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Assessing Self-Regulation in the Classroom: Validation of the BIS-11 and the BRIEF in Low-Income, Ethnic Minority School-Age Children

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Abstract

Research Findings: At present, few resources are available to researchers, teachers, and practitioners who wish to quickly and reliably assess children’s self-regulation within the classroom context, and particularly within settings serving low-income and ethnic minority children. This paper explores the psychometric properties of a teacher-report composite of 2 clinical measures of self-regulation—the Barratt Impulsiveness Scale (version 11; BIS-11) and the Behavior Rating Inventory of Executive Function (BRIEF)—in a sample of low-income African American and Hispanic children. Results of factor analyses revealed a 2-factor solution for the composite measure formed from the BIS-11 and the BRIEF that corresponded to the latent domains of cognitive and behavioral self-regulation. The composite scale was found to have high internal consistency, reliability, and concurrent validity compared to a previously validated measure of teacher-rated inattention and hyperactivity-impulsivity. In addition, results of multigroup comparisons provide evidence for measurement invariance of the composite measure across race, poverty risk status, and gender.

Practice or Policy: The results support the usefulness of a teacher-rated combined version of the BIS-11 and the BRIEF for the assessment of low-income, ethnic minority children’s cognitive and behavioral self-regulation. This study also helps to inform the theoretical relationship between the cognitive and behavioral subdomains of child self-regulation.

Emerging research at the intersection of developmental neuroscience and public policy suggests that poverty places children’s development of optimal self-regulation in serious jeopardy (Blair, 2002; Raver, 2004). Children facing the stressors associated with economic disadvantage have been found to have lower executive function, more difficulty with attention, and more problems with behavioral dysregulation (Evans & English, 2002; Shaw, Vondra, Hommerding, Keenan, & Dunn, 1994). In the fields of science and policy, investigators increasingly seek to test whether children’s self-regulatory skills are modifiable through environmental support. To address this question, a parallel set of prevention studies targeting children’s self-regulation has capitalized on the large amount of time that children

spend in school settings by implementing interventions in preschool and early elementary classrooms (Bierman, Nix, Greenberg, Blair, & Domitrovitch, 2008; Diamond, Barnett, Thomas, & Munro, 2007; Greenburg & Kusché, 2006; Raver et al., 2009).

Despite recent advances, researchers continue to face significant methodological obstacles in testing these important theoretically driven and policy-relevant questions. The inclusion of children's cognitive and behavioral self-regulation in prevention science research is so new that there are few available validated measures for capturing the multiple dimensions of low-income, ethnic minority children's self-regulatory skills in the classroom (see Fantuzzo et al., 2001, for one potential exception). In this study, we aim to fill this gap by providing preliminary evidence for the reliability and validity of a composite measure based on the Barratt Impulsiveness Scale (version 11; BIS-11) and the Behavior Rating Inventory of Executive Function (BRIEF). Although these measures were originally designed for clinical purposes, we argue in the current paper that they work well together as a single teacher-rated measure of children's self-regulation that may be particularly useful for research in school settings.

To make our case, we begin by providing definitions and operationalizations of the domains of child self-regulation. We then discuss the importance of establishing the psychometric properties of measures of self-regulation in diverse social contexts. We also outline our rationale for establishing whether a given measure shows invariance, or psychometrically similar properties, across groups of children residing in different ecological contexts bounded by social status characteristics such as race/ethnicity and poverty status. Correspondingly, the aims of this study are outlined, where our goal is to assess these measures' concurrent validity, internal consistency, and measurement invariance across race, poverty risk status, and gender within a sample of Hispanic and African American elementary school-age children.

THE DEFINITION AND MEASUREMENT OF SELF-REGULATION

Research from multiple theoretical vantage points consistently indicates that self-regulation is important for young children's academic and behavioral outcomes, yet the field continues to struggle to agree upon a common definition of this multidimensional construct (Blair & Razza, 2007; Boekaerts, Pintrich, & Zeidner, 2005; Nigg, Quamma, Greenberg, & Kusché, 1999). In this paper, we include both cognitive and behavioral forms of self-regulation by drawing on past research in the areas of children's executive function and effortful or inhibitory control, respectively. Cognitive self-regulatory skills include children's use of working memory and cognitive flexibility (or set shifting) to inhibit, plan, and problem solve (Miyake et al., 2000; Senn, Espy, & Kaufmann, 2004). Behavioral self-regulation refers to children's ability to modulate their attention, behavior, and emotions in affectively arousing conditions with competing sets of demands (Eisenberg et al., 1996; Kochanska, Murray, & Coy, 1997; Liew, Eisenberg, & Reiser, 2004).

One question with which the field has grappled is whether the differences between constructs of executive function and inhibitory control are more semantic than substantive. For example, children's inhibition and attention shifting are key components of definitions

(and many measures) of both executive functioning and inhibitory control (Aron, 2007; Schachar & Logan, 1990). However, consensus has emerged that despite this theoretical and empirical overlap, these dimensions are sufficiently distinct, hierarchically organized (in both functional and anatomical terms), and reciprocally related that it is important to consider them as independent vectors in measurement space (Garavan, Ross, Murphy, Roche, & Stein, 2002; Miyake et al., 2000). For example, children's executive function has been argued to be inextricably tied to children's modulation of affective arousal and attention through bidirectional "bottom-up" and "top-down" processes (Blair & Ursache, in press; Lewis & Todd, 2007). For this reason, we are particularly interested in trying to identify measures that can capture both the cognitive and behavioral dimensions of children's self-regulation but that are sufficiently short that they can be included in large-scale survey research efforts. The BIS-11 and the BRIEF represent promising candidate measures for this purpose.

