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### Understanding Trait and Sources Effects in Attention Deficit Hyperactivity Disorder and Oppositional Defiant Disorder Rating Scales: Mothers', Fathers', and Teachers' Ratings of Children From the Balearic Islands

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## REGULAR ARTICLES

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# Understanding Trait and Sources Effects in Attention Deficit Hyperactivity Disorder and Oppositional Defiant Disorder Rating Scales: Mothers', Fathers', and Teachers' Ratings of Children From the Balearic Islands

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Confirmatory factor analysis was used to model a multitrait (attention deficit hyperactivity disorder [ADHD]–inattention, ADHD–hyperactivity/impulsivity, oppositional defiant disorder [ODD]) by multisource (mothers, fathers, and teachers) matrix to determine the convergent and discriminant validity of ratings by mothers, fathers, and teachers. Participants were 1,749 elementary school children from the island of Majorca in the Balearic Islands. The results showed good convergent validity for the measures for mothers' and fathers' ratings with moderate support for the measures discriminant validity for mothers' and fathers' ratings. There was no convergent and discriminant validity, however, between mothers' and teachers' as well as fathers' and teachers' ratings for the ADHD-IN, ADHD-HI, and ODD measures. The results provide additional evidence that the construct validity of parent and teacher ADHD/ODD rating scales is mostly parent (home) and teacher (school) specific.

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Ratings by mothers, fathers, and teachers of the symptoms of attention deficit hyperactivity disorder–inattention (ADHD-IN), ADHD–hyperactivity/impulsivity (HI), and oppositional defiant disorder (ODD) play an important role in understanding these disorders. Because of

their importance, it is critical to examine the construct validity of these ratings carefully (Burns & Haynes, 2006). One issue concerns the agreement between sources on the occurrence of the symptoms (see Achenbach, 2006; Achenbach, McConaughy, & Howell, 1987; De Los Reyes & Kazdin, 2005; Duhig, Renk, Epstein, & Phares, 2000, for general summaries of this research and Wolraich et al., 2004, for research specific to ADHD rating scales). Although this research is typically viewed as an examination of inter-source reliability because the focus is on a single symptom dimension, it can also be viewed as an evaluation of construct validity, especially the convergent and discriminant validity of the symptom dimensions if the focus involves two or more symptom dimensions (i.e., Is the correlation between sources for the same symptom dimension significant *and* significantly larger than the correlation between sources for different symptom dimensions?; Burns et al., 2008).

This research on agreement between sources has almost entirely used first-order correlations and raw mean differences to investigate this issue. Latent variable modeling approaches, however, provide a much more sophisticated set of procedures to examine the convergent and discriminant validity of the ratings between sources (e.g., Achenbach, 2006, 2009; Burns et al., 2008). These procedures take into account measurement error in the symptom dimensions, thus allowing for the creation of latent factors consisting of only true score variance. Latent variable modeling procedures also allow for the separation of trait and source variance in symptom dimensions, an outcome that is particularly relevant to better understanding the construct validity of parent and teacher ratings of ADHD and ODD symptoms.

#### CONFIRMATORY FACTOR ANALYSIS TO MODEL A MULTITRAIT BY MULTISOURCE MATRIX

One latent variable modeling procedure involves the use of confirmatory factor analysis (CFA) to model a multitrait (ADHD-IN, ADHD-HI, and ODD) by multisource (mothers, fathers, and teachers) matrix. This procedure provides a powerful means to test the construct validity of ratings. This procedure separates the variability in *each* measure (symptom dimension) into trait, source, and error components (Brown, 2006). Trait variance represents the amount variance in a measure (e.g., ODD measure for mothers) accounted for by a latent trait factor (e.g., ODD trait), while source variance represents the amount of variance in a measure (e.g., ODD measure for mothers) accounted for by a latent source factor (e.g., mother source). Error variance represents the amount of variance in a measure (e.g., ODD measure for mothers) not accounted for by the latent trait (e.g., ODD trait) and source factors (e.g., mother source).

If each measure for each source (e.g., ADHD-IN for mothers, ADHD-IN for fathers, and ADHD-IN for teachers) contains a significant and substantial amount of trait variance, then such a finding indicates that mothers, fathers, and teachers rated the children's behavior on the particular symptom dimension in a similar manner (e.g., the convergent validity of the ADHD-IN measure was high for the three sources). And, if a measure contains more trait than source variance, then such a finding supports the discriminant validity of the measures among the sources.

#### SOURCE EFFECTS IN RATING SCALES

Strong source effects are usually considered a form of bias due to characteristics of the source (Podsakoff, Mackenzie, Lee, & Podsakoff, 2003). Halo effects in parent and teacher ratings of ADHD/ODD symptoms are one likely cause of source effects (e.g., Abikoff, Courtney, Pelham, & Koplewicz, 1993; Jackson & King, 2004; Stevens, Quittner, & Abikoff, 1998). That is, one cause of source effects could be the use of general negative labels to describe the child's behavior (i.e., the negative label results in a general pattern of symptom endorsement that is not construct specific). The effect of such negative labels could be transmitted through verbal communications among parents and teachers. These various influences result in systematic variance in the ADHD-IN, ADHD-HI, and ODD measures that is specific to a source factor rather than specific to the ADHD-IN, ADHD-HI, and ODD traits factors.

