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Internal and External Validity of Sluggish Cognitive Tempo in Young Adolescents with ADHD

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University.

By

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Abstract

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By Zoe Smith, B.A.

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Adolescents with Sluggish Cognitive Tempo (SCT) show symptoms of slowness, mental confusion, excessive daydreaming, low motivation, and drowsiness/sleepiness. Although many symptoms of SCT reflect internalizing states, no study has evaluated the utility of self-report of SCT in an ADHD sample. Further, it remains unclear whether SCT is best conceptualized as a unidimensional or multidimensional construct. In a sample of 262 adolescents comprehensively diagnosed with ADHD, the present study evaluated the dimensionality of a SCT scale and compared CFA and bifactor model fits for parent- and self-report versions. Analyses revealed the three-factor bifactor model to be the best fitting model. In addition, SCT factors predicted social and academic impairment and internalizing symptoms. Therefore, SCT as a multidimensional construct appears to have clinical utility in predicting impairment. Also, multiple reporters should be used, as they predicted different areas of functioning and were not invariant, suggesting that each rater adds unique information.

Introduction

The construct of Sluggish Cognitive Tempo (SCT) includes symptoms of slowness, mental confusion or "fogginess," excessive daydreaming, low motivation, and drowsiness/sleepiness. SCT first emerged in the literature in the 1980s, and has since reemerged, primarily focusing on the internal and external validity of SCT in children with Attention-Deficit/Hyperactivity Disorder (ADHD; Becker, Marshall, & McBurnett, 2014). With respect to internal validity (i.e., do SCT symptoms hold together statistically and also remain distinct from other psychopathologies), although SCT is correlated with ADHD inattentive symptoms, multiple factor analytic studies show that the two constructs are overlapping but empirically distinct (Bernad, Servera, Grases, Collado, & Burns, 2014; Burns, Servera, Bernad, Carrillo, & Cardo, 2013; Garner, Marceaux, Mrug, Patterson, & Hodgens, 2010; Hartman, Willcutt, Hyun Rhee, Pennington, 2004; McBurnett, Pfiffner, & Frick, 2001; Jacobson, Murphy-Bownman, Pritchard, Tart-Zelvin, Zabel, & Mahobe, 2012; Penny, Waschbusch, Klein, Corkum, & Eskes, 2009). With respect to external validity (i.e., are SCT symptoms related to impairment domains), there is a growing body of research showing that the general construct of SCT uniquely contributes to impairment above and beyond the influence of ADHD (Becker, 2014; Langberg, Becker, & Dvorsky, 2014; Wilcutt et al., 2014). However, findings are mixed, and associations between SCT and impairment may be domain specific (Becker, 2014; Becker, Luebbe, & Joyce, 2015; Becker & Langberg, 2012). Overall, although SCT research has rapidly increased in the past 15 years (Becker et al., 2014), the field remains significantly constrained by measurement limitations, including the fact that there is no gold standard or even uniform way of measuring SCT.

SCT Measurement Limitations

Currently, there are multiple measures of the SCT construct, each containing a different number and set of items. At least partly because extant research employs different measures of SCT, it remains unclear whether SCT in childhood is best conceptualized as a single- or a multi-factor construct. Some studies support SCT as a single factor (e.g., Barkley, 2012; Becker et al., 2015; Lee, Burns, Snell, & McBurnett, 2014; Willcutt et al., 2014), while other studies suggest that SCT consists of multiple distinct factors (e.g., Barkley, 2013; Fenollar Cortés et al., 2014; Jacobson et al., 2012; McBurnett, Villodas, Burns, Hinshaw, Beaulieu, & Pfiffner, 2014; Penny et al., 2009). In addition, it is unclear what source/rater should be relied upon to gather information about SCT. To date, almost all of SCT research has focused on parent- and teacher-report of SCT. This is probably because most SCT research has taken place in the context of ADHD, where parents and teachers are considered the most reliable and valid sources of information (Pelham, Fabiano, & Massetti, 2005). However, many SCT items query about internal states and SCT symptoms are significantly related to internalizing symptoms (Becker et al., 2016). It may be the case that, similar to internalizing symptoms, the best method for obtaining information about SCT in childhood is self-report. These limitations are discussed in more detail below, beginning with a review of factor analytic research focused on whether SCT is a single or multi-dimensional construct.

Factor Structure of SCT

One of the more widely used SCT measures, the 14-item Penny et al. (2009) scale, identified SCT as a multi-faceted construct in a school-based sample of children. Specifically, an exploratory factor analysis (EFA) of parent-reported SCT on this scale revealed three separate dimensions; Slow (e.g. “is slow or delayed in completing tasks), Sleepy (e.g. “seems drowsy”),

and Daydreamer (e.g. "gets lost in his or her own thoughts") (Penny et al., 2009). In contrast, using teacher-report, Penny and colleagues (2009) found that the Sleepy and Daydreamer items loaded together on one factor, creating a 2-factor model of Slow and Sleepy/Daydreamer. However, Jacobson and colleagues (2012) later reported that an EFA with the teacher version of this scale in a clinic-referred sample of children resulted in a three-factor structure similar to that reported for the parent scale in Penny et al. (2009): Sleepy/Sluggish (e.g. "seems drowsy"), Slow/Daydreamy (e.g. "seems to be in his or her own world"), and Low Initiation/Persistence (e.g. "is unmotivated"). Importantly, these factors seem to be meaningful in that they are differentially related to impairment (Becker & Langberg, 2014; Jacobson et al., 2012; Langberg, Becker, & Dvorsky, 2014). For example, the slow factor has been found to relate to academic impairment and executive functioning above and beyond the other two factors and ADHD symptoms (Becker & Langberg, 2014; Langberg et al., 2014).

Moving Beyond Exploratory Factor Analysis

As is made clear in the name, EFAs are exploratory, data-driven techniques that look for patterns in the data, typically run without any particular *a priori* theory about factor structure (Farrell, 1999; Floyd & Widaman, 1995). As such, EFAs are often difficult to replicate and the patterns and factor structure are often unique to a particular dataset (Farrell, 1999; Floyd & Widaman, 1995). To truly evaluate the validity of a proposed theoretical factor structure, confirmatory factor analysis (CFA) must be used. CFAs assess the construct validity of a measure and evaluate the fit of the proposed dimensionality of the construct (Floyd & Widaman, 1995). Although increasingly used in research, the multi-factor structure of the Penny et al. (2009) scale has not been validated in any type of sample using CFA. In addition, there has been minimal use of bifactor modeling strategies in evaluating measures of SCT. Given that

psychological constructs are complex, and comparing unidimensional and multidimensional models might not fully conceptualize SCT, bifactor modeling may be needed (Reise, Moore, & Haviland, 2010). Bifactor modeling includes a latent structure with each item loading onto an underlying general factor that reflects the commonality and individual differences among items as they are related to the general factor (Reise et al., 2010), in this case the SCT construct. The bifactor model specifies a single general trait that explains some proportion of common variance of all items, but also contains grouped factors (or specific factors) that explain additional common variance (Reise et al., 2010). Thus, using bifactor modeling would allow for recognizing SCT as a multidimensional construct while also retaining a single general factor of SCT.

To date, only two studies of SCT in childhood have used CFAs to understand which factor model (i.e. a 1-factor, 2-factor, or 3-factor model) best fits the SCT construct. McBurnett et al. (2014) found support for the fit of a four-factor structure of SCT and ADHD symptoms in a clinical sample of children aged 7 to 11 years with ADHD. The four-factors included an ADHD inattentive factor, a daydreaming factor, a sleepy/tired factor, and a working memory factor (e.g., "forgets what he or she was going to say," "loses train of thought"). In a CFA with a clinical sample of 131 Spanish children ages 6-16 with ADHD, Fenollar Cortés and colleagues (2014) found support for a two-factor construct of SCT that included slowness and inconsistent-alertness factors. Although both of these studies suggest that SCT is multidimensional, they used different measures and found support for different factor structures. Additional studies that directly compare multiple factor structures are needed in order to evaluate whether SCT is best conceptualized as unidimensional or multidimensional and, if multidimensional, whether a 2- or 3-factor model seems optimal. Further, both of these studies only collected information about

SCT from parents and teachers. Since SCT and internalizing symptoms are highly correlated and self-report is considered the best source of information for assessing internalizing symptoms (Klein, Dougherty, & Olino, 2005; Silverman & Ollendick, 2005), it seems critical to incorporate self-report into the measurement of SCT.

