On the specific inattentive factor, other-rated symptom loadings were all significant, but self-rated “mental effort,” “distracted,” and “forgetful” symptoms were not significant. For the specific hyperactive–impulsive factor, “fidgets” and “on the go” did not load significantly as rated by self or others. Other-rated “plays quietly” and “waiting turn” did not significantly load on the specific hyperactive–impulsive factor, and self-rated “leaves seat” and “runs or climbs” did not load significantly on the specific hyperactive–impulsive factor. Thus, there appear to be some

hyperactive–impulsive symptoms that were not good items across raters, as well as some hyperactive–impulsive items that exhibited differential effects based on rater. Finally, for the rater-specific factors, while all other-rated symptom items exhibited significant loadings on the other perspective factor, self-ratings for the symptoms of “fidgets,” “leaves seat,” runs or climbs,” “plays quietly,” “on the go,” “talks,” and “blurts out” were nonsignificant on the self-perspective factor.

Threshold parameter estimates for the full model are shown in Table 2. These are akin to difficulty or severity parameters in item response theory, in that they represent differences between items in the probability of a given response option being endorsed, independent of the latent trait. There is one threshold parameter for each boundary between one response option and the next (i.e., one for the boundary between responding “0” and “1” [*absent*], another for the boundary between “1” and “2,” and another for the boundary between “2” [*subthreshold*] and “3” [*present*]). For many symptoms, the subthreshold option was not endorsed for any participants, leading to only 2 thresholds being available. The thresholds shown in Table 2 suggest that, for many symptoms, the full range was not utilized by either the self or others, but—when the full range was utilized—self and others were more likely to rate individuals more highly based on higher general ADHD problems. Both self and others exhibited this pattern of utilizing the whole range with higher ratings indicating more ADHD problems for the symptom “follow through.” Self-ratings also followed this pattern for the symptom “sustained mental effort.” Other ratings followed this pattern for the symptoms “sustained attention,” organization,” and “loses things.” Therefore, “follows through,” “sustained attention,” “organization,” and “loses things” seemed to be particularly sensitive items, especially as rated by others.

Differential Item Functioning Across Self-Ratings and Other Ratings of Symptoms

Differential item functioning was next evaluated for all levels of trifactor model sequentially. First, differential item functioning at the general factor level was tested by constraining the general factor loadings for the same item across informants to be the same; that is, we constrained the loading of inattentive symptom #1 (and all symptoms) on the general factor to be equivalent across the self and other. This model fit significantly worse ($\chi^2[17] = 99.21, p < .01$; RMSEA = .029; 90% CI [.023, .035]; CFI = .99) than the first model where all loadings were freely estimated. This suggests that informants are not equivalent in their ability to rate the overall ADHD factor after controlling for specific informant perspectives and specific ADHD symptom domains.

We next tested differential item functioning at the specific inattention and hyperactivity–impulsivity factor level by constraining the inattentive and hyperactive–impulsive factor loadings for the same item across informants to be the same; that is, we constrained the loading of inattentive symptom #1 (and all symptoms) on the *inattentive* factor (and hyperactive–impulsive factor) to be equivalent across self and others. This model also fit significantly worse than the baseline model ($\chi^2[25] = 115.75, p < .01$; RMSEA = .029; 90% CI [.023, .035]; CFI = .99), suggesting that self and others did not agree in their report of individual items in the specific ADHD symptom domains of inattention and hyperactivity–impulsivity.

Finally, we tested differential item functioning at the level of thresholds, or informant differences in ratings of severity of individual symptoms. This model also fit significantly worse than the baseline model ($\chi^2[36] = 88.27, p < .01$) with an RMSEA of .026 (90% CI [.019, .032]) and a CFI of .99, suggesting that different raters did not similarly endorse levels of symptoms. Tests of diagnostic invariance across ADHD and non-ADHD subgroups suggested that differential item functioning across diagnostic groups was particularly evident at the level of specific inattentive and hyperactive-impulsive factors ($\chi^2[50] = 153.57, p < .01$).

Therefore, self-ratings and other ratings of ADHD symptoms were significantly different from one another at the general, specific, and threshold levels.