Rather than view source effects as a form of bias due to characteristics of the source, an alternative view considers source effects to mean the children's behavior is specific to the source (e.g., the child displays hyperactivity/impulsivity behaviors in the classroom in the presence of the teacher but does not display such behavior in the home situation in the presence of the mother). Here source effects are considered to represent true differences in children's behavior between sources (Greenbaum, Dedrick, Prange, & Friedman, 1994). Within this view, the results of the CFA on the multitrait by multisource matrix is expected to result in the ADHD-IN, ADHD-HI, and ODD measures for mothers, fathers, and teachers containing mostly source variance and hardly any trait variance (i.e., the behavior of the children is specific to sources with no common variance for the trait factors).

#### TRAIT AND SOURCE EFFECTS IN ADHD/ODD RATING SCALES

The use of CFA to model a multitrait by multisource matrix provides one of the best latent variable

approaches to evaluate the construct validity of ADHD/ODD rating scales (see also Burns et al., 2008; Hartman, Rhee, Willcutt, & Pennington, 2007, for alternative latent variable modeling approaches to this question). At this time, however, just three studies have used this procedure to evaluate parent and teacher *Diagnostic and Statistical Manual of Mental Disorders* (4th ed. [DSM-IV]; American Psychiatric Association, 1994) ADHD/ODD scales with community samples (Burns, Walsh, & Gomez, 2003; Gomez, Burns, Walsh, & Hafetz, 2005; Gomez, Burns, Walsh, & Moura, 2003). Although these studies used Brazilian, Australian, and Malaysian children and found similar results in each sample (i.e., consistently stronger source than trait effects), each study used only two sources, a parent source for rating home behavior and a teacher source for rating school behavior. This methodology makes the interpretation of the strong source effects impossible. The strong source effects could represent a form of bias associated with each source. The strong source effects could also represent the source specific nature of the children's ADHD-IN, ADHD-HI, and ODD behaviors (i.e., the children's behavior is specific to parents and teachers).

To the best of our knowledge, no study has used the multitrait by multisource procedure with mother, father, and teacher sources to test the construct validity of a DSM-IV ADHD/ODD rating scale. The use of three sources—two in the home and one in the school—allows for a differential test of the source specific behavior and the source specific bias hypotheses. Before describing how the use of three sources allows a differential test of these two hypotheses, we first note the *ideal* outcomes

necessary for construct validity between mothers', fathers', and teachers' ratings. Although we do not expect these ideal outcomes to occur, their description outlines the traditional view of construct validity for the multitrait by multisource matrix.

### CONSTRUCT VALIDITY FROM THE MULTITRAIT BY MULTISOURCE MATRIX

Figure 1 shows the multitrait by multisource matrix, which involves nine manifest measures (i.e., ADHD-IN measures for mothers, fathers, and teachers; ADHD-HI measures for mothers, fathers, and teachers; ODD measures for mothers, fathers, and teachers), three latent trait factors (ADHD-IN, ADHD-HI, and ODD), and three latent source factors (mothers, fathers, and teachers). Four outcomes are required to establish construct validity of the ADHD-IN, ADHD-HI, and ODD measures for mothers', fathers', and teachers' ratings. First, each of the nine measures must contain a statistically significant and substantial amount of trait variance. This outcome requires that the three ADHD-IN measures have substantial loadings on the ADHD-IN trait, the three ADHD-HI measures have substantial loadings on the ADHD-HI trait, and the three ODD measures have substantial loadings on the ODD trait. Although there is no clear definition of substantial, a loading of .70 is considered "substantial" by many researchers (Brown, 2006). A loading of .70 would mean that 49% of the variance in the particular measure (e.g., ODD measure for mothers) was

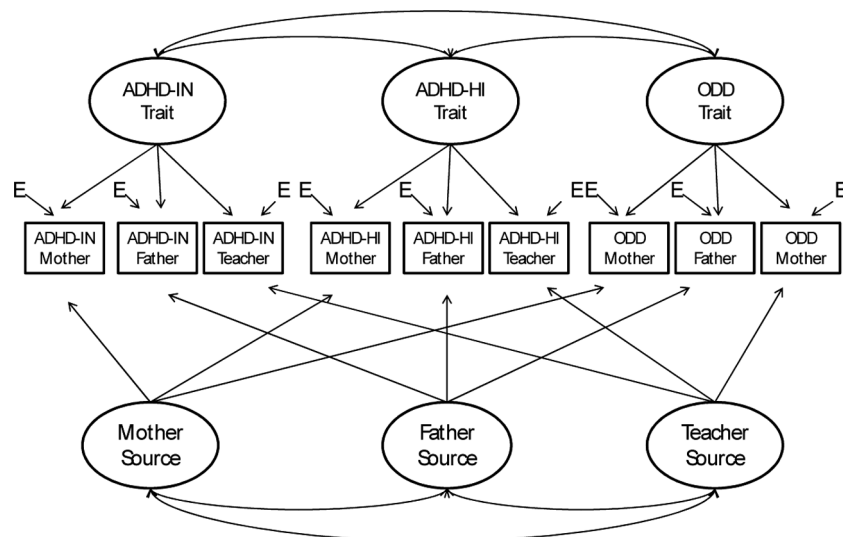


FIGURE 1 Multitrait (ADHD-IN, ADHD-HI, and ODD) by multisource (teachers, fathers, teachers) model. Latent trait and source factors are represented by circles and manifest variables by rectangles. Note: ADHD = attention-deficit/hyperactivity disorder; IN = inattention; HI = hyperactivity/impulsivity; ODD = oppositional defiant disorder.