Self-Report of SCT in Adolescence

Previous bifactor modeling studies examined SCT within the bifactor structure of ADHD using only parent and teacher raters (Garner et al., 2014; Lee, Burns, Beauchaine, & Becker, 2015). Only one study has collected self-report of SCT and also conducted a CFA or a bifactor analysis. Specifically, Becker et al. (2015) modified the items of the Penny et al. (2009) scale for self-report (e.g., changing "does your child…" to "do you…") and used exploratory structure equation modeling (ESEM), which is a mixture of EFA and CFA analyses, to evaluate the factor structure in a general education sample of 124 elementary-aged children. The ESEM found the same three factors identified as present in the parent SCT measure (Slow, Sleepy, and Daydreamer). However, a bifactor model was conducted given the high correlations reported between the Slow and Sleepy factors. After conducting a bifactor analysis, the authors concluded that SCT was better conceptualized as one overarching general factor since the three specific factors did not demonstrate adequate reliability after accounting for the general SCT factor. However, this study has not been replicated in a clinical sample, self-report of SCT in youth remains largely unexamined, and no study has evaluated how youth report of SCT corresponds to parent report of SCT.

External Validity

The open questions about whether SCT is unidimensional or multidimensional and whether self-report should be utilized also have implications for external validity. If SCT is

indeed multidimensional, then clinically, it will be important to determine which factors are most highly associated with impairment. Similarly, if a model using self-report of SCT demonstrates good fit, an important next step will be to evaluate how self-report of SCT relates to impairment in comparison to other reporters, such as parents. These types of analyses would have implications for what source should be emphasized when evaluating SCT. To date, almost all research evaluating associations between SCT and impairment has treated SCT as unidimensional and utilized parent and/or teacher report. Nevertheless, this literature is reviewed below to help inform hypotheses for the present study.

Social Functioning

The association between SCT and social functioning has been documented in both ADHD and general school samples. In a longitudinal general school sample, Becker (2014) found that teacher-rated SCT predicted poorer teacher-rated peer functioning, levels of popularity, and social preference after controlling for child demographics, other psychopathologies (anxiety, depression, ADHD, oppositional and conduct problems), and baseline peer functioning. Overall, teachers rated 75% of children with high levels of SCT as impaired in peer functioning (Becker, 2014). In another large general school sample, Bernad et al. (2015) found that higher levels of teacher-rated SCT predicted teacher-rated peer-rejection two-years later above and beyond symptoms of ADHD. SCT has also been shown to predict multiple aspects of social functioning in ADHD samples. For example, Barkley (2013) reported associations between SCT and community-leisure activities (e.g., play with neighborhood children, sports, play at school) and Willcutt et al. (2014) found associations between SCT and social isolation and social cognition after controlling for ADHD, comorbid conditions, and intelligence. In fact, only SCT symptoms and not ADHD symptoms were independently

associated with social isolation (Willcutt et al., 2014). One limitation of the literature completed to date is the reliance on the same source to measure SCT and social functioning (e.g. parent SCT to parent impairment). However, in a cross-sectional study, Marshall, Evans, Eiraldi, Becker, & Power (2014) demonstrated a cross-rater association, with higher levels of parent-rated SCT symptoms predicting lower levels of teacher-rated relational and overt aggression from peers. Other significant limitations include that most studies have treated SCT as unidimensional and measured SCT from the parent or teacher perspective only.

In one of the only studies to evaluate SCT dimensionally, Fenollar Cortés et al. (2014) separated SCT into two dimensions; SCT-Inconsistent Alertness (SCT-IA; e.g. daydreaming, losing one's train of through) and SCT-Slowness (SCT-S; e.g. slowed thinking, drowsiness). The SCT-IA factor as rated by parents was positively associated with peer relation problems, but the factor of SCT-S was not (Fenollar Cortés et al., 2014). This finding suggests that specific dimensions of SCT may be differentially related to social impairment. Finally, in the only study to explore self-report of SCT, Becker et al. (2015) found that self-reported SCT was related to poorer teacher-rated social functioning in a general elementary sample. However, this association was nonsignificant after controlling for demographics and other psychopathology (Becker et al., 2015). Accordingly, important next steps will be to evaluate associations between self-report SCT measured as multidimensional with social functioning in an ADHD sample.

Academic Impairment

There is also some support for an association between SCT and academic impairment in general school (Bernad et al., 2014; Bernad et al., 2015; Servera et al., 2015; Willcutt et al., 2014) and ADHD samples (Langberg et al., 2014; Marshall et al., 2014). For example, after controlling for ADHD symptoms of inattention and depression, Bernad et al. (2014) found that

higher levels of SCT remained cross-sectionally associated with higher levels of academic impairment. Longitudinally, both parent- and teacher-rated SCT have been found to predict ratings of academic impairment, up to two years after the initial assessment (Bernad et al., 2015; Servera et al., 2015). There is also some evidence that SCT is associated with non-rating metrics of academic functioning such as standardized achievement scores after controlling for ADHD symptoms (Wilcutt et al., 2014). Associations between SCT and academic functioning within ADHD samples have been more mixed and not as thoroughly evaluated. Children with ADHD Inattentive Presentation and SCT had significantly more homework problems than children with ADHD Combined Presentation, showing that SCT may increase rates of academic impairment in children with inattention (Marshall et al., 2014).

Only one study to date has examined associations between SCT measured multidimensionally and academic impairment. In a sample of 52 adolescents diagnosed with ADHD, Langberg et al. (2014) found that parent-rated SCT-Slow and teacher-rated SCT-Low Initiation/Persistence predicted multiple aspects of academic impairment above and beyond the ADHD and the other SCT factors (three-factor structure was evaluated). Importantly, some of the findings were cross-rater (e.g., parent SCT-Slow predicting teacher academic impairment) and one association was with a non-rating metric (teacher SCT-Low Initiation/Persistence predicted school grades). This work shows the possibility that specific SCT factors may be differentially related to academic impairment. Finally, as noted above, only one study has evaluated child self-reported SCT symptoms in relation to academic impairment. In that study, Becker et al. (2015) found that self-reported SCT symptoms in a general school sample were significantly associated with poorer child-rated academic functioning above and beyond demographic factors and other psychopathology, but not teacher-rated academic functioning

(Becker et al., 2015). These mixed results may be because factors of SCT are differentially related to academic impairment, or that different raters perceive different academic impairment. Important next steps include evaluating the relationship between academic impairment and SCT in an ADHD sample, including associations with a general factor of SCT as well as specific SCT factors, and using multiple raters and objective measures of academic outcomes.

Psychopathology

Studies evaluating whether SCT predicts the presence or development of psychopathology have found that SCT is more related to internalizing problems than externalizing problems. Overall, in both general school and ADHD samples, SCT appears to be *negatively* related to impulsivity, hyperactivity, oppositional behaviors, and conduct problems (Becker & Langberg, 2012; Bernad et al., 2014; Capdevila-Brophy et al., 2014; Carlson & Mann, 2002). In terms of associations with internalizing problems, SCT symptoms are moderately positively correlated with internalizing symptoms (Bernad et al., 2014; Bernad et al., 2015; Servera et al., 2015), and SCT within children with ADHD may increase the risk of internalizing comorbidities (Barkley, 2013; Capdevila-Brophy et al., 2014; Carlson & Mann, 2002; Garner et al., 2010). In particular, SCT seems to increase the risk of comorbid depression after controlling for ADHD symptoms (Barkley, 2013; Bernad et al., 2014; Servera et al., 2015). The only study to evaluate associations between depression and multiple factors of SCT found that only SCT-Slowness was positively associated with depression (Fenollar Cortés et al., 2014). Overall, less is known about the relationship between SCT and anxiety, with only two studies completed to date finding that SCT is associated with higher levels of anxiety (Bernad et al., 2015; Skirbekk, Hansen, Oerbeck, & Kristensen, 2011).