External Validation With Executive Function and Impairment

Bivariate correlations were next conducted between the freely estimated trifactor latent factors (i.e., general ADHD, specific inattention, specific hyperactivity-impulsivity, self, and other) and the executive function latent factor. As shown in Table 3, the executive dysfunction latent factor was significantly correlated with increased specific inattention ($r = .43, p < .01$, driven by non-ADHD group) and marginally with the general ADHD latent factor ($r = .19, p = .09$, not seen in either ADHD or non-ADHD group when examined separately) and high ratings of ADHD based on the other perspective ($r = .20, p = .081$, seen in both ADHD and non-ADHD groups). However, the executive function latent factor was not significantly correlated with specific hyperactivity-impulsivity ($r = -.15, p = .16$) or the self-perspective ($r = .06, p = .49$). Significant and nonsignificant correlations significantly differed from one another ($p < .05$). As a secondary check on these results, correlations were also conducted between the executive function task exhibiting the highest loading on the executive function latent factor, set shifting, and the trifactor latent factors. Set shifting was significantly correlated with specific inattention ($r = .28, p < .01$) and higher ratings of ADHD symptoms based on the other perspective ($r = .20, p < .05$), but not with any of the other latent factors ($r = -.11-.13, p > .05$).

Bivariate correlations were also conducted between the freely estimated trifactor latent factors (i.e., general ADHD, specific inattention, specific hyperactivity-impulsivity, self, and other) and the GAF impairment index generated by the diagnostic team. As shown in Table 3, more GAF impairment (i.e., low ratings of functioning) was significantly correlated with increased general ADHD latent factor ($r = -.55, p < .01$, driven by non-ADHD group) and specific inattention ($r = -.29, p < .01$, driven by ADHD group) and high ratings of ADHD based on self-perspective ($r = -.27, p < .01$, driven by non-ADHD group). However, GAF impairment was not significantly correlated with specific hyperactivity-impulsivity ($r = -.06, p = .25$) or the other perspective ($r = .01, p = .87$). Again, significant and nonsignificant correlations significantly differed from one another ($p < .05$).

Therefore, both executive function and impairment were significantly associated with general ADHD and specific inattention, but while executive function was significantly associated with other ratings of symptoms, impairment as rated by a diagnostic team was significantly associated with self ratings.

Discussion

To advance the field's consideration of the optimal strategy for combining reports from multiple informants in the assessment of ADHD in adults, the current study provided the first use of an advanced trifactor model of ADHD. This model has the advantage of allowing for examination of the relatively well-established bifactor model of ADHD with inclusion of informant perspectives. Results suggested that self reports and other reports of adult ADHD symptoms provide different information about the latent ADHD construct, function differentially, and are endorsed differentially based on similar levels of ADHD-related problems. External validation with laboratory executive function tasks and impairment rated by a diagnostic team suggest that inattention may be a more developmentally sensitive manifestation of ADHD during adulthood and that others and self provide different information in relation to external criteria. These results have implications for clinical practice and diagnosis that we discuss below.

In line with prior work (e.g., Amador-Campos, Forns-Santacana, Martorell-Balanzo, Guardia-Olmos, & Pero-Cebollero, 2006; Martel et al., 2010; Toplak et al., 2009), once the unique perspectives of each informant and variance unique to each individual symptom domain was accounted for, all individual informant reports on all individual symptoms contributed significantly to the general ADHD construct. This is consistent with theory of cross-situational convergence of ADHD-related behaviors (APA, 2013). Notably, on the general ADHD factor, self-rated symptoms loaded somewhat higher than informant-rated symptoms. This may suggest a form of bias in which individuals may be somewhat more likely than others to rate individual symptoms in line with their general idea of whether they believe they have global ADHD-related problems.

Other informant ratings of all inattentive symptoms on were significant, suggesting that other (vs. self) informants may be especially important raters of inattentive behaviors. Although self-ratings for most symptoms on the specific inattention symptom were significant, self-ratings for certain symptoms, that is, "mental effort," "distracted," and "forgetful" symptoms were not significant, suggesting that other ratings on these particular symptoms may be especially informative. "Fidgets" and "on the go" symptoms did not load significantly on the specific hyperactive-impulsive factor as rated by self or others, suggesting these symptoms may not be as sensitive to ADHD symptom manifestation in adulthood, in line with some prior work (Kessler et al., 2010; Martel, von Eye, & Nigg, 2012), although it should be noted that the expanded form of these items just recently published in *DSM-5* were not utilized in the current study. Furthermore, "plays quietly" and "waiting turn" did not load significantly on the specific hyperactive-impulsive factor, as rated by others, and "leaves seat" and "runs or climbs" did not load significantly on the specific hyperactivity-impulsivity factor, as rated by the self, suggesting these items may also be less sensitive to adult manifestation of ADHD symptoms or differentially accessible or notable to different raters.