TESTING THE PSYCHOMETRIC UTILITY OF MEASURES ACROSS MULTIPLE ECOLOGICAL CONTEXTS

The BIS-11 and the BRIEF are two widely used assessments of impulsiveness, inhibition, and other behavioral and cognitive components of self-regulation in children and adults. Both measures have a long tradition of use in clinical contexts, yet little is known about whether they are appropriate for use as evaluative research tools in school settings. A key psychometric concern of this study is whether these two measures are reliable and valid when used together as a teacher-report assessment of self-regulation within the classroom setting. Although a recently emerging body of research has established the reliability and validity of the direct assessment of executive function and inhibitory control with low-income children in field settings such as preschools (Blair & Razza, 2007; Cameron et al., 2008; Diamond, Carlson, & Beck, 2005; Raver et al., in press), there has been comparatively little work to establish internal and criterion validity of corresponding teacher-reported measures. Given the increased focus on promoting regulatory skills in the classroom, coupled with school professionals' limited resources, it is vital to establish accurate and reliable ways for researchers to assess these skills in a time- and resource-efficient manner. Teacher-reported scales offer an important opportunity to assess children's self-regulation and behavior but must be appropriately validated prior to their broad-scale implementation in the classroom. Thus, a key aim of this paper is to establish whether the BIS-11 and BRIEF meet this empirical set of standards and might represent a promising option for researchers with a pressing need for such tools.

Given the increasing economic and racial/ethnic diversity of schools in the United States, another key concern is whether a given teacher-reported measure is psychometrically robust across groups of children from widely varying socioeconomic and sociocultural contexts. Increasing recognition of the role of ecological context in shaping human development has led investigators to empirically test whether measures and models fit equivalently or differently for groups of children (Abe & Izard, 1999; Knight & Hill, 1998; Raver, Gershoff, & Aber, 2007). In psychology, measurement invariance is established when the relationships between measured, observed indicators and their corresponding latent, unobserved

constructs are sufficiently similar as to be considered invariant across groups of individuals. The issue of measurement equivalence is critical to empirical rigor: If a given measure does not tap latent constructs in sufficiently similar ways across groups of children from different social contexts, the resulting variances, covariances, and central tendencies are rendered difficult, if not impossible, to interpret (Curran & Willoughby, 2003).

Why might measurement invariance be of concern when one is assessing children's self-regulatory skills? Evidence from cross-cultural psychology suggests that self-regulation may manifest differently depending on the ecological context in which a child is raised, which may have implications for the ways in which these skills are assessed in ethnic minorities or in children at risk for experiencing poverty-related stressors (Armengol, 2007; Cole, Bruschi, & Tamang, 2002). In other words, cultural or contextual conditions may necessitate the prioritization of particular skills over others in order to promote success within a given ecological setting. In addition, differences in levels and types of boys' and girls' self-regulation skills have been noted in past research, with evidence suggesting that gender may interact with context when predicting child regulatory outcomes (Kochanska, Coy, & Murray, 2001). Despite this theoretical framing, very little research has been done regarding the extent to which measures of self-regulation either accurately or inaccurately reflect latent constructs across categories delineated by race, socioeconomic status, and gender for American schoolchildren.

THE PRESENT STUDY

The overall goal of the present study is to examine the psychometric properties of a composite scale created from two popular clinical measures of self-regulation—the BIS-11 and the BRIEF—in order to establish the appropriateness of its use for assessing low-income African American and Hispanic third graders. The present study has four complementary aims:

1. To test the underlying factor structure of a teacher-rated composite measure of child cognitive and behavioral self-regulatory skill formed by combining items from the BIS-11 and the BRIEF;
2. To establish the concurrent criterion validity of the BIS-11/BRIEF composite measure of self-regulation by comparing it to a previously validated measure of teacher-reported inattention and hyperactivity-impulsivity;
3. To explore the internal consistency of the composite measure of child self-regulation and its cognitive and behavioral subscales in a sample of low-income, ethnic minority children and to explore whether the reliability varies across racial, socioeconomic, or gender subgroups; and
4. To test for measurement invariance of the composite measure of self-regulation across race, poverty risk status, and gender in this particular sample.

Using these findings, we are able to provide guidance on assessing the cognitive and behavioral components of self-regulation in low-income, ethnic minority students. Specifically, we examine the appropriateness of the use of the BIS-11/BRIEF teacher-rated

composite measure of self-regulation within particular demographic subgroups. Our findings are geared primarily toward researchers interested in the assessment of behavioral and cognitive self-regulation, but they may also be useful for teachers and other school professionals who seek to quickly and efficiently capture the self-regulatory skills of their students. Finally, in light of increased concern in the field over the relationship between executive function and inhibitory control, theoretical and conceptual considerations regarding distinctions between cognitive and behavioral self-regulation are also discussed.

