

# Structure and Validity of Sluggish Cognitive Tempo Using an Expanded Item Pool in Children with Attention-Deficit/Hyperactivity Disorder

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Published online: 21 November 2013  
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**Abstract** We evaluated the latent structure and validity of an expanded pool of Sluggish Cognitive Tempo (SCT) items. An experimental rating scale with 44 candidate SCT items was administered to parents and teachers of 165 children in grades 2–5 (ages 7–11) recruited for a randomized clinical trial of a psychosocial intervention for Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type. Exploratory factor analyses (EFA) were used to extract items with high loadings ( $>0.59$ ) on primary factors of SCT and low cross-loadings (0.30 or lower) on other SCT factors and on the Inattention factor of ADHD. Items were required to meet these criteria for both informants. This procedure reduced the pool to 15 items. Generally, items representing slowness and low initiative failed these criteria. SCT factors (termed Daydreaming, Working Memory Problems, and Sleepy/Tired) showed good convergent and discriminant validity in EFA and in a confirmatory model with ADHD factors. Simultaneous regressions of impairment and comorbidity on SCT and ADHD factors found that Daydreams was associated with global impairment, and Sleepy/Tired was associated with organizational problems and depression ratings, across both informants. For teachers, Daydreams also predicted ODD (inversely); Sleepy/Tired also predicted poor academic behavior, low social skills, and problem social behavior; and Working Memory Problems

predicted organizational problems and anxiety. When depression, rather than ADHD, was included among the predictors, the only SCT-related associations rendered insignificant were the teacher-reported associations of Daydreams with ODD; Working Memory Problems with anxiety, and Sleepy/Tired with poor social skills. SCT appears to be meaningfully associated with impairment, even when controlling for depression. Common behaviors resembling Working Memory problems may represent a previously undescribed factor of SCT.

**Keywords** Sluggish cognitive tempo · Attention-deficit/hyperactivity disorder · Working memory · Daydream · Impairment · Diagnostic classification

## Introduction

After a period of relative neglect from researchers, the construct of Sluggish Cognitive Tempo (SCT) has received increasing attention in this century. When it occurs in the presence of Attention-Deficit/Hyperactivity Disorder (ADHD), SCT is thought to be more characteristic of the Predominantly Inattentive Type of ADHD (ADHD-I) than of the Hyperactive-Impulsive or Combined types. Evidence for this prevalence originally came from comparisons of DSM-III Attention Deficit Disorder with Hyperactivity to Attention Deficit Disorder without Hyperactivity (Barkley et al. 1990; Lahey et al. 1985, 1987, 1988) and was later reported to extend to DSM-IV ADHD types (Garner et al. 2010; McBurnett et al. 2001).

The internal validity of SCT (as a latent construct separate from those of Inattention and Hyperactivity-Impulsivity) has been established and replicated many times over (Barkley et al. 1990; Barkley 2013; Bauermeister et al. 2012; Garner et al. 2010; Lahey et al. 1985, 1987, 1988; McBurnett et al. 2001) (note, however, that the separation between Inattention

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and SCT has not been fully resolved (Jacobson et al. 2012; Todd et al. 2004). The external validity of SCT is less clear. Perhaps the most-replicated finding using subjects with ADHD is an association with either anxiety, depression, or general internalizing problems and a non-significant or inverse (when associations with Inattention are controlled) association with symptoms of Oppositional Defiant Disorder or general externalizing problems (Bauermeister et al. 2012; Becker and Langberg 2013; Capdevila-Brophy et al. 2012; Carlson and Mann 2002; Garner et al. 2010, 2013; Lee et al. 2013; Penny et al. 2009) (also note that this finding is not always replicated, (Harrington and Waldman 2010)). Other potential validators, such as social skills and academic functioning, have been inconsistently associated with SCT (Lee et al. 2013), but cognitive performance aspects of social interactions have been linked to SCT (Mikami et al. 2007).