Importantly, there were striking differences in self- and other- item loadings on their respective perspective factors, after controlling for general ADHD and specific inattention and hyperactivity-impulsivity. While all other-rated symptom items exhibited significant

loadings on the other informant–perspective factor, self-rated item loadings for the symptoms of “fidgets,” “leaves seat,” “runs or climbs,” “plays quietly,” “on the go,” “talks,” and “blurts out” were nonsignificant on the self-perspective factor. Therefore, the other informant perspective seemed more coherent across symptom ratings, compared with the self-perspective.

In line with this idea that self and others provide different information about ADHD symptoms, differential item functioning was found for ratings at the general ADHD level and the specific inattention and hyperactivity–impulsivity level. That is, self and others appear to rate the same symptoms quite differently. This supports prior work that also suggested that informants provide unique information about ADHD symptoms in adults (Barkley et al., 2002; Barkley et al., 2008; Mannuzza et al., 1993, 1998; Molina & Sibley, 2014; Sibley et al., 2012). In our data, threshold parameter estimates (similar to severity parameters in item response theory), suggested that other informants exhibited more sensitive ratings in that they rated individuals as higher on symptoms given higher levels of ADHD problems, particularly on the following ADHD inattentive items: “follow through,” “sustained attention,” “organization,” and “loses things.” Therefore, these particular symptoms, as rated by others, may have utility for screening or short form ADHD ratings. Thus, we concur with Kessler et al. (2010) and Barkley et al. (2008) that differential validity of self reports and other reports of ADHD symptoms merit further examination. In any case, differential item functioning tests indicated that self and others did not similarly rate symptoms given comparable levels of ADHD problems.

Finally, external validation using executive function tests and impairment as rated by a diagnostic team supported the utility of a focus on inattentive symptoms in adulthood (Barkley et al., 2008; Kessler et al., 2010). Inattentive symptoms may be more sensitive to adult ADHD symptom manifestation, in line with prior work (Martel et al., 2012). Yet, while other ratings (but not self ratings) of adult ADHD symptoms exhibited significant correlations with laboratory executive function tasks, self-ratings (but not other ratings) of ADHD symptoms exhibited significant correlations with impairment rated by a diagnostic team. Thus, results are consistent with the idea that self and others provide different information about symptom manifestation in relation to external criteria (Achenbach, 2006; De Los Reyes et al., 2015) and therefore that preserving their unique inputs in some fashion is important. Therefore, it is likely that ultimately a weighted combination of self-symptom and other-symptom ratings with an emphasis on inattentive symptoms might be useful for diagnostic purposes. Models like that shown here can be helpful in developing such algorithms, which would likely be implemented by clinicians with the aid of handheld computers. That is, particular symptoms might warrant differential weighting by informant. For example, in the current data, other informant ratings of the inattentive symptoms of “follow through,” “sustained attention,” “organization,” and “loses things” would be prioritized over self ratings on these symptoms. Of course, such an idea would first need to be replicated in other samples and appropriate normative and standardization data prior to clinical application.

Despite the promise and implications of our approach, several limitations of the study deserve mention. ADHD is a complex, multifaceted disorder with substantial interindividual

heterogeneity, currently represented by three presentations, or subtypes (APA, 2013; Sonuga-Barke, 2003); the model may not accurately capture clinical heterogeneity. In addition, the inclusion of executive function and impairment as external validators is a study strength; yet other external validation measures (e.g., academic performance, social functioning, observational ratings), including additional psychological tasks (e.g., reward or choice delay) that are conceptually related more to impulsivity than inattention, might yield different findings. Although we used a community recruitment strategy and detected no obvious selection bias in relation to socioeconomic status, race, income, comorbidity, or sex ratios, and this method protects to some extent against feigning of ADHD, this was a volunteer sample which may have introduced other unknown bias in relation to clinical features relative to the entire population of individuals with ADHD. For example, some individuals with ADHD deny their symptoms and/or may be unwilling to participate in a study, and this may introduce unknown bias relative to the entire population of individuals with ADHD. Nonetheless, these data illustrate the promise in utilizing a more psychometrically informative approach to build toward next generation diagnostic algorithms.

Since ADHD is a neurodevelopmental disorder, it will be particularly important for future work and replications to evaluate possible developmental change in this model across the lifespan; results by Martel, Schimmack, Nikolas, and Nigg (2015) in childhood sample, for example, suggest that parent and teacher reports of childhood ADHD symptoms may, in many instances, be best averaged. Furthermore, consideration of the expanded developmental descriptors for *DSM-5* adulthood ADHD symptom items is also an important future direction (see Matte et al., 2015).