METHOD

Sample

The sample for the present study included 215 former Head Start participants from a large midwestern city. The average age of the children in the study was 8 years (range = 7–9), and 116 (54%) were boys. Of the 215 children, 109 (51%) were identified by their primary caregivers as African American and 106 (49%) were identified as Hispanic. Children resided in families with a median annual household income of \$22,096 (range = \$0– \$107,000). Of the 215 children, 118 lived in single-parent households. Of the caregivers, 52 reported having less than a 12th-grade education, 68 had a high school diploma or its equivalent, 65 had attended some college, 22 had a bachelor's degree or higher, and 8 chose not to report their education.

Procedure

Children in this study were former participants in a classroom-based socioemotional intervention study called the Chicago School Readiness Project (CSRP).¹ Children were originally recruited from 18 Head Start sites that were located in one of seven high-poverty neighborhoods in Chicago. (For full inclusion criteria, see Raver et al., 2008.) Data for the present study were collected in the winter 4 years after the children's initial recruitment into CSRP. The 215 children included in our analyses represented 64% of the original 344 members of the first cohort of CSRP participants. Of the 129 children who were not included in the analyses, 25 were excluded because they did not meet inclusion criteria (i.e., were not identified as either African American or Hispanic), and the remaining 104 either did not consent to participate in the follow-up portion of CSRP or were not able to be contacted.

As part of the data collection process, children's primary caregivers were asked to complete in-person interviews in either English or Spanish with trained and reliable data collectors. These interviews included the collection of demographic information about the caregiver, household, and child (e.g., race, household income). When caregivers were unable to be interviewed in person, they completed questionnaires over the phone ($n = 46$). Teachers reported on children's self-regulatory skills using English versions of the BIS-11 and the BRIEF as part of a larger interview with the data collector. During this interview, teachers were also asked about children's inattention and hyperactive-impulsive behavior using the Teacher Report Form (TRF). This measure was chosen because of the theoretical

¹The CSRP is not associated with The Chicago School®, which is a trademark of The Chicago School of Professional Psychology.

relationships between children's inattention and cognitive self-regulation and between hyperactivity-impulsivity and behavioral self-regulation (Blair, 2002; Boekaerts et al., 2005; Carlson, 2001). Caregivers and teachers were provided modest monetary compensation for their time.

Measures

BIS-11.—To capture children's self-regulatory skills, teachers completed the BIS-11 (Patton, Stanford, & Barratt, 1995). The original version of the BIS was designed to assess impulsiveness in adults and consequently places emphasis on behavioral rather than cognitive forms of inhibitory control (Barratt, 1959). The most recent iteration of the BIS (version 11) has been found useful in distinguishing among three second-order substrates of impulsiveness (Patton et al., 1995). Specifically, the scale can be broken down to include attentional impulsiveness (lack of focus or attention), motor impulsiveness (acting on the spur of the moment), and nonplanning impulsiveness (lack of a future orientation; Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). Over the past 15 years, use of the BIS-11 in assessing self-regulation has extended from adult clinical populations to include both psychiatric and nonpsychiatric individuals ranging from young children to adults. The BIS-11 has also been translated into at least seven different languages, with results of empirical testing yielding relatively (but not completely) consistent factor structures across language groups (Fossati, Di Ceglie, Acquarini, & Barratt, 2001; Someya et al., 2001).

For the present study, only items from the three second-order subscales were used in order to keep the measure as brief as possible without compromising the strength of its measurement capabilities. Specifically, the present version of the BIS-11 included 16 of the original 30 items and used a scale of 1 to 4 to indicate the frequency of behavior (1 = rarely/never, 2 = occasionally, 3 = often, 4 = almost always/always).² The nonplanning impulsiveness subscale was created by taking the sum of seven items, including "child plans tasks carefully" (reversed) and "child is self-controlled" (reversed). Attentional impulsiveness consisted of the sum of four items, including "child concentrates easily" (reversed) and "child is a steady thinker" (reversed). Finally, motor impulsiveness was the sum of five items, including "child does things without thinking" and "child makes up his/her mind quickly." A higher overall score on these subscales indicates higher levels of nonplanning, attentional, and motor impulsiveness, respectively.

BRIEF—Working memory and inhibit subscales.—The BRIEF (Gioia, Isquith, Guy, & Kenworthy, 2000) was selected as an additional measure of children's self-regulation. The BRIEF is an 86-item rating scale originally designed for both parents and teachers to measure the everyday executive functioning behavior of children ages 5 to 18 (Gioia et al., 2000; Isquith, Gioia, & Epsy, 2004). It has been widely used by practitioners in a clinical context in order to aid in the diagnosis and categorization of attention-deficit/hyperactivity disorder (Mahone et al., 2002). Specifically, the working memory and inhibit subscales of the BRIEF have been found to demonstrate the greatest overlap with the inattentive and

²Because of an administrative error, the questionnaire used in this study provided five options, where 1 = rarely/never, 2 = occasionally, 3 = often, 4 = almost, 5 = almost always/always. To correct for the inclusion of the erroneous option 4, we collapsed scores for option 4 and option 5 into a single response category during data cleaning.

hyperactive-impulsive types of attention-deficit/hyperactivity disorder, respectively, which has led to their widespread use by practitioners (Gioia et al., 2000). Unlike those of the BIS-11, the psychometric properties of the BRIEF have not been widely studied. One study, however, did reveal small but potentially important differences between the latent factor structure of the BRIEF across children from the United States and Mexico matched on age and socioeconomic variables (Isquith, Gioia, & Armengol, 2000).