The content boundaries of SCT have not been firmly established, and there has been a trend toward including more numerous and more varied manifest indicators. Early studies of SCT capitalized on the serendipitous inclusion of SCT items in existing child psychopathology rating scales, which sometimes included only *daydreams* and *seems sluggish or drowsy*. However, these few items are not sufficient in number to reliably represent a latent construct (Devellis 2003). Carlson and Mann (2002) assembled an experimental SCT scale using five items from the Teacher's Report Form (Achenbach 1991b): *Confused, seems lost in a fog; Daydreams or gets lost in his or her thoughts; Apathetic or unmotivated; Stares blankly; and Underactive, slow moving or lacks energy*. Researchers using the Child Behavior Checklist (Achenbach 1991a) have employed these same items, with the exception of *Apathetic or unmotivated*, which is not included in the parent form (Garner et al. 2010). Hartman et al. (2004) constructed an SCT scale that drew five items from across different rating scales: *Sluggish/slow to respond, Seems to be "in a fog," Drowsy or sleepy, Easily confused, and Daydreams/stares into space*. Pffner et al. (2007) employed a 17-item scale (McBurnett and Pffner 2007) that expanded the SCT item pool and found SCT to be responsive to psychosocial treatment. Items were *"Daydreams", "Stares into space", "In a fog", "Unresponsive", "Easily confused", "Mind wanders", "Absentminded", "Easily disoriented", "Loses cognitive set", "Gets tongue tied", "Poor memory consolidation", "Drowsy", "Moves slowly", "Works slowly and takes a long time to complete tasks", "Gets tired easily", "Low initiative", and "Poor time appreciation"*. Each item was followed by a brief behavioral description in lay terms. Skirbekk et al. (2011) compared the 17-item and the 5-item (Hartman et al. 2004) SCT scales and found that, although the 17-item scale resulted in slightly more numerous significant findings, the two scales appeared to measure the same construct. Penny et al. (2009) used a sophisticated content validation procedure

in which experts were asked to rate potential items on how well they represented SCT, and whether they appeared unique to SCT. The procedure retained 14 items from a pool of 26 items that had been generated using literature searches. Skirbekk et al. (2011) observed that the 14-item scale differed from the 17-item scale in not containing items about confusion or forgetfulness. Barkley (2012) devised a 9-item self-report SCT scale for adults, presumably to allow for symmetry with the number of items on DSM-IV symptom lists for Inattention and for Hyperactivity-Impulsivity: *"Prone to daydreaming when I should be concentrating"; "Have trouble staying alert or awake in boring situations"; "Easily confused"; "Easily bored"; "Spacey or in a fog"; "Lethargic, more tired than others"; "Underactive or have less energy than others"; "Slow moving"; and "I don't seem to process information as quickly or as accurately as others"*.

Recently, studies have queried whether SCT is multi-dimensional. The Penny et al. (2009) study extracted two factors from teacher ratings (*Sleepy/Daydreamer* and *Slow*) and three factors from parents (*Slow, Sleepy, and Daydreamer*). The Jacobson et al. study (2012) used the same scale with teachers and extracted three factors (*Sleepy/sluggish, Slow/daydreamy, Low initiation/persistence*). (Note that one of the factor analytic procedures in this study obtained four factors, but this solution was discarded because one of the factors contained only two items. This fact in itself argues for increasing the item pool.) After controlling for Inattention symptoms, all three factors concurrently predicted academic impairment, and this association remained significant for all three factors when Inattention and Depression were controlled. The strongest regression coefficient for academic impairment was that for *Low initiation/persistence*. The weakest predictor of academic impairment, *Sleepy/sluggish*, was the strongest predictor of depression, and none of the SCT factors was significantly predictive of anxiety (Jacobson et al. 2012).

It is not clear that existing item pools, even as they have proliferated, adequately sample the range of SCT behavior. As previously noted, item content of SCT scales has been disproportionately influenced by the content of existing rating scales. If progress is to be made in establishing the boundaries of SCT and providing the content that may be required to extract all meaningful factors, additional SCT items, including alternate phrasings of existing items, need to be tested. In this study, we attempted to take a fresh look at SCT by testing a much-expanded item pool. We generated an experimental scale of 44 items from existing SCT items, clinical descriptions of "Primary Disorder of Vigilance" (Weinberg et al. 2001; Weinberg and Brumback 1990), and our own efforts to collect vernacular phrases that appear to be alternative descriptions of SCT features. We attempted to create multiple items representing what we imagined to be SCT-related constructs: (1) *daydreams, variable alertness, drowsy*; (2) *working memory slips, loses place*; (3) *slow processing*; (4) *slow*