In sum, these findings suggest that SCT is more likely to serve as a risk for internalizing problems such as depression than for externalizing problems. However, as with impairment, a major limitation is that SCT has largely been measured unidimensionally. Further, no study has evaluated associations between self-report of SCT and psychopathology and most findings have been within rater. Importantly, self-report is considered the best source of information regarding internalizing conditions (Klein et al., 2005; Silverman & Ollendick, 2005), and to date no study has evaluated associations between SCT and self-reported symptoms of anxiety and depression.

Present Study

The present study included three aims designed to evaluate the internal and external validity of parent- and self-report SCT as measured by the Penny et al. (2009) scale in a clinical sample of young adolescents with ADHD.

Aim 1: Comparing factor structures to validate measurement of SCT. The first goal of this study was to compare parent- and self-report CFAs (1 factor, 2 factor, 3 factor) of the Penny et al. (2009) SCT scale. The primary purpose of this aim was to determine if the three-factor structure originally identified through EFA (Penny et al., 2009) could be confirmed using CFA with either parent- or self-report, and if a three factor structure fits better than a one- or two-factor structure. In this study we only included SCT symptoms in the models, as opposed to also including ADHD symptoms of inattention, for two reasons. First over 20 studies have already found SCT symptoms to be distinct from ADHD symptoms, including several studies using the same SCT measure as evaluated in this study (Becker et al., 2016). Second, the participants in this study were comprehensively diagnosed with ADHD, which significantly reduces variability in ADHD symptoms, potentially biasing the findings.

Hypothesis 1. Based on previous studies using the Penny et al. scale (Becker et al., 2015; Jacobson et al., 2012; Penny et al., 2009), we predicted that the multi-faceted nature of SCT would be confirmed as evidenced by the 3-factor model demonstrating better fit than either a 1- or 2-factor model for both parent- and self-report.

Aim 2: Comparing best fitting CFA model to bifactor model. Given that the SCT factors identified in prior work were highly correlated, bifactor modeling was also used to evaluate the dimensionality of SCT and to determine if the factors were best explained by an underlying SCT factor. Aim 2 included comparisons between the best fitting CFA models with the bifactor model.

Hypothesis 2. Based on Becker et al. (2015) we predicted that the fit statistics for the bifactor model would be equivalent to or better than CFA, suggesting that SCT is best conceptualized as having a generalized factor with specific factors.

Aim 3: Use validated factor structure to explore external validity of SCT. The third aim evaluated academic and social impairment and internalizing psychopathology in relation to the best fitting SCT models from Aims 1 and 2. Multiple regression analyses were conducted to control for parent-rated ADHD symptoms in evaluating associations between parent- and self-report of SCT and academic impairment, social impairment, anxiety, and depression.

Hypothesis 3a. Given that adolescents with ADHD have been shown to exhibit a positive illusory bias particularly when rating their own social functioning (Hoza et al., 2013), we predicted that parent-report accounted for a greater amount of variance in predicting social impairment of adolescents. As described above, Fennollar Cortes et al. (2014) found differential relationships between SCT factors and social impairment. Accordingly, we predicted that the SCT factors would be differentially related to social impairment, and that the SCT-Daydreamer

factor, similar to the SCT-IA factor in Fenollar Cortes et al. (2014), would best predict social impairment.

Hypothesis 3b. We predicted that parent-report would account for more variance in predicting grades and teacher-rated homework problems compared to self-report. Consistent with Langberg et al. (2014), we predicted that the SCT-Daydreamer factor would predict impairment measured by grades, while SCT-Slow would predict teacher-rated homework problems.

Hypothesis 3c. To date, no study has examined associations between self-report of SCT and internalizing psychopathology. Given that internalizing symptoms are often covert, self-report is considered most "accurate" or at least best-practice recommendations emphasize self-report in assessing internalizing symptoms. Therefore, we predicted that self-report of SCT would account for a greater proportion of the variance than parent-report in predicting symptoms of anxiety and depression. Consistent with Fenollar Cortés et al. (2014), we predicted that the SCT-Slow factor would best predict higher levels of depression and anxiety.

Methods

Participants

Participants included 262 middle-school students (boys 193, girls 69) in grades 6-8 (ages 10-15; *M*=11.95, *SD*=1.05) who were comprehensively diagnosed with ADHD. Participants were recruited from six public middle schools in the Eastern United States. The sample was diverse with parents identifying 30.2% of the youth as African American (*n*=79), 10.3% identified as Biracial (*n*=27), 56.5% as White (*n*=148), and 2.3% with another race (*n*=6). Two participants chose not to answer. Per procedures described next, 171 participants (65.3%) were diagnosed with ADHD Predominantly Inattentive Presentation (ADHD-IA) and 91 (34.7%) were diagnosed with ADHD Combined Presentation (ADHD-C). Participants' annual family income

ranged from less than $5,000 to more than $225,000 (*M* = $83,863.64, *Mdn* = $62,500). Highest level of education as reported by the participants' parents is as follows: did not earn a high school degree (3% of mothers, 5.7% of fathers), high school degree (20.3% of mothers, 22.5% of fathers), associate's degree (19.9% of mothers, 13% of fathers), bachelor's degree (28.1% of mothers, 24.6% of fathers), and advanced degree (17.7% of mothers, 13.8% of fathers). 44.5% of the sample had an Individualized Education Program (IEP) or a 504 Plan and 54.7% reported taking medication for ADHD. Demographic characteristics are shown in Table 1.

Table 1.
Demographics

Characteristics	Mean (SD)
Age	11.95 (1.05)
	Median
Family Income	62,500
	Percent
Sex	
Female	26.3%
Male	73.7%
Race	
African American	30.2%
Biracial	10.3%
White	56.5%
Other	2.3%
ADHD Presentation	
ADHD-IA	65.3%
ADHD-C	34.7%
Medication Status	
Medication for ADHD	54.7%

Note. Demographic Information. SD=Standard Deviation, ADHD-IA=ADHD-Inattentive Presentation, ADHD-C=ADHD-combined presentation. Income presented in US dollars.

Procedure

Participants who provided data for the current study were recruited as part of a larger study evaluating school-based intervention programs for adolescents with ADHD. All data evaluated in the present study were collected at baseline, prior to participants receiving any

intervention. Recruitment methods included study announcement letters mailed to all parents at participating middle schools, flyers posted in each school, and direct referral by school staff. Interested parents completed a phone screen that included rating their child on each of the nine DSM-5 ADHD-IA symptoms on a 4-point Likert scale (0 = *Rarely*, 1 = *Sometimes*, 2 = *Often*, 3 = *Very Often*). If a parent reported that their child had a previous diagnosis of ADHD or they endorsed the presence of at least four of nine ADHD-IA symptoms at clinically significant levels (i.e., "*Often*" or "*Very Often*"), an in-person evaluation was scheduled.

During the inclusion/exclusion evaluation, adolescents and parents/guardians independently were administered the *Parent Children's Interview for Psychiatric Syndromes* (P-ChIPS; Weller, Weller, Fristad, Rooney, & Schecter, 2000), a structured diagnostic interview which was administered by a doctoral student supervised by a licensed clinical psychologist. Additionally, parents and adolescents completed the *Behavior Assessment System for Children, Second Edition* (BASC-2; Reynolds & Kamphaus, 2004), a measure designed to broadly screen for behavioral or mood problems in children. Parents and at least one teacher of each student also completed the *Vanderbilt ADHD Diagnostic Rating Scale* (Wolraich, Lambert, & Doffing, 2003), a 45-item measure assessing symptoms of ADHD, oppositional defiant disorder (ODD), and conduct disorder (CD). Finally, adolescents were administered a brief battery assessing their cognitive and academic achievement abilities, including four subtests from the *Wechsler Intelligence Scale for Children, Fourth Edition* (WISC-IV; Wechsler, 2003), and seven subtests from the *Wechsler Individual Achievement Test, Third Edition* (WIAT-III; Wechsler, 2009).