The CSRP version of the BRIEF uses two of the original eight subscales, reducing the total number of items from 86 to 20. All items in the working memory and inhibit subscales were scored on a scale of 1 to 3 (1 never, 2 = sometimes, 3 = often) to measure the frequency of behavior, with higher scores indicating greater dysfunction. (For example, a high score on the working memory subscale would indicate *poorer* working memory skills.) Ten items were summed to form the working memory subscale, including “has short attention span” and “has trouble with chores that have more than one step.” Ten different items were aggregated to form the inhibit subscale, including “needs to be told ‘no’ or ‘stop that’” and “gets out of control more than friends.”

TRF—Inattention and hyperactivity-impulsivity subscales.—The TRF, part of the Achenbach System of Empirically Based Assessment (Achenbach, 1991), is a teacher-report measure of children’s academic performance, adaptive functioning, and behavioral/emotional problems. The original version includes 113 problem items rated on a 3-point scale (0 = not true, 1 = somewhat true or sometimes true, 2 = very true or often true). A number of studies across fields have used the TRF and have found its validity and reliability to be high when measuring behavior problems in low-income, ethnically diverse samples (Brooks-Gunn, Han, & Waldfogel, 2002; Zill et al., 2003).

For the purposes of this analysis, only the 26 items from the inattention and hyperactivity-impulsivity subscales were used. These two subscales were selected to match the subscales of the BIS-11 and the BRIEF, such that inattention was related to the cognitive forms of self-regulation (working memory and nonplanning/attentional impulsiveness) and hyperactivity-impulsivity was related to behavioral manifestations of regulatory dysfunction (inhibition or motor impulsiveness; Boekaerts et al., 2005; Carlson, 2001). Fourteen items were aggregated to form the inattention subscale, including “fails to finish things he/she starts” and “can’t concentrate, can’t pay attention for long.” Twelve items were aggregated to form the hyperactivity-impulsivity subscale, including “hums or makes other odd noises in class” and “fidgets.” Reliability in this sample was found to be high, with Cronbach’s alphas of .93 for both the inattention and hyperactivity-impulsivity subscales. It is important to note that higher scores on these subscales indicate higher levels of inattention and hyperactivity-impulsivity.

Child- and family-level covariates.—Demographic information was collected from the primary caregiver and included the following: child’s gender, age at assessment, and race/ethnicity; caregiver’s marital status and highest level of education completed; and household income for the previous year. Because the aim of this study was to understand the measurement of self-regulation within subgroups of African American and Hispanic children, biracial and non-Hispanic White children were excluded from all analyses.

Families' income-to-needs ratios were calculated using caregivers' reports of annual household income and the 2008 national poverty guidelines established by the U.S. Census Bureau. With this information, a household poverty risk status variable was created to distinguish between levels of poverty in the sample. Families that were considered to be at high risk for poverty had a ratio of income to federal poverty standards that was equal to or less than 1.00, whereas families with ratios greater than 1.00 were considered to be at low risk for poverty. The median income-to-needs ratio for the present sample was 1.01 (range = 0.00–5.77), and 101 of the 204 participants who reported their income were categorized as living in households that were at high risk for poverty.

Analytic Strategy

Multiple steps were taken to meet the four primary aims of this study. Because of the theoretical similarity between the BIS-11 and the BRIEF, items from both measures were combined to form a single composite measure of teacher-rated self-regulation. Based on results of an exploratory factor analysis, a two-factor model was tested using confirmatory factor analysis in the full sample of 215 children (Aim 1). All factor analyses were conducted using the Mplus software program (version 5.21; Muthén & Muthén, 2009), which uses a maximum likelihood estimator. Because the subscales of the BIS-11 and the BRIEF have been found to be moderately correlated with one another (Fossati et al., 2001; Gioia, Isquith, Retzlaff, & Epsy, 2002), an oblique rotation (Geomin) was used to allow factors to covary. To test the concurrent criterion validity of the newly formed composite measure of self-regulation (Aim 2), we used one-tailed bivariate correlations to assess the relationship between the inattention and hyperactivity-impulsivity subscales of the TRF and the cognitive and behavioral subscales of the composite measure. To test the internal consistency of the composite measure of self-regulation and its subscales (Aim 3), we calculated Cronbach's alphas. Internal consistency was measured for each demographic subgroup, broken down by race, poverty risk status, and gender. To test for measurement invariance across racial/ethnic, poverty risk status, and gender subgroups (Aim 4), we used a multiple-group comparison technique. Specifically, a model in which factor loadings were constrained to be equal across groups (African American vs. Hispanic children, male vs. female children, high- vs. low-risk children) was compared to an unconstrained model in which factor loadings were freely estimated across groups. Chi-square difference tests were used to evaluate whether the fit of the constrained model was significantly worse than that of the unconstrained model. In testing for measurement invariance, intercepts (which in preliminary analyses were found to be invariant across all groups) were constrained to be equal across groups in all models as a result of the relatively small sample size.