*behavior and movement*; and (5) *low initiative, low energy*. We examined the latent structure of these SCT items in a clinical population that is hypothesized to exhibit high levels of SCT (the Predominantly Inattentive Type of ADHD, ADHD-I). We then evaluated the potential significance of this approach in analyses of the external correlates of the obtained subfactors. We expected to replicate prior associations of SCT and internalizing comorbidities. We expected to replicate the often-reported association of Hyperactivity-Impulsivity, but not SCT, with externalizing behavior problems. We cautiously expected to find subfactors of SCT that resembled and supplemented previously reported subfactors and to replicate the association of a low initiative factor with academic impairment and the association of a sleepy or sluggish factor with depression, bearing in mind that these expectations drew from a single study (Jacobson et al. 2012).

## Method

### Participant Characteristics

Participants included 165 children in grades 2–5 (mean age=8.66 years, range 7–11) who were recruited as part of a two-site randomized clinical trial of a psychosocial intervention for ADHD-I conducted at two metropolitan university clinics in California. Both the treatment study and the add-on (SCT) study were approved and supervised by a university institutional review board. The treatment study was publicized, and families either contacted the clinics directly or were referred by educators or health care professionals. Families were incented to participate by becoming eligible for randomization to no-cost treatments for ADHD-I, and by modest payment for some of the experimental procedures in the treatment study. All data for this report were collected at baseline assessments, which was preceded by a 1-week washout of stimulant medication for the few children (4.5 %) being so treated.

Boys constituted 56 % of the sample. Participant race/ethnicity distribution was as follows: Caucasian 54 %, Hispanic/Latino 17 %, Mixed Race/Ethnicity 16 %, Asian or Pacific Islander 8 %, African American 5 %. On average, SES was relatively high. Education level of the primary parent participating in the treatment was as follows: 3 % had a high school degree or GED, 17 % had some college, 40 % had a college degree, and 40 % had a graduate degree. Total household income was below \$50,000 for 14 %, \$50,000–100,000 for 27 %, \$100,000–150,000 for 28 %, and more than \$150,000 for 31 % of families. Families were headed by single parents in 13 % of cases.

All participants met DSM-IV criteria for ADHD-I as described below. Inclusion criteria were as follows: (1) DSM-IV

primary diagnosis of ADHD-I, (2) IQ>80 (confirmed with WISC-IV), (3) living with at least one parent for past year, and (4) attending school full-time with school consenting to participate in school-based treatment. Children with visual or hearing impairment, severe language delay, major neurological illness, psychosis, or Pervasive Developmental Disorder were excluded.

### Screening and Diagnostic Procedures

Parents and teachers completed the Child Symptom Inventory (CSI)-4th Edition (Gadow and Sprafkin 1994). To meet screening cutoffs, the “or-rule” algorithm, used for establishing DSM-IV criteria (Lahey et al. 1994), was applied to the parent and teacher ratings of ADHD, such that a symptom was judged to be present if *either* the parent *or* teacher endorsed it as occurring often or very often. Children who appeared clinically inattentive by the screening team, based on rating scale symptom count and all other information, were scheduled for a diagnostic clinic visit to confirm the diagnosis of ADHD-I. Modules (including those for ADHD, Oppositional Defiant Disorder, Conduct Disorder, Anxiety and Mood Disorders) from the Kiddie-Sads-Present and Lifetime Version (K-SADS-PL) were administered to parents. The K-SADS has good psychometric properties, including adequate test-retest reliability (Ambrosini 2000; Kaufman et al. 1997). Trained clinicians conducted interviews under the supervision of a licensed clinical psychologist. Diagnostic decisions for ADHD-Predominantly Inattentive Type were made according to all DSM-IV criteria. Parents provided informed written consent and children provided written assent; study procedures were approved by the Committee on Human Research at the University of California, San Francisco and the Committee for Protection of Human Subjects at the University of California, Berkeley.

### Measures

*DSM-IV ADHD Symptoms* The ADHD items from the Child Symptom Inventory (CSI) (Gadow and Sprafkin 1994), completed by parents and teachers, correspond to DSM-IV ADHD symptoms and are rated on a 4-point scale (0 = never to 3 = very often). The Inattention scale has normative data, acceptable test-retest reliability and predictive validity for categorical diagnosis of ADHD (Gadow and Sprafkin 1997).