Participants were considered eligible for the study if they met five criteria: 1) attended a participating middle school, 2) met full DSM-5 diagnostic criteria for ADHD-IA or ADHD-C presentation based on the combination of parent report on the P-ChIPS and teacher report, 3)

experienced significant impairment due to ADHD symptoms based on parent and/or teacher report, 4) had an estimated Full Scale IQ (FSIQ) of at least 80 according to performance on the WISC-IV, and 5) did not meet diagnostic criteria for any bipolar disorder, psychosis, or obsessive-compulsive disorder (OCD) according to parent report on the P-ChIPS. To maximize generalizability, students with comorbid diagnoses of ODD, CD, anxiety and depression were allowed to participate in the study. Parent or child report on the P-ChIPS or CHIPS was used for both externalizing and internalizing comorbidities, with 30.6% meeting criteria for ODD, 4.8% for CD, 25.4% for anxiety, and 5.3% for depression.

Measures

Participants' parents/guardians completed a demographics questionnaire at the study baseline that included information on sex, race/ethnicity, grade in school, parent education and income, and ADHD medication status.

Children's Interview for Psychiatric Syndromes (ChIPS). The ChIPS (Weller, Weller, Fristad, Rooney, & Schecter, 2000) is a structured diagnostic interview for administration to parents and children (children ages 6–18) and has a parent (P-ChIPS) and child version (ChIPS). The ChIPS has shown high internal consistency and test-retest reliability (Fristad, Teare, Weller, Weller, & Salmon, 1998) as well as high convergent validity with the *Diagnostic Interview for Children and Adolescents—Revised–Child Version* (Fristad et al., 1998). A recent review of child and adolescent diagnostic interviews (Leffler, Riebel, & Hughes, 2015) found five separate studies documenting that the ChIPS has good concurrent validity with other validated diagnostic interviews, including the *Diagnostic Interview for Children and Adolescents-Revised-Child Version* (DICA-R-C) and the *Schedule for Affective Disorders and Schizophrenia for School Aged Children* (K-SADS). Further, the ChIPS has good construct

validity, with the percent of agreement between a consensus panel of child psychopathology experts and the results from ChIPS interviews ranging from 97.5% to 100%. Sensitivity averaged 87% across diagnostic categories and specificity averaged 76%, with sensitivity and specificity for attention deficit disorder at 100% and 44%, respectively (Fristad et al., 1998).

Vanderbilt ADHD Diagnostic Rating Scale (VADRS). The VADRS is a DSM-IV-based scale that includes all 18 DSM-IV symptoms of ADHD. Parents and teachers rate how frequently each symptom occurs on a 4-point Likert scale (0 = *Never*, 1 = *Occasionally*, 2 = *Often*, 3 = *Very Often*). The VADRS produces an Inattention score (sum of the nine inattention items) and a Hyperactivity/Impulsivity score (sum of the nine hyperactive/ impulsive items). The VADRS has excellent psychometric properties (Wolraich et al., 2003). In the present study, internal consistencies were: ADHD inattention α =.87, ADHD hyperactivity-impulsivity α =.90, ODD/CP α = .87, and anxiety/depression α = .87.

Sluggish Cognitive Tempo Scale. The parent-report version of the Penny et al. (2009) SCT Scale consists of 14 items that are each rated on a four-point scale from 0 = *Never* to 3 = *Very Often*. Three factors have been identified for the parent version: Sleepy, Slow, and Daydreamer (Penny et al., 2009). Test-retest reliability estimates range from 0.70 to 0.87 for parent-report. As in Becker et al. (2015), the parent-report scale was modified for use as a self-report measure in the present study (e.g., instead of "does your child…", "do you…"). Each of the 14 items were changed to reflect the first person, and items were kept as similar as possible to the original parent-report version, but some words were changed to make it more understandable for children (e.g. instead of "lethargic" use "don't have energy"). In the present study, internal consistencies for parent and child total scores were α = .87 and α = .86, respectively.

Grades. Grade Point Average (GPA) is a standardized numerical measure of aggregated grades from a student's courses within a given time period. GPA is on a 4-point scale, with higher numbers indicating better grades (4.0 = A, 3.0 = B, 2.0 = C, 1.0 = D). In the current study, grades from four core subjects (i.e., mathematics, English, science, and social studies) were collected and converted into the 4-point scale. The converted grades were averaged over each quarter.

Homework Performance Questionnaire (HPQ). The Homework Performance Questionnaire (HPQ; Power, Dombrowski, Watkins, Mautone, & Eagle, 2007) is a 22-item rating scale that assesses a student's homework behavior. The HPQ relies on teacher-report and is therefore useful for cross-rater academic analyses. The HPQ has previously demonstrated high internal consistency (α = .85-.91) and two-week test-retest reliability (Power, Dombrowski, Watkins, Mautone, & Eagle, 2007). For the current study, two teachers rated student's homework behaviors, and scores were averaged across the teachers.

Behavior Assessment System for Children, second edition (BASC-2). The BASC-2 is a widely used, multi-dimensional clinical assessment tool that includes self-report and informant-based report forms to evaluate a wide range of behavioral and emotional experiences of youth. In the current study, parents and adolescents completed the BASC-2 (Reynolds & Kamphaus, 2004). As this study was conducted with young adolescents, some youth and parents completed the BASC-2 child (BASC-2C) for ages 8-11 (n=96) and the rest completed the BASC-2 adolescent report (BASC-2A; n=166). Some items assess the frequency of experiences (rated from 0/never to 3/almost always), while others are true/false questions assessing the presence of thoughts and behaviors. The BASC-2 includes 12 clinical scales for self-report (e.g. anxiety, depression) and 4 adaptive scales (e.g. interpersonal relations) while parent-report includes 9

clinical scales (e.g. conduct problems, depression) and 5 adaptive scales (e.g. social skills). The BASC-2 is widely used in mental health and educational settings, and has been normed on a large representative sample (Reynolds and Kamphaus, 2004). T- scores representing age-normed domain scores were used for this study. T-scores reflect a continuous distribution within the population, with a mean of 50 and a standard deviation of 10. BASC-2 authors suggest that t-scores over 60 (i.e., scores above the 86th percentile of the normative sample) represent potentially meaningful clinical elevations.

In the current study, the interpersonal relations scale on the self-report measure and the social skills scale on the parent-report measure were of particular interest. It is important to note for the current study that the interpersonal relations and social skills scales do not contain the same items for children and adolescents. Specifically, the interpersonal relations scale includes six items on BASC-2C and seven items on BASC-2A. For instance, an item in the interpersonal relations scale for both child and adolescent is "other children don't like to be with me," while the only the child version includes "other people/my classmates make fun of me," while adolescent version includes "I am slow to make new friends" and "people think I am fun to be with." The parent-rated social skills scale contains eight items for both the child and adolescent versions. An example item is "shows interest in others' ideas." Other subscales of importance were the self-report of anxiety and depression. For anxiety, self-report consists of 13 items (e.g., "I get nervous"). For depression, self-report consists of 12 or 13 child and adolescent versions respectively including items such as "I feel sad." Given the differences across the child and adolescent versions for the interpersonal relations scale and the depression scale, T-scores will be used in all analyses with the BASC to standardize across versions.

Analytic Plan

Missing Data

We assessed the total proportion of data that was missing from all variables of interest before analyses began. Strategies for addressing issues of missing data were based on the recommendations of Schafer and Graham (2002). Little's Missing Completely at Random (MCAR) test was used to ensure that data is not missing from subjects in a systematic manner, which could skew analyses and lead to an incorrect interpretation of data (Little, 1988). Given that baseline data were used in this study, we did not anticipate high rates of missing data. If data were determined to be missing at random, then missing data were accounted for in subsequent analyses using maximum likelihood estimation. If the data were not missing completely at random, a pattern-mixture modeling approach was used to examine missing data patterns.