associated with the measure's latent trait (e.g., ODD latent trait factor). This outcome establishes the convergent validity of the nine measures among mothers, fathers, and teachers.

The second outcome requires that each of the nine measures contain more trait than source variance. This outcome means that each measure has a stronger loading on its particular trait factor than its particular source factor (e.g., the three ADHD-IN measures have a higher loading on the ADHD-IN trait factor than on the mother, father, and teacher source factors). This result establishes the discriminant validity of the nine measures and, in conjunction with the first outcome, establishes that the nine measures have convergent *and* discriminant validity.

The third outcome requires that the correlations among the ADHD-IN, ADHD-HI, and ODD latent trait factors provide evidence for discriminant validity. This is indicated by the correlations among the three traits being low enough (i.e., less than .85; see Brown, 2006) to suggest the presence of three separate constructs. Good discriminant validity is a prerequisite condition for attempts to establish the external validity of the three traits such as the identification of unique causes, risk factors, associated features, responses to treatment (Waldman, Lilienfeld, & Lahey, 1995). If the correlations among the traits are too high, it will be impossible to establish their external validity. To interpret the correlations among the ADHD-IN, ADHD-HI, and ODD latent factors, each of the nine measures must contain a meaningful amount of trait variance.

The fourth outcome requires that the correlations among the mother, father, and teacher latent source factors show discriminant validity (i.e., the latent source correlations are not too high). Extremely high correlations between source factors would suggest common source bias; that is, the two sources share highly similar biases in their use of the scale that are not specific to the trait factors (D. A. Cole, personal communication, June 23, 2008; D. A. Kenny, personal communication, July 10, 2008). Similar halo effects between sources would be one reason for high (e.g., greater than .85) correlations between source factors (see Hartung, McCarthy, Milich, & Martin, 2005, Table 4).

#### SOURCE SPECIFIC BEHAVIOR AND SOURCE SPECIFIC BIAS HYPOTHESES

These four outcomes represent the ideal results to establish the construct validity of ADHD-IN, ADHD-HI, and ODD measures for mothers', fathers', and teachers' ratings. Given the strong source effects found in the previous studies with only parent and teacher sources (Burns, Walsh, et al., 2003; Gomez et al., 2005; Gomez

et al., 2003; Hartung et al., 2005), we did not expect these ideal outcomes. More specifically, the design of the current study allows for a comparison of the source specific behavior and the source specific bias hypotheses. With two sources in the home situation and one source in the school situation, each hypothesis predicts a different pattern of results for the nine measures.

The source specific behavior hypothesis predicts that the ADHD-IN, ADHD-HI, and ODD measures for mothers and fathers will contain more trait variance than the three measures for teachers (i.e., the three measures for mothers and fathers will contain substantial amounts of trait variance, whereas the three measures for teachers will contain little or no trait variance). The rationale for this prediction is that a mother and father are expected to have a higher likelihood of simultaneously observing their child's behavior in the home and community than a mother, father, and a teacher are likely to observe a child's behavior at the same time in the school. If the occurrence of the ADHD-IN, ADHD-HI, and ODD symptoms tends to be specific to the home and school, then there should be more trait variance in the ADHD-IN, ADHD-HI, and ODD measures for mothers and fathers than teachers because of the common observational settings for mothers and fathers. The source specific behavior hypothesis, however, does not mean that there will be no source effects for mothers' and fathers' ratings (we still expect substantial source effects for mothers' and fathers' ratings due to halo effects and general communication between parents.). Rather, as previously noted, the prediction is that there will be much more trait variance in the three measures for mothers and fathers than teachers.

The bias hypothesis, in contrast, predicts that ADHD-IN, ADHD-HI, and ODD measures for mothers, fathers, *and* teachers will contain mostly source variance. In other words, if the strong source effects from the previous three studies represent bias, then all nine measures should contain mostly source variance with hardly any trait variance. Although this outcome might also seem consistent with the children's behavior being specific to mothers, fathers, and teachers, the argument for this interpretation requires the assumption that mothers and fathers share no common observations of their children's behavior and that the occurrence of the ADHD-IN, ADHD-HI, and ODD behaviors are completely specific to each parent. The assumptions necessary for this argument appear problematic. Thus, if the ADHD-IN, ADHD-HI, and ODD measures contain mostly source variance *for mothers, fathers, and teachers*, then it would seem more appropriate to view most of this source variance as representing bias rather than source specific behavior.