Overall, study results suggest that improved, empirically based algorithms for combining self reports and informant reports are tractable for ADHD. Furthermore, the inattentive symptom domain appears more sensitive than hyperactivity–impulsivity to adult ADHD manifestation, and self-ratings versus other ratings appear to provide different information in relation to external validation criteria, here, executive function and impairment. Future diagnostic algorithms should incorporate such insights into next generation diagnostics.

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Figure 1.
Simplified trifactor model.

Note. ADHD = attention-deficit/hyperactivity disorder.

Table 1

ADHD Symptom Loadings in Trifactor Model.

	ADHD general factor	Inattention factor	Hyperactivity-impulsivity factor	Self-factor	Other-factor
<i>Self-report</i>					
Close attention	.50**	.50**		.50**	.34**
Sustain attention	.88**	.31**		.27**	.49**
Listens	.76**	.32**		.25**	.37**
Follow through	.65**	.34**		.35**	.38**
Organizing	.53**	.45**		.46**	.36**
Mental effort	.62**	.13		.37**	.25**
Loses things	.53**	.45**		.30**	.33**
Distracted	.86**	.20		.27**	.53**
Forgetful	.68**	.23		.50**	.38**
Fidgets	.85**		.07	-.10	.49**
Leaves seat	.77**		.15	-.06	.67**
Runs or climbs	.91**		.09	-.16	.64**
Plays quietly	.74**		.33**	.06	.56**
“On the go”	.60**		.14	.04	.46**
Talks	.51**		.54**	.07	.36**
Blurts out	.62**		.51**	.13	.58**
Waiting turn	.69**		.29**	.20*	.53**
Interrupts	.62**		.51**	.20*	.54**
<i>Other report</i>					
Close attention	.34**	.63**			
Sustain attention	.56**	.45**			
Listens	.34**	.36**			
Follow through	.36**	.47**			

	ADHD general factor	Inattention factor	Hyperactivity-impulsivity factor	Self-factor	Other-factor
Organizing	.28**	.59**			
Mental effort	.44*	.45**			
Loses things	.18*	.68**			
Distracted	.62**	.38**			
Forgetful	.29**	.62**			
Fidgets	.65**		-.15		
Leaves seat	.46**		-.20*		
Runs or climbs	.67**		-.16*		
Plays quietly	.38**		.20		
“On the go”	.50**		-.16		
Talks	.41**		.49**		
Blurts out	.36**		.51**		
Waiting turn	.51**		.04		
Interrupts	.43**		.46**		

Note. ADHD = attention-deficit/hyperactivity disorder.

* Loadings significant at $p < .05$.

** Loadings significant at $p < .01$.

Table 2**ADHD Threshold Parameters in Trifactor Model.**

	Self			Other		
	<i>b1</i>	<i>b2</i>	<i>b3</i>	<i>b1</i>	<i>b2</i>	<i>b3</i>
Close attention	0.39	0.56		0.48	0.68	
Sustained attention	-0.20	-0.06		0.004	0.32	2.7
Listens	0.20	0.34		0.48	0.76	
Follow through	0.38	0.52	2.77	0.56	0.83	2.7
Organization	0.23	0.39		0.15	0.36	2.7
Sustained mental effort	0.03	0.21	2.77	0.32	0.6	
Loses things	0.13	0.28		0.17	0.32	2.7
Easily distracted	-0.20	-0.03		-0.09	0.23	
Forgetful	0.20	0.32		0.31	.056	
Fidgets	-0.19	-0.05		0.12	0.32	
Leaves seat	0.70	0.82		0.67	0.89	
Runs or climbs	0.26	0.37		0.35	0.52	
Plays quietly	0.74	0.86		0.82	1.07	
"Driven by a motor"	0.16	0.34		-0.09	0.25	
Talks a lot	0.24	0.46		.12	0.40	
Blurts	0.38	0.56		0.33	0.66	
Waiting turn	0.53	0.67		0.48	0.80	
Interrupts/intrudes	0.22	0.56		0.26	0.65	2.7

Note. ADHD = attention-deficit/hyperactivity disorder. *Nonsignificant, or $p > .05$.*

Table 3

Correlations Between Trifactor Latent Factors and Executive Function and Impairment.

	<u>Executive function</u>		<u>Impairment</u>	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
General ADHD	.19	.09	-.55	.00
Specific inattention	.43	.00	-.29	.00
Specific hyperactivity-impulsivity	-.15	.16	-.06	.25
Self	.11	.49	-.27	.00
Other	.20	.08	.01	.87

Note. ADHD = attention-deficit/hyperactivity disorder.