Invariance Testing

In order to formally test whether the fit of the models differed across raters, invariance analyses of the best fitting model (bifactor model; see Results section for details) was conducted. A configural model was estimated in which factor loadings and thresholds were unconstrained, scale factors were fixed at one, and factor means were set to zero across both raters. This model served as the baseline model for invariance testing. Given that the best fitting model was non-orthogonal, metric (or factor loading invariance) could not be tested for parameterization reasons (see Mplus Version 7. 1 Language Addendum; Muthén & Muthén, 1998-2012). Instead, a scalar invariance model was tested in which both factor loadings and thresholds were constrained to equality across groups (see Mplus Version 7.1 Language Addendum for additional specifications). A chi-square likelihood test (DIFFTEST command in Mplus) was used to statistically compare the models. A significant chi-square indicates a lack of invariance. Since

chi-square testing can be overly sensitive in large samples, we also examined changes in model fit where an increase in RMSEA of $\geq$ .05 and/or a decrease in CFI $\leq$ .01 indicates that the models are not invariant (Little, 2013).

Aim 1

Analyses were conducted in Mplus Version 7.13 (Muthén & Muthén, 1998-2012). CFA was used to estimate one (SCT), two (Slow and Sleepy/Daydreamer) and three (Slow, Sleepy, and Daydreamer) factor models based on the Penny et al. (2009) EFA in which latent factors were allowed to correlate for self- and parent-report separately. In all models, items were treated as categorical indicators and robust weighted least squares (WLSMV estimator) was used. Factor loadings that were above .40 were deemed good fit on the construct. Estimated models were compared by examining various fit indices including Comparative Fix Index (CFI; ideal study criterion >0.95), Tucker Lewis Index (TLI; ideal study criterion $\geq$ 0.95), root mean square error of approximation (RMSEA; ideal study criterion $\leq$ 0.06), and weighted root mean square residual (WRMR; ideal study criterion $\leq$ 0.90 (Hu & Bentler, 1999; Kline, 2011; Yu, 2002). Chi-square difference testing statistically compares models and was used along with the model with the best global fit (i.e., highest CFI and TLI indices; lowest RMSEA and WRMR indices) to determine the best fitting model.

Aim 2

Analyses were conducted in Mplus Version 7.13 (Muthén & Muthén, 1998-2012). A bifactor model was estimated for self- and parent-report in which all items load directly onto an underlying SCT general 'g' factor and specific factors. The CFA was used to inform the bifactor model. Specifically, if the three-factor CFA were found to be the best fitting model (as hypothesized in aim 1), then the bifactor analyses would be conducted using Slow, Sleepy, and

Daydreamer as the specific factors. On the other hand, if the one factor CFA was the best model, the three specific factors would still be used in the bifactor because previous work (Becker et al., 2015) found a bifactor structure with the three specific factors of Slow, Sleepy, and Daydreamer, and comparison between the one-factor CFA and bifactor model would be useful in understanding the conceptualization of SCT (i.e., is SCT unidimensional or multidimensional with an underlying general factor). If Aim 1 found the two-factor CFA to be the best fitting model, the bifactor analyses would be run with the Slow and Sleepy/Daydreamer factors.

In the bifactor model, all factors (general and specific) were specified to be orthogonal to one another (Reise, 2012). The correlations between 'g' and specific factors across raters (self and parent) were also estimated in Mplus. Since Mplus estimates covariance rather than factor correlations by default, phantom factors for the latent factors, which standardize the latent factors, must typically be created. In these analyses, latent factors were identified by fixing the variances of latent variable to 1, thereby standardizing latent variables (Kline, 2011, p. 128). The advantage of this approach is that it eliminates the need to create phantom factors in order to estimate the correlation between latent variables. Chi-square difference testing is not appropriate when comparing non-nested models such as the bifactor model, an orthogonal model, to the 1, 2 and 3 factor non-orthogonal models. Accordingly, when comparing non-nested models to one another, we compared model fit indices using overall global model fit (i.e., highest CFI and TLI indices; lowest RMSEA and WRMR indices).

Aim 3

To assess the external validity of SCT, multiple regression analyses were used. Because ADHD symptoms are known to be associated with impairment, parent-rated ADHD symptoms were entered as a covariate. Two regressions were conducted for each outcome (Social,

Academic, Anxiety, Depression): 1) including both parent- and self-report of the general SCT factor, and 2) including both parent- and self-repot of the specific factors, identified through the CFA. For example, if the three-factor CFA were found to be the best fitting CFA, then all three factors of Slow, Sleepy, and Daydreamer would be used as predictors while controlling for ADHD. For the subscales on the BASC-2, t-scores were used to standardize across the child and adolescent versions. Additionally, the multicollinearity of the predictors (ADHD, SCT, Sleepy, Slow, and Daydreamer) was examined. If two variables were closely related, then any potential effect of one predictor could be artificially reduced by the presence of the collinear variable in the model. To test for multicollinearity, the Variance Inflation Factor (VIF) was calculated for each predictor in the models, with VIFs greater than 10 indicating multicollinearity.

Results

Pre-analysis

The correlation matrix showing bivariate relationships, means, and standard deviations of the independent and dependent variables can be seen in Table 2. An exploration of all independent and dependent variables found that 2.66% of the data were missing, indicating that maximum likelihood estimation of the data is warranted. Little's MCAR test resulted in a nonsignificant p-value, which demonstrated that data were missing in a random fashion and are not significantly influenced by a confounding variable. Therefore, analyses were conducted as planned.

Internal Validity

Model fit statistics for the 8 models (4 self-report and 4 parent-report) are summarized in Table 3. For both self- and parent-report ratings, the three-factor model demonstrated statistically better fit than the one- and two-factor models based on chi-square difference testing as well

Table 2.
Correlation Matrix

	ADHD IA	ADHD HI	SCT SR	Slow SR	Sleepy SR	DD SR	SCT PR	Slow PR	Sleepy PR	DD PR	HPQ	Grades	Anxiety	Dep	Rel	Social Skills
ADHD IA	1															
ADHD HI	.357**	1														
SCT SR	.076	-.005	1													
Slow SR	.089	-.004	.872**	1												
Sleepy SR	.083	-.009	.860**	.614**	1											
DD SR	.017	.026	.798**	.539**	.543**	1										
SCT PR	.469**	.189**	.162*	.176**	.161*	.036	1									
Slow PR	.527**	.222**	.126	.156*	.143*	-.019	.851**	1								
Sleepy PR	.216**	.028	.143*	.149*	.153*	.023	.780**	.466**	1							
DD PR	.327**	.200**	.111	.090	.081	.117	.706**	.460**	.322**	1						
HPQ	-.115	.002	-.042	-.108	-.028	.042	-.183**	-.206**	-.136*	-.058	1					
Grades	-.053	-.041	-.040	-.039	-.074	.014	-.170*	-.243**	-.180**	.100	.558**	1				
Anxiety	.016	.101	.513**	.414**	.426**	.474**	-.065	-.088	-.078	.058	.099	.121	1			
Depression	.046	.082	.484**	.431**	.381**	.411**	.042	.057	.010	.034	-.121	-.058	.538**	1		
Relations	.069	-.044	-.375**	-.330**	-.303**	-.298**	.005	.001	.020	-.038	.030	.009	-.385**	-.460**	1	
Social Skills	-.186**	-.078	-.051	-.087	-.039	.052	-.277**	-.359**	-.197**	-.027	.045	.195**	.150*	-.016	-.027	1
Mean	7.380	3.290	28.07	12.06	9.29	6.71	30.13	15.63	7.77	6.70	1.87	2.21	50.58	47.73	51.22	43.45
Standard Deviation	1.99	2.76	7.76	3.38	3.11	2.60	7.38	3.60	3.21	2.48	1.00	.90	10.79	8.25	10.02	9.78

Note. ADHD IA= Inattentive symptoms, ADHD HI= Hyperactive/Impulsive Symptoms, HPQ= Homework Performance Questionnaire, Relations=Self-reported interpersonal relations subscale.

as global model fit. In the three-factor model, the latent factors were strongly correlated with one another when using self-report (*r*s = .69 to .83) and to a lesser extent when using parent-report (*r*s = .40 to .57) suggesting that items might share variance with one another due to the presence of a common underlying general factor. Consistent with this hypothesis, the bifactor model was the best overall fitting model for both self- and parent-ratings, although it should be noted that the self-report model generally demonstrated better fit than the parent-report model.