The design of the current study allows for a more careful examination of the strong source effects found

in the three previous studies (Burns, Walsh, et al., 2003; Gomez et al., 2005; Gomez et al., 2003). With the inclusion of mother and father sources for the home and a teacher source for the school, the study provides a differential test of the source specific behavior and source specific bias hypotheses. In addition, because the participants in the current study involved mothers, fathers, and teachers of children from the Balearic Islands off the coast of Spain, the sample represents a new country and language relative to the first three studies with only parents and teachers as sources (Brazilian, Australian, and Malaysian samples).

## METHOD

### Participants and Procedures

On the island of Majorca in the Balearic Islands there were 215 elementary schools with an enrollment of approximately 30,000 children at the time of the study. Twenty-four schools were randomly selected from the 215 schools with all 24 schools agreeing to participate in the study. Data collection occurred at 16 of these schools. (Data collection did not occur at the final eight schools because additional participants were not needed at this point.) At each of the 16 schools, 4 to 8 classes were randomly selected from the first four grades for participation in the study (i.e., 80 classes). School policy also involved the random assignment of children to classes. The participants were the mothers, fathers, and teachers of the children in the 80 randomly selected classes. The inclusion criteria for the children of the potential participants were that the children could not have a school diagnosis of mental retardation, developmental coordination disorders, pervasive developmental disorders or severe emotional disturbance. This resulted 1,785 children in the 80 classes. It is unknown how many children were excluded because of a school diagnosis.

With the approval of the schools and institutional review board of the University of the Balearic Islands, the 1,785 children were given a sealed envelope to take home to their parents. Each envelope contained the consent form (i.e., the purpose the study, participation was voluntary, anonymity of the ratings, and parental permission for the child's teacher to complete the questionnaire), and the rating scales (with specific instructions for the parents to complete the scales separately). A total of 36 families opted not to participate in the study, leaving 1,749 children. Teacher ratings were obtained for each child. Mothers' ratings were obtained for 1,422 children and fathers' ratings for 1,380 children (a total of 1,293 children had ratings from all three sources). The study involved 80 teachers with each teacher rating an average of 21.87 children ( $SD = 11.88$ ). The average age of the children was 8.31 years

( $SD = 1.21$ , range = 6.15–11.13) with 52.32% of the sample being boys. A total of 23.84% of the children were in the first grade, 25.16% in the second, 25.21% in the third, and 25.79 in the fourth.

### Measure

The ADHD Rating Scale–IV (DuPaul et al., 1997; DuPaul, Power, Anastopolous, et al., 1998) was used to obtain the mothers', fathers', and teachers' ratings of the ADHD-IN and ADHD-HI symptoms and the ODD section of the Disruptive Behavior Disorders (DBD) rating scale (Barkley & Murphy, 1998) was used to obtain the ratings of the ODD symptoms. The ADHD Rating Scale–IV and the DBD rating scale are almost identical other than the absence of the ODD symptoms from the former. The ADHD Rating Scale–IV was used for the ratings of the ADHD symptoms because there is much more reliability and validity information on this scale than the DBD rating scale.

A 4-point scale, ranging 0 (*never or rarely*), 1 (*sometimes*), 2 (*often*), and 3 (*very often*) was used to rate the occurrence of each symptom. The instructions asked the parents (teachers) to "circle the number that best describes your (this) child's behavior over the past 6-months." Teachers had been interacting with the children for at least 8 months at the time of the ratings. Earlier research indicates that the parent and teacher versions of the ADHD Rating Scale–IV have good reliability and validity (e.g., DuPaul et al., 1997; DuPaul, Power, Anastopoulos, et al., 1998; DuPaul, Power, McGoey, et al., 1998; Power et al., 1998). These studies provide support for the internal consistency and 4-week test–retest reliability of the ADHD-IN and ADHD-dimensions as well as the ability of scores on the dimensions to predict classroom behavior, task accuracy, and diagnostic status. In addition, in studies with parent and teacher ratings on the DBD rating scale with Malaysian children (Burns, Walsh, Gomez, & Hafetz, 2006; Gomez et al., 2005), support was found for the convergent and discriminant validity of the ADHD-IN, ADHD-HI, and ODD factors for parents' and teachers' ratings separately (see also Hartman et al., 2007). The Spanish version of the ADHD Rating Scale–IV and the ODD section of the DBD rating scale were developed through the procedure of forward and backward translation.

## RESULTS

### Analytic Strategy

Mplus's (Version 5.1, Muthén & Muthén, 2007) robust maximum likelihood estimation (MLR) procedure was used to evaluate the fit of the correlated traits

by correlated sources model (Figure 1). The robust maximum likelihood procedure was used due to the lack of multivariate normality (i.e., the normalized estimate of Mardi's coefficient, a measure of multivariate kurtosis, was 74.56 for the nine measures). Overall model fit was evaluated with the comparative fit index (CFI; minimum study criterion of .90, with approximately .95 being ideal), the root mean square error of approximation (RMSEA; study criterion of .06 or lower), and the standardized root mean square residual (SRMR, study criterion of .06 or less). We used the direct maximum likelihood estimation procedure to deal with the missing data (i.e., children who were missing a mother or father rating). Because teachers rated more than a single child (i.e., children were clustered within teachers), the Mplus option Type = Complex was used take into account the lack of independence in the teacher ratings. This procedure corrects the chi-square test of model fit and the standard errors for the lack of independence (Muthén & Muthén, 2007, p. 221).