Missing Data

Across the BIS-11 and the BRIEF, less than 1% (0.79%) of data across all items was found to be missing at random, with a range of 0 to 6 cases out of 215 missing per item. To avoid the bias inherent in excluding cases with missing data, we substituted the mean for each item for missing values in the BIS-11 and the BRIEF when conducting descriptive analyses, establishing criterion validity, and calculating alphas. For all factor analyses in Mplus, a full information maximum likelihood approach was used to handle missing data. In the TRF, the sample's modal response (0, or "not true") was substituted for all missing items. Mode

substitution for categorical variables is considered analogous to mean substitution for continuous variables and reduces the need for listwise deletion of cases with small amounts of missing data.

Model Fit Indices

To test for model fit, we selected four indices based on recent work in the field (e.g., Guo, Suarez-Morales, Schwartz, & Szapocznik, 2009; Pakarinen et al., 2010). The following criteria were used to indicate adequate model fit: (a) a relative chi-square value (the ratio of chi-square to degrees of freedom) of 3 or less, (b) a root mean square error of approximation (RMSEA) of less than .08 (less than .06 was ideal), (c) a comparative fit index (CFI) of .95 or greater, and (d) a standardized root-mean-square residual (SRMR) of less than .09 (Hatcher, 1994; Hu & Bentler, 1999; Kline, 1998; Ullman, 2001).

RESULTS

The results of this study are presented in four sections that correspond to the four specified aims of the paper.

Factor Structure of the BIS-11/BRIEF Composite Measure

To form the composite measure of teacher-rated self-regulation, we combined all 16 items of the BIS-11 and 20 items of the BRIEF into a single scale. Because past studies have found dissimilar factor structures in the BIS-11 and the BRIEF (i.e., the BIS-11 has been found to tap three latent constructs, whereas the BRIEF has been found to tap two), an exploratory factor analysis was conducted on the composite measure to determine the number of underlying factors and to identify the items that loaded on each. Results of the exploratory factor analysis suggested that a two-factor model reflecting the dimensions of cognitive and behavioral self-regulation provided the best fit for the data, $\chi^2(494, N=215) = 1,194.80, p < .01; \chi^2/df = 2.42; CFI = .895; RMSEA = .081; SRMR = .041$. Results also suggested that two items from the BIS-11 (“child makes up his/her mind quickly” and “child gets easily bored when solving thought problems”) should be excluded from the final measurement model because they did not load highly on either factor. In addition, two items (“child doesn’t ‘pay attention’” and “child is self-controlled”) were included on both factors because they loaded highly on both. (See Table 1 for the list of items and their loadings.)

To confirm the proposed two-factor model of cognitive and behavioral self-regulation, we conducted a confirmatory factor analysis on the composite measure using the full sample of 215 children. A total of 19 items from the BIS-11 and the BRIEF were included in the cognitive self-regulation subscale, and 17 items were included in the behavioral self-regulation subscale. Model fit indices initially indicated a less than acceptable fit for the proposed measurement model, $\chi^2(524, N=215) = 1,345.25, p < .01; \chi^2/df = 2.57; CFI = .877; RMSEA = .085; SRMR = .067$; To improve model fit, we added residual covariances to the model based on modification indices that suggested that their inclusion would reduce the overall model chi-square by 20 or more. By allowing these residuals to covary, we improved the model fit to an adequate level, $\chi^2(511, N=215) = 919.89, p < .01; \chi^2/df = 1.90; CFI = .939; RMSEA = .061; SRMR = .059$.

The BIS-11/BRIEF composite scale and its cognitive and behavioral subscales were used for all subsequent analyses. Descriptive information, including group means, standard deviations, and ranges, is listed in Table 2 by race, poverty risk status, and gender. It is important to note that a higher score on the cognitive and behavioral self-regulation subscales indicates greater regulatory difficulty.

Criterion Validity

In testing for concurrent criterion validity, we correlated the inattention and hyperactivity-impulsivity subscales of the teacher-rated TRF with the cognitive and behavioral subscales of the newly formed composite measure of self-regulation (see Table 3). As expected, the inattention subscale of the TRF was significantly positively correlated with the cognitive self-regulation subscale of the composite measure ($r = .87, p < .01$). The hyperactivity-impulsivity subscale of the TRF was also significantly positively correlated with the behavioral self-regulation subscale of the composite ($r = .90, p < .01$). Correlations across domains (i.e., inattention with behavioral self-regulation, and hyperactivity-impulsivity with cognitive self-regulation) were also statistically significant but smaller in magnitude ($r_s = .60$ and $.61$, respectively).

Internal Consistency

In order to explore the internal consistency of the BIS-11/BRIEF composite measure of self-regulation, we recorded inter-item correlations (Cronbach's alphas) for the full sample and each racial, socioeconomic, and gender subgroup (see Table 4). Inter-item correlations in the full sample were high, with an alpha of .97 for the overall composite measure, .95 for the cognitive subscale, and .96 for the behavioral subscale. It is important to note that alpha values did not vary greatly by demographic subgroup, indicating a high degree of internal consistency across race, poverty risk status, and gender.