Table 3.
Model Fit Indices

	χ^2	*df*	RMSEA	CFI	TLI	WRMR	χ^2 difference test	df	*p*-value
Self-report									
One Factor	238.94***	77	.090	.926	.912	1.119			
Two Factor	217.63***	76	.084	.935	.922	1.062			
One Factor vs Two Factor							114.789	1	<.001
Three Factor	135.40***	74	.056	.972	.965	.802			
Two Factor vs Three Factor							106.930	2	<.001
Bifactor	**109.08*** **	**63**	**.053**	**.979**	**.970**	**.695**			
Parent Report									
One Factor	889.15***	77	.201	.784	.744	2.708			
Two Factor	631.94***	76	.168	.852	.823	2.257			
One Factor vs Two Factor							17.268	1	<.001
Three Factor	342.72***	74	.118	.928	.912	1.505			
Two Factor vs Three Factor							51.04	2	<.001
Bifactor	**231.66*** **	**63**	**.101**	**.955**	**.935**	**1.168**			

Note. CFI = Comparative Fit Index; Tucker Lewis Index (TLI); RMSEA = root mean square error of approximation; WRMR = weighted root mean square residual; ****p* < .001; Non-orthogonal models were not statistically compared to the orthogonal (bifactor) models as these models are not nested; Bold indicates best fitting model.

Table 4.
Factor Loadings and Measures of Internal Validity for Bifactor Model

	General SCT		Specific Slow		Specific Sleepy		Specific Daydream	
	Self	Parent	Self	Parent	Self	Parent	Self	Parent
Apathetic; little interest	.23	.64	.22	-.22				
Effort fades quickly	.49	.55	.25	.69				
Is slow or delayed in completing tasks	.64	.68	.19 [ns]	.27				
Lacks initiative	.61	.67	.37	.47				
Needs extra time	.62	.63	-.14 [ns]	.23				
Unmotivated	.70	.76	.52	.05 [ns]				
Drowsy	.62	.43			.73	.85		
Sluggish	.66	.68			.35	.49		
Tired; lethargic	.66	.35			.32	.85		
Underactive, slow moving, lacks energy	.67	.63			.18	.59		
Yawning, stretching, sleepy eyed-appearance	.62	.45			.20	.55		
Daydreams	.54	.46					.49	.63
Gets lost in own thoughts	.71	.41					.43	.76
Seems to be in world of own	.57	.63					.48	.61
ω_H	.84	.74						
ω_h			.02	.03	.04	.14	.02	.06
ECV (%)	.72	.50	.07	.11	.11	.24	.09	.14
Correlation coefficient (*r*)	.23		-.18 [ns]		-.11 [ns]		.40	

Note. SCT = sluggish cognitive tempo; ECV = Expected common variance; ωH =omega hierarchical for g; ω*h*=omega hierarchical for specific factors. All estimates were significant ($p<.05$) unless noted as nonsignificant (ns).

The standardized factor loadings for self and parent bifactor models are summarized in Table 4. Across both the self and parent models, all items loaded above .40 on the general SCT factor (range: .54 to .71 for self-report; .41 to .76 for parent-report), with the exception of one self-report item ("apathetic; little interest") which loaded at .23 and one parent-report item ("tired; lethargic") which loaded at .35. Although these items were below the established .40,

both items were kept due to the theoretical importance of apathy and sleepiness to the construct of SCT. Results also indicated that most of the Sleepy and Daydreamer items loaded strongly on their specific factor after controlling for the general SCT factor (and the loadings for all Sleepy and Daydreamer items were significant). However, the Slow items demonstrated more variability in their loadings on their specific factor, with several items having strong loadings on the specific Slow factor while other items did not. Specifically, in the self-report bifactor model, the loadings of two items (*I am slow or delayed in completing tasks* and *I need extra time for assignments*) did not reach significance, and in the parent-report bifactor model one item had a significant negative loading on Slow (*Is apathetic; shows little interest in things or activities*) while the loading of another item (*Is unmotivated*) was non-significant.

Additional measures of the validity of the internal structure of the bifactor model were calculated as described in Rios and Wells (2014). These measures provide information regarding whether the use of a total score (general SCT factor) or specific subscale scores (specific factors) is recommended. In particular, measures of unique reliability of the general factor (omega hierarchical; ω_H) and of the specific factors (ω_h), were calculated. Large values of ω_H combined with low scores on the ω_h indicate that the subscales do not provide reliable information beyond the general factor and that the use of a total score may be indicated (Rios & Wells, 2014). A minimum ω_h of .50 has been suggested to indicate useful specific factors (Reise, Bonifay, & Haviland, 2013). Explained common variance (ECV) was also calculated to determine the unique variance accounted for by the general factor and specific factors above controlling for all other factors. As noted in Table 4, the reliability of the general factor was good for self-report (ω_H = .84) and acceptable for parent-report (ω_H =.74) accounting for 72% of the variance and 50% of the common variance (Rios & Wells, 2014). In contrast, the reliability of the specific

factors was low for both self- and parent-report after accounting for the general factor with ω_h ranging from .02 - .04 for self-report and .03 - .14 for parent-report. Moreover, the variance accounted for by the specific factors was minimal (ECV of specific factors ranging from 7-11% for self-report and 9-24% for parent-report) after controlling for shared variance with the general factor. Table 4 also depicts the correlations between self- and parent-report latent 'g' and specific factors. These correlations were weak and nonsignificant with the exception of the self-and parent-reported specific Daydreamer factors, which were moderately correlated (r = .40, p < .001).

The bifactor model was used for invariance testing across raters. Specifically, the fit of the bifactor model was estimated for both raters simultaneously allowing all parameters to be freely estimated. This model (configural model) exhibited adequate fit (χ^2 = 353.83, df=126, p<.001) and was tested against a model in which factor loadings and thresholds were set to equality across raters (scalar model). This model exhibited a worse fit as indicated by statistical difference testing (χ^2 = 143.40, df=48, p<.001) and by changes in model fit (ΔCFI = .012, ΔRMSEA = .002), indicating that the models were not invariant. Examination of chi-squares for parent (χ^2 = 261.26) and self-report (χ^2 = 92.57) in the configural model suggests that the self-report model is better fitting than the parent-report model.

External Validity

Correlations between variables can be found in Table 2. For all data, assumptions of univariate and multivariate normality, linearity, and normally distributed errors were checked and met.

Social Functioning. A multiple regression analysis was conducted to examine if parent- and self-report of SCT predicted social skills when controlling for ADHD. The model

significantly predicted parent-rated social skills, $F(4, 226)=4.71$, $p<.001$, $R^2=.077$. Only parent-reported SCT was a significant predictor of parent-rated social skills, $\beta=-.215$, $t(226)=-2.94$, $p=.004$. A second model was conducted using the specific factors Slow, Sleepy, and Daydreamer to predict parent-rated social skills, controlling for ADHD. This model was significant, $F(8,222)=4.95$, $p<.001$, $R^2=.151$, with parent-rated Slow, $\beta=-.361$, $t(222)=-4.24$, $p<.001$ and Daydreamer, $\beta=.184$, $t(222)=2.54$, $p=.012$, both significantly predicting social skills. To examine the predictors of self-reported interpersonal relations, a multiple regression analysis was conducted with parent- and self-report of SCT while including ADHD. This model was significant, $F(4,232)=10.94$, $p<.001$, $R^2=.159$, with only self-report of SCT as a significant predictor, $\beta=-.388$, $t(232)=-6.35$, $p<.001$. A second model was conducted to analyze which specific SCT factors predicted interpersonal relations while controlling for ADHD. This model was significant, $F(8, 228)=5.58$, $p<.001$, $R^2=.164$, and the self-reported Slow factor was the only significant predictor, $\beta=-.221$, $t(228)=-2.71$, $p=.007$.