### Preliminary Analyses

Table 1 shows the descriptive information for the ADHD-IN, ADHD-HI, and ODD measures for teachers, fathers, and mothers. Each of the measures had good internal consistency (i.e., Cronbach's alpha range = .83–.95). These values were similar to other studies in the United States (e.g., DuPaul et al., 1997;

TABLE 1  
Descriptive Information on the ADHD-Inattention, ADHD-Hyperactivity/Impulsivity, and Oppositional Defiant Disorder Measures for Elementary School Children

| Measure                      | $\alpha$ | $M$  | $SD$ | $S$  | $K$  |
|------------------------------|----------|------|------|------|------|
| Teacher Ratings <sup>a</sup> |          |      |      |      |      |
| ADHD-IN                      | .95      | 0.67 | 0.74 | 1.20 | 0.70 |
| ADHD-HI                      | .94      | 0.54 | 0.67 | 1.53 | 1.87 |
| ODD                          | .94      | 0.35 | 0.56 | 2.27 | 5.59 |
| Father Ratings <sup>b</sup>  |          |      |      |      |      |
| ADHD-IN                      | .90      | 0.75 | 0.61 | 1.12 | 1.08 |
| ADHD-HI                      | .85      | 0.78 | 0.59 | 0.89 | 0.53 |
| ODD                          | .83      | 0.62 | 0.51 | 1.31 | 1.98 |
| Mother Ratings <sup>c</sup>  |          |      |      |      |      |
| ADHD-IN                      | .90      | 0.75 | 0.61 | 1.08 | 0.94 |
| ADHD-HI                      | .85      | 0.79 | 0.59 | 0.95 | 0.67 |
| ODD                          | .85      | 0.65 | 0.54 | 1.24 | 1.62 |

Note: ADHD = attention-deficit/hyperactivity disorder;  $\alpha$  = Cronbach's alpha; S = skewness; K = kurtosis; IN = inattention; HI = hyperactivity/impulsivity; ODD = oppositional defiant disorder. Rating anchors are 0 (*never or rarely*), 1 (*sometimes*), 2 (*often*), and 3 (*very often*).

<sup>a</sup> $n = 1,749$ .

<sup>b</sup> $n = 1,380$ .

<sup>c</sup> $n = 1,422$ .

DuPaul, Power, Anastopoulos, et al., 1998) and other countries (e.g., Gomez et al, 2005).

Similar to the procedure used in other rating scale studies (e.g., Burns, Walsh, et al., 2003; Gaub & Carlson, 1997; Wolraich, Hannah, Pinnock, Baumgaertel, & Brown, 1996), a rating of "often" or "very often" was used to count an ADHD or ODD symptom present. For teachers, this procedure resulted in 14.75% of the children meeting the *DSM-IV* ADHD symptom count criteria (i.e., combined type, 5.09%; inattentive type, 6.80%; and hyperactive-impulsive type, 2.86%) and 6.06% for ODD. For fathers, 12.75% met the symptom count criteria for ADHD (i.e., combined type, 3.26%; inattentive type, 5.58%; and hyperactive-impulsive type, 3.91%) and 9.13% for ODD, whereas for mothers 12.44% met the symptom count criteria for ADHD (i.e., combined type, 3.16%; inattentive type, 4.50%; and hyperactive-impulsive type, 4.78%) and 10.06% for ODD.

Because these percentages are based only on symptom counts and do not include measures of impairment due to symptom occurrence, impairment in two or more situations, and an onset prior to age 7, the percentages are higher than the values from recent epidemiological studies where the rate for ADHD (all types) was approximately 6% for children in the United States and 5% worldwide (Nigg & Nikolas, 2008, p. 304) and for ODD approximately 3% for children (Maughan, Rowe, Messer, Goodman, & Metzger, 2004, p. 615). For example, the requirement of meeting the symptom count criteria for ADHD for teachers and mothers ( $n = 1,422$ ) in our sample, a procedure closer to the *DSM-IV* criteria, resulted in an ADHD prevalence of 3.87% (3.70% for teachers and fathers,  $n = 1,380$ ), findings closer to the 5% worldwide prevalence rate (Nigg & Nikolas, 2008, p. 304).

### Trait, Source, and Error Variance in the ADHD-IN, ADHD-HI, and ODD Measures

The correlated traits by correlated sources model provided an admissible solution (i.e., no negative residuals, no out of range values, no large standard errors) and excellent fit,  $\chi^2(12) = 50.81$ ,  $p < .001$  (CFI = .993, RMSEA = .043; 90% CI = .031–.056, SRMR = .022). Given the admissible solution, it was appropriate to use this approach to examine the trait, source, and error variance in the nine measures (Brown, 2006).