*Symptoms of SCT* The Kiddie Sluggish Cognitive Tempo (K-SCT) Rating Scale completed by parents and teachers, includes 44 items rated on a 4-point scale (0 = never to 3 = very often). The scale consists of previously-studied SCT items, supplemented by items thought to be alternative behavioral descriptions of SCT or clinically related behaviors. The full

item pool appears in [Appendix](#). This scale has not been previously evaluated or reported.

**Academic Performance** Parent-rated academic performance was captured using the Homework Problems Checklist (HPC) (Foley and Epstein 1993). The 20 items on the HPC are descriptions of problem behaviors related to homework and are rated on a 4-point scale. Internal consistency has been reported between 0.90 and 0.92. Teacher-rated academic skills, attitudes, and behaviors were captured using the Academic Competency Evaluation Scale (ACES; DiPerna and Elliott 2000). The Academic Enablers scale from the ACES includes 40 items rated on a 5-point scale ranging from (1 = Never to 5 = Almost Always) and indicates the frequency with which children engage in a number of behaviors that facilitate learning (e.g., “Participates in class discussions”, “Attempts to improve on previous performance”, “Turns in homework on time”). The total score from this scale (used in these analyses) has excellent psychometric properties including high internal consistency and test-retest reliability ( $\alpha = 0.98$ ,  $r = 0.96$ ). Higher scores on this scale indicate better competence.

**Organization** Teachers and parents completed the Children’s Organizational Skills Scale (COSS) (Abikoff et al. 2013). Items are rated on a 4-point scale (hardly ever/never to just about all the time); those assessing organizational skills, management of materials/supplies, and task planning skills (parent=58 items, teacher=35 items) are totaled for analyses. The parent and teacher versions both have adequate psychometric properties, including excellent internal consistency (alphas=0.98 and 0.97, respectively), test-retest reliability ( $r_s = 0.99$  and 0.94, respectively), and evidence of structural, convergent, and discriminant validity. Lower scores indicate better organizational skills.

**Social Behavior** Teachers and parents completed the Social Skills Improvement Scale (SSIS) (Gresham et al. 2010). The SSIS has excellent psychometric properties, including high internal consistency for the parent and teacher versions (0.94 and 0.95, respectively). Test-retest reliability is adequate (0.84 and 0.81 for teacher and parent versions respectively). In this study, we report separately on subscales for social skills (higher scores indicate better functioning) and for problem social behavior (lower scores indicate better functioning).

**Global Psychosocial Functioning** Global ratings of the severity of psychosocial functioning were captured using the 7-item Clinical Global Impression Scale (NIMH 1985), Severity version (CGI-S). In most instances, the CGI-S is completed by a clinician, but in this study we adapted the scale for completion by parents and teachers.

## Data Analytic Plan

The first step was to reduce the SCT items to meaningful factors with common items across parent and teacher informants. An exploratory factor analytic (EFA) model was applied to the 44 SCT symptoms for parents’ and teachers’ ratings. The number of factors was a priori set to five, in accordance with our conceptual grouping of items into five categories on the original scale (see [Appendix](#)). Items were allowed to load on all five factors (i.e., cross-loadings). Items were treated as ordered-categories (WLSMV estimation), with the Mplus statistical software used for the analyses (Version 7, Muthén & Muthén, 1998–2012). For an SCT symptom to be considered to have convergent and discriminant validity, the symptom was required to have a loading greater than 0.59 on its primary factor, with loadings on the four other factors being less than 0.30. In addition, the symptom had to meet these criteria for *both* parent and teacher ratings. For example, if the symptom met the criteria for parents’ ratings and did not meet the criteria for teachers’ ratings, then the symptom would not be included in the next step. This procedure required the results to replicate across parents and teachers for an item to be retained in the SCT measure, and only three factors were identified as having reasonable numbers of items. Then, another EFA was conducted specifying four factors, this time including the nine Inattention items, as a rigorous screen for items that loaded across SCT and Inattention.

We proceeded in a second step to evaluate the discriminant validity of SCT as a single construct. We regressed variables representing functional impairments and comorbidities on Inattention, Hyperactivity-Impulsivity, and the total SCT score (mean of 15 items). The rationale here was to compare our findings to previous literature, using a similar SCT measure.