Academic Functioning. To investigate how parent- and self-reported SCT predicts teacher-rated homework performance, a multiple linear regression analysis was conducted including ADHD symptoms in the model. This model was significant, $F(4, 209)=2.96$, $p=.021$, $R^2=.053$, however, only parent-report of SCT $\beta=-.219$, $t(209)=-2.82$, $p=.001$ was a significant predictor of teacher-rated homework performance. A second multiple regression analysis was conducted, using the specific factors Slow, Sleepy, and Daydreamer to predict teacher-rated homework performance while including ADHD symptoms. This model was significant, $F(8,205)=2.56$, $p=.011$, $R^2=.091$. However, only the parent-reported Slow factor $\beta=-.209$, $t(205)=-2.24$, $p=.026$ was a significant predictor of homework performance. When examining whether the general construct of parent- and self-report SCT predicted GPA, the model was

found to be non-significant, $F(4, 210)=1.55$, p=.19. However, when inputting the specific factors of Slow, Sleepy, and Daydreamer as predictors, the model was significant, $F(8,206)=4.60$, p<.001, $R^2=.152$. Only two of the parent-rated specific factors, Slow β=-.377, $t(206)=-4.29$, p<.001 and Daydreamer β=.302, $t(206)=4.06$, p<.001, were significant individual predictors.

Internalizing Symptoms. To predict anxiety, parent- and self-reported SCT was entered into a multiple linear regression analysis when controlling for ADHD symptoms. This model was significant, $F(4, 232)=23.76$, p<.001, $R^2=.291$, with both parent β=-.174, $t(232)=-2.73$, $p=.007$ and self-report SCT β=.532, $t(232)=9.49$, $p<.001$ as well as ADHD-HI β=.125, $t(232)=2.12$, $p=.035$ significantly predicting anxiety. A second model was conducted with the Slow, Sleepy, and Daydreamer factors, and this model was found to be significant, $F(8,228)=12.98$, $p<.001$, $R^2=.313$. Each of the self-reported SCT factors predicted anxiety, Slow, β=.190, $t(228)=2.58$, $p=.011$, Sleepy, β=.195, $t(228)=2.65$, $p=.009$ and Daydreamer, β=.250, $t(228)=3.57$, $p<.001$. For parent-report, only Sleepy β=-.135, $t(232)=-2.14$, $p=.033$ predicted anxiety.

Depression was predicted with both parent- and self-report of SCT using a multiple regression analysis including ADHD symptoms. This model was significant, $F(4,232)=17.99$, $p<.001$, $R^2=.237$, with only self-report of SCT significantly predicting depression, β=.481, $t(324)=8.28$, $p<.001$. A second multiple regression was run using the specific factors of SCT, Slow, Sleepy, and Daydreamer. This model was significant, $F(8, 228)=9.34$, $p<.001$, $R^2=.247$, and self-reported Slow, β=.258, $t(228)=3.34$, $p=.001$ and Daydreamer β=.232, $t(228)=3.16$, $p=.002$ were both significant predictors of depression.

Discussion

This was the first study to use both CFA and bifactor modeling to evaluate the dimensionality and external validity of SCT in an ADHD sample, and one of the first to include

self-report of SCT. The CFA results support past exploratory findings with the same scale (Jacobson et al., 2012; Penny et al., 2009) in demonstrating that a 3-factor model (Slow, Sleepy, and Daydreamer) best fit the data. We also replicated and expanded upon previous research (Becker, Luebbe et al., 2015) in finding that the bifactor model was the best fitting model across both youth and parent ratings, supporting the presence of an underlying general factor. Importantly, the self-report models showed strong fit statistics and the latent self- and parent-report factors were weakly correlated with one another (with the exception of Daydreamer), suggesting that both parent and youth reporters provide unique information. Coupled with the findings that self-report predicts internalizing symptoms as well as social impairment, these data suggest that it is important to obtain youths' perspectives of their SCT symptoms.

SCT Factor Structure and Dimensionality

Using CFA and bifactor modeling with both parent and self-report, the present study adds to an accumulating body of research suggesting that SCT is a multidimensional construct (e.g., Barkley, 2013; Fenollar Cortés et al., 2014; Jacobson et al., 2012; McBurnett et al., 2014; Penny et al., 2009). The CFA in this study supports previous exploratory work (Penny et al., 2009) in confirming the presence of three distinct SCT factors (Slow, Sleepy, and Daydreamer). Similar to Becker, Luebbe and colleagues (2015), although the three-factor CFA model demonstrated adequate fit, moderate correlations between the factors and the superior fit of the bifactor model support the presence of a general, underlying SCT factor. Further, consistent with Becker, Luebbe et al. (2015), the general SCT factor was reliable, and when accounted for, rendered the reliability of the three separate factors weak and accounting for minimal variance. Interestingly, in the present study, although fit for the self-report bifactor model was excellent, only one of the four fit indices (CFI=.95) met ideal study criteria when using parent-report. Further, agreement

between parent- and self-report of SCT was low, with the exception of the specific factor Daydreamer. In addition, invariance testing suggested that parents and adolescents were not interchangeable in rating SCT symptoms, with each rater providing unique information. Taken together, these findings suggest that self-report of SCT is important and that parent-report version of this measure needs further exploration, potentially using an expanded item pool or updated measures.

Overall, these findings suggest that similar to the current conceptualization of ADHD, both bifactor and specific factor approaches may have utility for SCT. That is, research strongly supports the presence of an underling ADHD factor (Burns, Alves de Moura, Beauchaine, & McBurnett, 2014; Martel, Roberts, Gremillion, Von Eye & Nigg, 2011; Ullebø, Breivik, Gillberg, Lundervold, & Posserud, 2012), yet the specific symptom dimensions are still considered valid (Willcutt et al., 2014) and clinically meaningful (e.g., the inattention domain being the primary driver of academic impairment; Langberg et al., 2014; Willcutt et al., 2014). SCT may be understood similarly, with a general factor of SCT that underlies the specific factors of Slow, Sleepy, and Daydreamer, similar to the general factor of ADHD underlying the specific dimensions of inattention and hyperactivity/impulsivity (Ullebø et al., 2012). If confirmed, this conceptualization of SCT could have important implications for SCT etiology and for the developmental course of SCT symptoms (Martel et al., 2011). Specifically, little is known about the etiology of SCT, and support for a bifactor model suggests that there may be multiple, distinct etiologies based on the three factors (Slow, Sleepy, Daydreamer) that contribute to SCT (Martel et al., 2011).

There also may be intraindividual variability in the clinical presentation of SCT, with some individuals exhibiting more cognitive symptoms (daydreaming, getting lost in one's

thoughts), others exhibiting behavioral symptoms (e.g., slowness, sluggishness), and others exhibiting both behavioral and cognitive symptoms of SCT. Further, similar to ADHD symptom profiles which often change over time (American Psychiatric Association, 2013; Willcutt et al., 2012), an individual's SCT symptom profile may change across development. To date, there has been minimal longitudinal research on the developmental trajectory or stability of SCT symptoms. It is worth noting that in contrast to most prior SCT measurement work, which has focused on elementary-aged samples, the present study employed a young adolescent sample (e.g., Becker, Luebbe et al., 2015; Penny et al., 2009). Our finding that the SCT factor structure for this measure could be replicated in a young adolescent sample is consistent with preliminary evidence suggesting that SCT symptoms are stable or increase slightly across childhood and adolescence (Becker, Leopold et al., 2016).

External Validity

As noted above, the general SCT factor was found to be reliable, and when accounted for, rendered the reliability of the three separate factors weak and accounting for minimal variance. Given this, it was important to evaluate whether the specific factors of SCT had clinical utility in predicting outcomes and what source of information, parent or self-report, had the greatest predictive power. Consistent with our hypothesis, only parent-report of SCT predicted social and academic impairment. Importantly, these associations included cross-rater findings and associations with more objective outcomes. For academic impairment, parent-report of SCT predicted teacher ratings of homework problems and GPA. These findings build upon prior research evaluating the functional impact of SCT, which has largely focused on within-source (i.e., parent to parent) associations. In contrast to the findings with social and academic functioning, youth self-report of SCT was most important in predicting higher rates of anxiety

and depression. Further, the self-report SCT models accounted for relatively high levels of variance; 29.1% and 23.7% for anxiety and depression respectively.

Evaluation of associations between specific SCT factors and impairment demonstrated the utility of considering SCT as multidimensional, given that the specific factors of Slow, Sleepy, and Daydreamer differentially predicted outcomes. For social skills, only parent-reported Slow predicted impairment. This was contrary to the findings from Fenollar Cortés et al. (2014), where the Inconsistent Alertness factor, similar to the Daydreamer factor, predicted social impairment. This could be due to different item pools and factor structures across the two studies, highlighting the importance of creating a gold standard of measurement for SCT.