Table 2 shows the amount of trait, source, and error variance in the measures for mothers', fathers', and teachers' ratings. The amount of trait variance in the ADHD-IN, ADHD-HI, and ODD measures for teachers' ratings was trivial (i.e.,  $M = 6.33\%$ , range = 1–16%). Each of the three manifest variables for teacher ratings, however, contained a substantial amount of

TABLE 2

Trait, Source, and Error (Uniqueness) Variance in ADHD-Inattention, ADHD-Hyperactivity/Impulsivity, and Oppositional Defiant Disorder Measures for the Correlated Traits by Correlated Sources Model for Elementary School Children

| Measure         | Trait            | Source | Error (Uniqueness) |
|-----------------|------------------|--------|--------------------|
| Teacher Ratings |                  |        |                    |
| ADHD-IN         | .16              | .50    | .34                |
| ADHD-HI         | .01 <sup>a</sup> | .95    | .05 <sup>a</sup>   |
| ODD             | .02              | .55    | .43                |
| Father Ratings  |                  |        |                    |
| ADHD-IN         | .48              | .42    | .10                |
| ADHD-HI         | .42              | .55    | .03 <sup>a</sup>   |
| ODD             | .64              | .29    | .07 <sup>a</sup>   |
| Mother Ratings  |                  |        |                    |
| ADHD-IN         | .53              | .38    | .09                |
| ADHD-HI         | .23              | .66    | .11                |
| ODD             | .37              | .39    | .24                |

Note: All values were significant at  $p < .05$  unless indicated as non-significant with a superscript. Trait, source, and error components sum to 1.0 within rounding error for each measure. ADHD = attention-deficit/hyperactivity disorder; IN = inattention; HI = hyperactivity/impulsivity; ODD = oppositional defiant disorder.

source variance (i.e.,  $M = 66.67\%$ , range = 50–95%). In contrast, the amount of trait variance in the three measures for mothers' and fathers' ratings was more substantial (i.e., fathers:  $M = 51.33\%$ , range = 42–64%; mothers:  $M = 37.67\%$ , range = 23–53%). This pattern of results—more trait variance in the ADHD-IN, ADHD-HI, and ODD measures for mothers and fathers than teachers—was consistent with the source specific behavior hypothesis.

The measures for mothers and fathers contained more trait variance than the measures for teachers and three of the measures for mothers and fathers contained more trait than source variance (i.e., ADHD-IN and ODD for fathers; ADHD-IN for mothers) and one measure contained an essentially equal amount of trait and source variance (i.e., ODD for mothers). However, the amount of source variance was still substantial for the mothers and fathers. For example, the average amount of source variance for fathers' ratings was 42.00% (range = 29–55%) and 47.67% (range = 38–66%) for mothers' ratings. Thus, on average, slightly less than 50% of the variance in the ADHD-IN, ADHD-HI, and ODD measures for mothers and fathers was source specific. This source variance probably mostly reflects bias (e.g., halo effects, response bias, communication between parents about children's behavior that is not trait specific). A small amount of this source variance, however, may also reflect the children's behavior being specific to each parent.

The findings of essentially no trait variance for teachers' ratings in conjunction with marginal to excellent trait variance in the measures for mothers' and

fathers' ratings indicates that any convergent validity among the three sources is restricted to mothers' and fathers' ratings. The possible exception to this statement concerns the ADHD-IN measure. Because the ADHD-IN measure contained 16% trait variance for teachers (the only teacher measure with any trait variance) and the ADHD-IN measure contained 48% and 53% trait variance for fathers' and mothers' ratings, respectively, there was some convergence among teachers, mothers, and fathers for this one measure in this study. However, this was the only measure with any evidence of convergence among the three sources because the amounts of trait variance in the ADHD-HI and ODD measures for teachers were 1% and 2%, respectively.

### Discriminant Validity of Among Traits and Source Factors

Table 3 shows the correlations among the ADHD-IN, ADHD-HI, and ODD trait factors. The three trait factors showed good discriminant validity with the correlations among ADHD-IN, ADHD-HI, and ODD factors ranging from .31 to .42. Given that the ADHD-HI and ODD measures for teachers' ratings contained essentially no trait variance, the correlations among the three traits were mostly based on the trait variance in the measures for fathers' and mothers' ratings. These results should thus be viewed as indicating discriminant validity among the three traits for mothers' and fathers' ratings.

Table 3 also shows the correlations among the teacher, father, and mother source factors. As was expected, the correlation between the teacher and father as well as teacher and mother source factors were much lower (i.e.,  $r = .48$  and  $r = .47$ , respectively) than the correlation between the mother and father source factors (i.e.,  $r = .87$ ). The correlation between the source variance for mothers' and fathers' ratings was perhaps

TABLE 3

Correlations Among Trait Factors and Correlations Among Source Factors for the Correlated Traits by Correlated Sources Model for Elementary School Children

| Factors | ADHD-IN | ADHD-HI | ODD  | Teacher | Father | Mother |
|---------|---------|---------|------|---------|--------|--------|
| ADHD-IN | 1.00    |         |      |         |        |        |
| ADHD-HI | .32     | 1.00    |      |         |        |        |
| ODD     | .31     | .42     | 1.00 |         |        |        |
| Teacher |         |         |      | 1.00    |        |        |
| Father  |         |         |      | .48     | 1.00   |        |
| Mother  |         |         |      | .47     | .87    | 1.00   |

Note: All correlations were significant at  $p < .01$ . The correlated traits by correlated sources model does not allow for correlations between the trait and source factors. ADHD = attention-deficit/hyperactivity disorder; IN = inattention; HI = hyperactivity/impulsivity; ODD = oppositional defiant disorder.

higher because the relative consistency of halo effects may be stronger between mothers' and fathers' ratings than between parents' and teachers' ratings due to more similar biases between parents.