Measurement Invariance

Lastly, measurement invariance was tested across racial/ethnic groups (African American vs. Hispanic children), poverty risk status groups (children whose families were at high vs. low risk based on their income-to-needs ratio), and gender (boys vs. girls). As a first step, the two-factor structure was tested in each subgroup using confirmatory factor analysis and was found to show good model fit in all cases. To test for measurement invariance, we used a chi-square difference test to assess the difference between the model in which factor loadings were constrained to be equal across groups and one in which loadings were free to vary. The factors were allowed to correlate freely in both models.

Chi-square difference tests were not statistically significant across race, difference in $\chi^2(34, N = 215) = 26.76, p = .81$; poverty risk status, difference in $\chi^2(34, N = 215) = 23.76, p = .91$; or gender, difference in $\chi^2(34, N = 215) = 43.93, p = .14$. This indicated measurement invariance across demographic subgroups for the composite measure of self-regulation tested in this sample of children.

DISCUSSION

At present, few validated measures are available for researchers to accurately and quickly assess the self-regulatory skills of at-risk children. Though task-based methods have been found to be reliable and valid, these assessments are often time consuming and impractical for the assessment of large groups of children, especially when one takes into account the limited resources often associated with classrooms that serve low-income, ethnic minority children. The goal of the present study was to explore the psychometric properties of a 34-item teacher-rated scale formed from two clinical measures of children's self-regulation—the BIS-11 and the BRIEF—using a sample of low-income African American and Hispanic third graders.

In previous research the BIS-11 and the BRIEF were found to capture various components of children's cognitive and behavioral self-regulation, including working memory, attention, inhibition, and impulsivity (Gioia et al., 2000; Patton et al., 1995). Given the complementary relationship between the identified constructs in both measures, items from the BIS-11 and the BRIEF were combined into a single composite measure whose underlying factor structure was explored and confirmed using factor analysis. Results revealed that items from the working memory subscale of the BRIEF and the nonplanning and attentional impulsivity subscales of the BIS-11 together reflected the construct of cognitive self-regulation, whereas items from the BRIEF's inhibition subscale and the BIS-11's motor and nonplanning impulsivity subscales mapped onto the latent construct of behavioral self-regulation. Combining the BIS-11 and the BRIEF into a composite measure presented an important empirical opportunity to capture the theoretical constructs of executive function and inhibitory control in a unified way. Separately these scales provide important but incomplete information about children's regulatory skills. Together they provide a more comprehensive picture of the multiple cognitive and behavioral domains of children's self-regulation, including working memory, planfulness, problem solving, attentional processes, impulsiveness, hyperactivity, and inhibitory control.

From a measurement standpoint, evidence from this study suggests that the teacher-rated composite measure of the BIS-11 and the BRIEF is an empirically reliable and valid method by which to capture low-income, ethnic minority children's self-regulatory skills. The composite measure showed reliability scores (as measured by Cronbach's alpha) of greater than .90 across subscales and racial, socioeconomic, and gender subgroups. We also confirmed the concurrent validity of the cognitive and behavioral self-regulation subscales using a well-established measure of children's inattention and hyperactivity-impulsivity. Specifically, correlations between the corresponding subscales were found to be approximately .90, indicating a strong relationship between the measures' subscales.

In addition to testing the reliability and validity of the BIS-11/BRIEF composite measure, we examined its measurement invariance across demographic subgroups. Results of multigroup comparisons revealed measurement invariance across race, poverty risk status, and gender, indicating that the composite measure was able to assess cognitive and behavioral self-regulation similarly across groups. Few measures of self-regulatory skills have been validated in such a way in a low-income, ethnic minority sample. By explicitly

testing for whether the underlying measurement properties varied across demographic groups, we were able to complete an important first step in understanding how self-regulatory development may or may not differ across multiple contexts.

From a theoretical perspective, the results of this study provide further support for distinguishing between the unique roles of cognitively oriented domains of self-regulation, such as executive function, and more behavioral aspects of self-regulation, such as inhibitory control. The two-factor solution found for the BIS-11/BRIEF composite measure suggests the importance of conceptualizing cognitive and behavioral self-regulation as related but separate constructs. Though the results of this study indicate that cognitive and behavioral self-regulation can be seen as distinct domains, it is important to note that these constructs are neither empirically nor theoretically completely orthogonal. When testing for concurrent criterion validity, we saw a positive, statistically significant correlation between the inattention subscale of the TRF (a “cognitive” component) and the behavioral self-regulation subscale of the BIS-11/BRIEF composite measure. The same was true of the hyperactivity-impulsivity subscale of the TRF (a “behavioral” component) and the cognitive self-regulation subscale of the composite measure. In addition, the cognitive and behavioral subscales of the composite measure were found to be significantly positively correlated with each other.

From a conceptual perspective, it is not surprising that children with greater problems with working memory, attention, and planning may also have more problems regulating themselves behaviorally and vice versa. Indeed, B. Zimmerman (2008) has proposed a “cyclical model of self-regulated learning” based on components of social learning theory that implicates the interconnectedness of behavior, environment, and “covert self-regulation,” which includes the self-monitoring of cognitive states. Evidence from the present study supports this notion of interdependency between these regulatory processes.