Consistent with Langberg et al. (2014), the parent-reported Slow factor predicted teacher-rated homework problems and lower grade point averages (GPAs). This is now the second study to find that the SCT-Slow factor is uniquely related to academic impairment. Although little is known about the etiology of each distinct factor of SCT, one possible explanation is underlying executive functioning (EF) deficits (Barkley, 2012; Becker & Langberg, 2014; Becker, Leopold, et al., 2016; Jiménez et al, 2015; Willcutt et al., 2014). In the only study to date to examine specific factors of SCT and EF, the parent-reported SCT Slow factor predicted both parent- and teacher-reported metacognitive EF deficits (e.g. working memory, managing task demands, material organization, self-monitoring) above and beyond demographics and ADHD symptoms (Becker & Langberg, 2014). Consistent with these findings, the Slow factor includes items such as "lacks initiative to complete work" and "effort on tasks fades quickly," which may represent the underlying metacognitive EF deficits such as planning, organization, and self-motivation, which can negatively affect academic performance (Barkley, 2012; Becker & Langberg, 2014; Jiménez et al, 2015). Further, it is important to note that the general construct of SCT did *not*

significantly predict grades, but when the model included the specific factors, the Slow factor emerged significant. This finding highlights the clinical utility of the specific factors.

In contrast to predicting academic impairment, each self-reported specific factor (Slow, Sleepy, Daydreamer) predicted higher levels of anxiety. Consistent with Fenollar Cortés et al. (2014), the self-reported Slow factor predicted higher levels of depression, though the Daydreamer factor also predicted depression. As the Slow factor may have an underlying EF deficit in motivation (Becker & Langberg, 2014; e.g., "I am not interested in participating in activities," "I don't have the drive to complete my work"), it is understandable that it would also predict depression, as depression is related to apathy and a lack of motivation to participate in life events.

There were also some unexpected findings with the regression analyses. For example, adolescents with higher levels on the self-reported Slow factor had lower levels of interpersonal relation problems. One potential explanation is that similar to the reported effect of symptoms of anxiety (Becker, Langberg, et al., 2015), exhibiting slow behaviors may not be seen as problematic with peers or, may actually serve to buffer hyperactive/impulsive behaviors in social interactions. Further, twice the parent-reported Daydreamer factor predicted results contrary to hypotheses, including lower levels of social skill impairment and higher grade point averages. These findings may be a result of the Daydreamer factor containing only three items, although the reliability for these three items was sufficient (α =.83 and α=.75 for parent and self respectively). An alternative explanation is that parents have a difficult time observing and rating these items for adolescents. Overall, it is noteworthy that parent-reported Daydreamer did not predict any impairment/psychopathology except for these two unexpected findings, suggesting the need to return to a larger item pool, especially for parent-report. In a recent meta-analysis,

thirteen items were found to best represent SCT across multiple studies (Becker, Leopold et al., 2016). Adding items from this list such as “in a fog” or “spacey” that are not included in the Penny et al. (2009) measure Daydreamer factor, may improve fit for the parent version and prediction of impairment. One additional finding that was not consistent with hypotheses was that parent-reported Slow predicted lower levels of anxiety symptoms. Anxiety has not previously been examined with specific factors of SCT and as such, this finding needs to be replicated before drawing any conclusions. Overall, it appears that these unexpected findings were not a function of multicollinearity as all VIFs were less than 10, and a correlation matrix in Table 2 shows that the regression findings are consistent with bivariate associations.

Limitations

The present study should be interpreted in light of several limitations. The cross-sectional nature of the data does not allow conclusions to be drawn about causality or the direction of the effects regarding SCT, impairment and psychopathology. Also, although the use of a clinical sample of young adolescents with ADHD builds on prior work, it is important to note that these findings may not generalize to younger children or to adults with ADHD. There is some evidence that these findings will generalize to non-ADHD samples as Becker, Luebbe et al. (2015) reported similar results in a school sample of elementary-aged children. Overall, SCT research in ADHD and non-ADHD samples remains important as there may be different etiologies and outcomes for individuals with and without ADHD and SCT symptoms. Finally, an important limitation is that the Penny et al. (2009) scale used in this study only includes 14 items, and may not fully capture the three dimensions of SCT. Going forward, it may be important to reexamine the original pool of 26 items (Penny et al., 2009) or to add items from other studies (e.g., McBurnett et al., 2014 who included 44 SCT items in the original EFA).

Future Directions

It is important for researchers to identify and settle on a gold standard item set for SCT (see Becker, Leopold et al., 2016). Studies currently use SCT scales with varying numbers of items (e.g., Marshall et al., 2014 used 3 SCT items; Capdevila-Brophy et al., 2014 used 4 SCT items, Willcutt et al., 2014 used 6 SCT items, Fenollar Cortés et al., 2014 used 8 SCT items, and Barkley, 2013 used 12 SCT items). It seems likely that that more than 3 or 4 items will be needed to adequately capture the multidimensional nature of SCT supported in the present study. According to a recent meta-analysis, for optimal reliability, at least seven items of SCT are needed, and there are thirteen items that load onto a specific SCT factor that have been identified across multiple studies (Becker, Leopold, et al., 2016). Of note, the Penny et al. (2009) measure used in the present study included seven of the recommended thirteen items. Adding the remaining six items from the meta-analysis to the Penny et al. scale could serve to bolster the Daydreamer factor (i.e., include "in a fog" or "spacey"), as well as further inform the Slow and Sleepy factors by including items that represent processing speed (e.g., "slow thinking"). Further, although the thirteen meta-analysis items are thought to be a "good starting point," they loaded onto a single factor of SCT, using a unidimensional perspective. A larger item pool may be needed to adequately capture SCT as a multidimensional construct.

Given that SCT is best conceptualized as multidimensional, latent profile analyses (LPA) may be helpful in understanding whether there are naturally occurring SCT symptom profiles or clusters. It is currently unclear whether there is variability within SCT, with youth scoring high on some factors but low on others. For example, perhaps some individuals exhibit slow behaviors but do not appear "sleepy" or to be "daydreaming". If multiple profiles emerged, this would have implications for intervention given the differential associations between the three

SCT factors and domains of impairment. It would also be important to evaluate whether these profiles are stable across time, or if similar to ADHD symptom presentations, change occurs across development (American Psychiatric Association, 2013; Willcutt et al., 2012). The stability of the profiles created by the LPA could be analyzed using latent transition analysis (LTA).

At this point, there is compelling evidence that SCT symptoms predict multiple domains of functional impairment above and beyond ADHD symptoms, yet to date no intervention has been created to specifically target SCT symptoms. Due to the cognitive, internal aspects of some SCT symptoms (e.g., fogginess, daydreaming and losing train of thought), a cognitive-behavioral intervention approach may be needed. Specifically, it may be difficult to take a purely behavioral approach which is common in ADHD treatment, as behavioral approaches rely on the application of contingencies for observed behaviors. Behavioral activation may also be a good strategy to incorporate, as some symptoms, such as apathy, slow movements, and sleepiness, are similar to depression, and behavioral activation could help to increase motivation for adolescents displaying these symptoms.

Conclusions

This study provides additional evidence for the validity of one of the most frequently used measures of SCT and furthers our understanding of the structure, dimensionality and clinical utility of SCT. Some studies have found SCT to be unidimensional (Barkley, 2012; Lee et al., 2014; Willcutt et al. 2009) whereas others have found support for two or three-factor structures (Barkley, 2013; Fenollar Cortés et al., 2014; Penny et al., 2009; McBurnett et al., 2014). Our results indicate that SCT is best conceptualized as multidimensional, with a general factor of SCT and three specific factors. It is common in psychological research to observe strong evidence for a single factor, while also uncovering multiple factors that fit the data (Reise

et al., 2010). Our findings suggest that the subscale structure of SCT is complex and hierarchical, and is best conceptualized using a bifactor structure. As parent-reported SCT predicted academic and social impairment, and self-report predicted anxiety and depression, it will be important to continue using both parent- and self-report when examining SCT, especially given low rater agreement.

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