## DISCUSSION

Three earlier studies used CFA to model multitrait (ADHD-IN, ADHD-HI, and ODD) by multisource (parents and teachers) matrices to evaluate the convergent and discriminant validity of parent and teacher measures of the ADHD and ODD symptom dimensions (Burns, Walsh, et al., 2003; Gomez et al., 2005; Gomez et al., 2003). The findings were highly consistent across the Brazilian, Australian, and Malaysian samples of children with source effects being stronger than trait effects. Because these three studies only used two sources, parents for the home situation and teachers for the school situation, it was not possible to determine if the strong source effects represented source specific bias or the source specific nature of children's ADHD-IN, ADHD-HI, and ODD behaviors. Our purpose in this study was to attempt to provide a better understanding of the source effects from the three earlier studies.

With two sources in the home situation, mothers and fathers, and one source in the school situation, teachers, the current study's use of CFA to model a multitrait (ADHD-IN, ADHD-HI, and ODD) by multisource (mothers, fathers, and teachers) matrix allowed for an evaluation of the source specific bias and source specific behavior hypotheses. The results from the study largely supported the source specific behavior hypothesis. The ADHD-IN, ADHD-HI, and ODD measures for mothers' and fathers' ratings contained a moderate to substantial amount of trait variance, whereas the three measures for teachers contained no meaningful amount of trait variance. This pattern of results suggests that the strong source effects from the three earlier studies reflect the children's behavior being specific to parents in the home and teachers in the school. These results also mean that the ADHD-IN, ADHD-HI, and ODD measures demonstrated convergent validity between mothers and fathers with there being minimal convergent validity between mothers and teachers, as well as fathers and teachers.

Because the convergent validity of the ADHD-IN, ADHD-HI, and ODD measures (i.e., a significant amount of trait variance) is a prerequisite condition to evaluate the discriminant validity of the measures (i.e., Is the trait variance in a measure greater than the source variance?), the discriminant validity of the measures is only relevant to the mothers' and fathers' ratings. The ADHD-IN and ODD measures for fathers, as well as

the ADHD-IN measure for mothers, contained more trait than source variance. Thus, only the ADHD-IN measure showed clear convergent *and* discriminant validity between mothers' and fathers' ratings. To summarize, the scale demonstrated moderate to excellent convergent validity for the ADHD-IN, ADHD-HI, and ODD measures and some discriminant validity (i.e., ADHD-IN measure) for mothers' and fathers' ratings.

A recent study with mothers' and fathers' ratings of ADHD-IN, ADHD-HI, ODD, and Academic Competence factors for Brazilian ( $n = 894$ ), Thai ( $n = 2,075$ ), and American ( $n = 817$ ) children also found support for the convergent and discriminant validity of the five factors between mothers' and fathers' ratings within each sample (Burns et al., 2008). In addition, there are findings from clinical samples of children with ADHD and ODD that suggest the lack of agreement between parents' and teachers' on the occurrence of these symptoms may be the norm rather than the exception (Barkley, 2003, pp. 82–84; Biederman, Keenan, & Faraone, 1990; DuPaul, 2003; Wolraich et al., 2004). The totality of the results suggest that convergent and discriminant validity of ADHD/ODD rating scales should probably be viewed as specific to mothers' and fathers' ratings in the home and teachers' ratings in the school. Although all six of the ADHD-IN, ADHD-HI, and ODD measures for mothers' and fathers' ratings contained a significant amount of trait variance (i.e.,  $M = 45.67\%$ , range = 23–64%), each of these six measures also contained a significant amount of source variance (i.e.,  $M = 45.83\%$ , range = 29–66%). This source effect is not trivial, and it is probably due to source specific behavior *and* source specific bias. For example, even though mothers and fathers rate the children's behavior in the home situation, it is likely that the mothers and fathers observe their children in slightly different contexts within the home, as well as the behavior of children being slightly different in interactions with mothers and fathers. Source specific bias is also a possibility here due to halo and other effects (e.g., Jackson & King, 2004). Whether most of these source effects in the mothers' and fathers' ratings were due to source specific bias or source specific behavior will be a difficult question to answer.

An important future goal in the construction of ADHD/ODD rating scales would be to reduce the amount of source specific bias as much as possible, such as by providing clearer instructions for raters, wording symptoms specific to the context of rater, using rating anchors that reduce subjectivity to the greatest extent possible, using rating anchors that distinguish between frequency and impairment (Burns, Gomez, Walsh, & Moura, 2003; Burns et al., 2008; DuPaul, 2003). The minimization of source specific bias is a necessary first step in order to understand how much the ADHD-IN,

ADHD-HI, and ODD behaviors are specific to mothers and fathers as well as to improve the psychometric properties of the scales.