Implications for Researchers and School Professionals

In recent years increased efforts have been made in the field of prevention science to boost the self-regulatory functioning of at-risk children from an early age. Several innovative interventions and socioemotional curricula have focused on self-regulation as a primary target for improvement because of the established associations between self-regulation and later outcomes, including academic functioning and mental health (Blair & Razza, 2007; Nigg et al., 1999; Pennington & Ozonoff, 1996). Despite the growing need for ways to assess the potential impacts of such interventions, few teacher-report tools have been validated for use with at-risk school-age children. The present study provides preliminary evidence that the BIS-11/BRIEF composite measure is a promising assessment that can be used in that research effort.

It is important to note that teacher-reported measures may have significant drawbacks, namely in that they provide molar rather than micro-level information regarding children’s executive function and inhibitory control (Isquith et al., 2004; Thomas, Forehand, Armistead, Wierson, & Fauber, 1990). At the same time, teacher reports may also offer significant advantages by reducing some of the potential methodological concerns that result from observational or task-based approaches. For example, observational techniques capture

only a small time frame, which could lead to bias based on the time of day or year. In addition, teachers may have a good grasp of children's styles of self-regulation across multiple learning and social contexts in which challenges are high (such as when a child must struggle with difficult material or maintain self-control in emotionally arousing conditions of conflict with peers). In short, teachers may serve as excellent informants for research studies, as they spend a great amount of time with their students and can therefore make generalizations about child behavior across time and, to a certain degree, situational context.

From a practical perspective, the composite measure proposed in this study is also useful for survey research in which the inclusion of direct assessments of the executive function and inhibitory control of school-age children may be unfeasible. In ideal circumstances, researchers might hope to maximize both internal validity (through the inclusion of more precise, direct assessments of executive function and inhibitory control) and external validity (through the selection of a very large and representative sample). Facing real-world constraints of limited research budgets, teacher report using the BIS-11/BRIEF composite may offer an inexpensive way of assessing children's psychological functioning, as it provides the opportunity for researchers to increase study power by capturing the self-regulatory skills of a larger number of children.

In addition to the potential utility of these measures in research contexts, the proposed composite measure may also provide an important opportunity for teachers and school professionals to identify particular children who are at risk for self-regulatory problems. Providing a method for early detection of behavioral or cognitive self-regulatory strength versus difficulty could help to identify particular children who might benefit from increased services or specialized curriculum changes. With early intervention, these children may have improved chances of increasing their ability to self-regulate and may be better able to avoid later risk of school failure (Bierman et al., 2008; Blair, 2002; Diamond et al., 2007).

Limitations and Future Directions

The present study expands upon measurement work that has been conducted with middle-class, Euro-American children by using a sample of African American and Hispanic children who were former Head Start participants in a large urban area. Despite the noted strengths of using such a sample, this method also presents important limitations in terms of generalizability. For example, because there were so few biracial and non-Hispanic White children in our sample, they had to be excluded from our analyses. Therefore, little can be said about the use of this measure with urban, low-income biracial and White children. In addition, self-regulatory skills are highly dependent on development, and tests of self-regulation may need to differ based on developmental age. Because the measures used in this study were administered when children were between the ages of 7 and 9, little can be said about their appropriateness for use with children outside this age range. This is especially true for younger children, for whom self-regulatory skills may still be developing.

An additional limitation of this study is our inability to account for potential cultural confounds and other biases in teacher ratings of children's self-regulatory skills. Past evidence has suggested that teachers may rate children's behavior and academic

achievement differently when the children's racial/ethnic background differs from their own (Dee, 2004; R. S. Zimmerman, Khoury, Vega, Gil, & Warheit, 1995). Because close to half (47%) of the children in our sample were assessed by teachers of different racial or ethnic backgrounds than their own, it is possible that these ratings suffered from cultural biases.

In the future, it would be of great empirical worth to test the validity of combined teacher-report measures such as the BIS-11 and BRIEF against direct assessments of children's executive functioning and inhibitory control using racially and socioeconomically diverse samples. Such efforts are important for three reasons. First, we recognize that molar levels of measurement alone are unlikely to provide the methodological precision needed to be able to explore underlying neurocognitive and behavioral mechanisms implicated in children's self-regulation. Second, direct assessments by independent raters would serve as another criterion measure against which to compare teacher ratings. In the present study, a single teacher rated children on both the BIS-11/BRIEF composite and the criterion measure (the TRF), which may have resulted in artificially high covariances between measures. Using a direct assessment of children's self-regulation would serve as an important opportunity to triangulate across raters and methodologies. Third, the use of more objective measures of children's self-regulation in the context of a racially/ethnically diverse sample of teachers would allow for an assessment of the potential impact of teachers' implicit or explicit cultural biases on the measurement of self-regulatory functions in diverse groups of children. We look forward to addressing these questions and continuing to explore innovative means of assessing school-age children's executive function and inhibitory control in field contexts in future research.

In sum, few validated teacher-report measures are available that would aid in evaluating individual differences in the multiple domains of school-age children's self-regulatory skills. This study provides psychometric evidence to support the use of a teacher-reported paper-and-pencil assessment of low-income, ethnic minority children's cognitive and behavioral self-regulation. With such tools, the field is placed in a stronger methodological position to answer pressing theoretical questions regarding the development of children's self-regulation in varying social contexts. These tools also provide empirically sound means of testing the modifiability of children's self-regulation as experts explore innovative new models of prevention and intervention.

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TABLE 1

Items and Corresponding Factor Loadings From an Exploratory Factor Analysis of the BIS-11/BRIEF Composite Measure of Self-Regulation

Item	Factor 1— <i>Cognitive Self-Regulation</i>	Factor 2— <i>Behavioral Self-Regulation</i>
BIS-11		
Child plans tasks carefully	-.831	-.502
Child concentrates easily	-.856	-.603
Child is a careful thinker	-.846	-.463
Child likes to think about complex problems	-.692	-.237
Child is a steady thinker	-.842	-.420
Child can only think about one thing at a time	.638	.317
Child likes puzzles	-.512	-.147
Child does things without thinking	.472	.727
Child “squirms” or is restless in class	.484	.692
Child says things without thinking	.374	.659
Child acts on impulse	.473	.880
Child acts on the spur of the moment	.435	.825
Child doesn’t “pay attention”	.700	.659
Child is self-controlled	-.622	-.695
BRIEF		
When given three things to do, remembers only the first or last	.683	.321
Has a short attention span	.794	.609
Has trouble concentrating on chores, schoolwork, etc.	.867	.590
Is easily distracted by noises, activity, sights, etc.	.755	.646
Has trouble with chores or tasks that have more than one step	.814	.447
Needs help from adult to stay on task	.792	.610
Forgets what he/she was doing	.744	.430
When sent to get something, forgets what is supposed to get	.541	.300
Has trouble finishing tasks (chores, homework)	.790	.500
Has trouble remembering things, even for a few minutes	.725	.437
Needs to be told “no” or “stop that”	.509	.829
Does not think before doing	.574	.743
Interrupts others	.526	.851
Is impulsive	.520	.881
Gets out of seat at the wrong times	.412	.761
Gets out of control more than friends	.482	.879
Acts too wild or “out of control”	.404	.820
Has trouble putting the brakes on his/her actions	.453	.876
Gets in trouble if not supervised by an adult	.540	.848
Does not think of consequences before acting	.579	.847

Note. BIS-11 = Barratt Impulsiveness Scale (version 11); BRIEF Behavior Rating Inventory of Executive Function. Bold text indicates the location of the item on Factor 1 vs. Factor 2.

TABLE 2
 Descriptive Results of the BIS-11/BRIEF Composite Measure of Self-Regulation by Demographic Subgroup

Scale	Full Sample (n = 215)			Race			Gender			Poverty Risk Status		
	M (SD)	Range		African American (n = 109)	Hispanic (n = 106)	Male (n = 116)	Female (n = 99)	High Risk (1.0) (n = 101)	Low Risk (>1.0) (n = 104)			
Cognitive subscale	36.42 (12.29)	19-61		37.67 (11.95)	35.13 (12.55)	37.33 (12.38)	35.35 (12.15)	37.31 (12.43)	35.69 (11.91)	19-61	19-61	19-60
Behavioral subscale	29.60 (11.39)	17-58		31.78 (11.31)	27.36 (11.08)	30.92 (11.70)	28.06 (10.86)	29.99 (11.85)	29.31 (11.17)	17-58	17-58	17-58
Total composite scale	64.72 (20.46)	36-114		67.96 (19.89)	61.39 (20.58)	66.81 (20.83)	62.27 (19.83)	66.01 (20.84)	63.69 (20.05)	36-114	36-114	36-109

Note. BIS-11 = Barratt Impulsiveness Scale (version 11); BRIEF = Behavior Rating Inventory of Executive Function.

TABLE 3

Bivariate Correlations Between Subscales of the TRF and the BIS-11/BRIEF Composite Measure of Self-Regulation

Variable	1	2	3	4	5
1. TRF–Inattention	—				
2. TRF–Hyperactivity-impulsivity	.58**	—			
3. BIS-11/BRIEF composite—Cognitive	.87**	.61**	—		
4. BIS-11/BRIEF composite—Behavioral	.60**	.90**	.70**	—	
5. BIS-11/BRIEF composite—Total	.81**	.81**	.93**	.91**	—

Note. All correlations are one-tailed. TRF = Teacher Report Form; BIS-11 = Barratt Impulsiveness Scale (version 11); BRIEF = Behavior Rating Inventory of Executive Function.

**
 $p < .01$.

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TABLE 4

Cronbach's Alphas for the BIS-11/BRIEF Composite Measure of Self-Regulation by Demographic Subgroup

Scale	Race			Gender		Poverty Risk Status	
	Full Sample	African American	Hispanic	Male	Female	High Risk (1.0)	Low Risk (>1.0)
Cognitive subscale	.95	.95	.96	.96	.95	.95	.96
Behavioral subscale	.96	.96	.96	.96	.96	.96	.97
Total composite scale	.97	.97	.97	.97	.97	.97	.97

Note. BIS-11 = Barratt Impulsiveness Scale (version 11); BRIEF = Behavior Rating Inventory of Executive Function.

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