### Limitations

Although the instructions explicitly asked the mothers and fathers to complete their ratings independently in order for the findings from the study to be meaningful, there was no way to determine if any parents failed to follow this request. Another limitation of the current study was the inclusion criteria. As noted earlier, these criteria resulted in the schools not providing the names of the children with a school diagnosis. With hindsight, it would have been better to include all the children. Although the exclusion of these children may have resulted in a restriction in the range of the ratings, the impact was probably not enough to have impacted the findings, especially given that the percentage of children who met the symptom count criteria for ADHD and ODD was higher in the current study than in earlier community studies that used a similar symptom count procedure (e.g., Burns, Walsh, et al., 2003; Gaub & Carlson, 1997; Wolraich et al., 1996). Finally, the lack of convergence and discriminant validity between mothers and teachers as well as fathers and teachers in the current study was also similar to the findings from community samples of children from Brazil, Australia, Thailand, Malaysia, and America (Burns, Walsh, et al., 2003; Burns et al., 2008; Gomez et al., 2005; Gomez et al., 2003). Given the consistent pattern of results with community samples of children from six different countries and languages as well as different ADHD/ODD rating scales, the possible restriction in range in the current study would not appear to limit our conclusions too much.

An additional limitation of the study was the use of a single rating scale. Although the findings between parents and teachers with the particular rating scale used in this study matched the results from the earlier studies that used several different types of ADHD/ODD rating scales, it would have been better include multiple scales. More important, an even better design would have included multiple methods (e.g., a diagnostic interview and a rating scale) with multiple sources (mothers, fathers, and teachers). Hartung et al. (2005) provides an excellent example of a study that used a diagnostic interview and a rating scale with parents and adolescents to examine the construct validity of ADHD-IN, ADHD-HI, and ODD. Future research on ADHD/ODD rating scales might also benefit from endeavors to more closely match the decisions of the parent in the completion of the scale to the decisions of the clinician in the completion of the diagnostic interview with the parent (e.g., Stein, 2004; Wender, 2004).

### Implications for Research, Policy, and Practice

It is important for future research to investigate a multitrait by multisource matrix with two sources in the classroom, as well as mothers and fathers at home. With each child rated by two sources in each context, the multitrait (ADHD-IN, ADHD-HI, and ODD) by multisource (mothers, fathers, teacher 1, and teacher 2) matrix could more clearly determine if the convergent and discriminant validity of ADHD/ODD rating scales was limited to each context (i.e., the scale has convergent and discriminant validity for mothers and fathers in the home and teachers in the school but has no convergent and discriminant validity across the two situations; Burns & Haynes, 2006).

Such a multitrait by multisource matrix could also be applied to the examination of the construct validity of the *individual* ADHD and ODD symptoms (Burns & Haynes, 2006; Gomez et al., 2003). This analysis would identify which symptoms on the rating scale had convergent and discriminant validity for the two sources in the home and for the two sources in the school, as well as if any symptoms had convergent and discriminant validity between the two contexts. If the ADHD and ODD symptom ratings demonstrated good convergent and discriminant validity within each context and *no* convergent and discriminant validity between home and school, then rater perception of the symptom occurrence would clearly be highly context specific, especially if the same result occurred with clinical samples. However, this analysis might identify a small subset of symptom ratings with convergent and discriminant validity between home and school.

This multitrait (ADHD-IN, ADHD-HI, and ODD) by multisource (mothers, fathers, teacher 1, and teacher 2) matrix also has relevance for the identification of the external correlates of the symptom dimensions (e.g., risk factors, associated features, treatment responses, prognosis, and so on). For example, the matrix would provide a highly sophisticated procedure to determine the external correlates of the trait and source variance for the ADHD-IN, ADHD-HI, and ODD measures within and across contexts as well as time (LaGrange & Cole, 2008). In our opinion, these types of analyses have the potential to advance our understanding of the ADHD-IN, ADHD-HI, and ODD symptom dimensions. We encourage other researchers to use these procedures more in the evaluation of ADHD/ODD rating scales.

A final implication concerns the relevance of the findings for the use of ADHD/ODD rating scales in clinical practice. A growing body of research with community and clinical samples indicates there is little relative agreement between parents' and teachers' ratings on these scales. And, because the *DSM-IV* diagnostic

criteria for ADHD require impairment from symptom occurrence in two or more settings (e.g., home and school), the findings present a quandary given the important role the parent and teacher rating scales have in the diagnosis of ADHD. A semistructured clinical interview with parents and teachers can be used to understand the reasons for the discrepancies among raters (e.g., the influence of *activity, setting* and *rater characteristics* on the rater's perception of the child's behavior, see Barkley, 2003, pp. 80–92 for specific suggestions). This type of clinical interview will result in a richer understanding of the parents' and teachers' ratings, thus allowing for the qualitative synthesis of the rating into a comprehensive clinical assessment.

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