The third step was to evaluate the convergent and discriminant validity of the three SCT factors and the two ADHD factors (Inattention and Hyperactivity-Impulsivity), using correlation and confirmatory factor analysis (CFA). This step was necessary because, despite prior evidence of the validity of SCT as a single construct distinct from ADHD, no test of the validity of these factors exists.

In a fourth step, we evaluated the external or predictive validity of the SCT factors, first in comparison with the ADHD factors and then in comparison with severity of depression, in order to provide interpretable explorations of the unique associations of SCT factors with impairment and comorbid psychopathology. We did so via correlation and with simultaneous regression of outcome variables (impairment and comorbidity) on the predictor variables. Out of curiosity, we included models for Inattention and Hyperactivity-Impulsivity, even though these were not crucial to our purposes in this step. All regressions represented a saturated path model with the manifest variables for predictors and outcomes (i.e., the average of the items for each variable); the robust

maximum likelihood estimation procedure (i.e., MLR) was used.

## Results

### ADHD Symptom Severity

The mean CSI symptom severity score for Inattention was 2.03 (SD=0.48) for parents and 1.97 (SD=0.56) for teachers (parent-teacher correlation=0.16,  $p=0.038$ ). The mean severity score for Hyperactivity-Impulsivity was 0.82 (SD=0.51) for parents and 0.68 (SD=0.53) for teachers (correlation=0.41,  $p<0.0001$ ). These scores reflect an overall mean item severity of around 2 (a common threshold for clinical status) for Inattention, and an overall mean of below 1 (well below clinical status) for Hyperactivity-Impulsivity for both informants.

### Convergent and Discriminant Validity of the SCT Symptoms

The initial EFA of the 44 SCT items identified five factors for parents and teachers' ratings. These factors were as follows: (1) Daydreams (items 1, 2, 3, 4, 5 and 6, see Appendix); (2) Working Memory Problems (items 16, 18, 19, 20, 21, 22, 24 and 25); (3) Sleepy/Tired (items 10, 12, 36 and 37); (4) Slow Movement (items 31 and 32); and (5) Low Initiative (items 42 and 43). Given that the Slow Movement and Low Initiative factors contained only two items, we did not include them in subsequent analyses. The other items either had high loadings on two or more factors or failed to have a substantial loading on any factor.

The next step evaluated the discriminant validity of the items on the Daydreams, Working Memory and Sleepy/Tired factors in comparison with the nine ADHD-IN symptoms. This analysis involved a Daydreams, Working Memory Problems, Sleepy/Tired and ADHD-IN four-factor model with the items again allowed to have cross-loadings. The purpose was to determine if any of the 18 SCT symptoms had loadings greater than 0.30 on the ADHD-IN factor. For the parent ratings, none of the 18 SCT symptoms had a loading greater than 0.26 on the ADHD-IN factor (i.e., range=-0.26 to 0.23). For the teacher ratings, three of the SCT items from the Working Memory Problems factor had loadings greater than 0.30 on the ADHD-IN factor (i.e., item 22 "Can't remember things he/she just learned or was told" with a loading of 0.42; item 24 "Needs to have information repeated to him or her" with a loading of 0.50; and item 25 "Quickly forgets what he/she just read" with a loading of 0.32". These three items were dropped from the Working Memory Problems scale for teachers and parents. All the other SCT items for teachers had loadings less than 0.21 on the ADHD-IN scale (i.e., range=-0.20 to 0.14).

The final SCT measure consisted of Daydreaming (Items 1, 2, 3, 4, 5 and 6), Working Memory Problems (Items 16, 18, 19, 20 and 21) and Sleepy/Tired (Items 10, 12, 36 and 37) factors. Cronbach's alphas for the Daydreams, Working Memory Problems and Sleepy/Tired measures were 0.91, 0.87 and 0.85, respectively, for parents' ratings, and 0.95, 0.90, and 0.88 for teachers' ratings. These values compare favorably to the internal consistency estimates for Inattention and Hyperactivity (alphas for both factors were 0.83 for parents and 0.82 for teachers). These three SCT scales were used in all the subsequent analyses.

*Fit of a Daydreams, Working Memory, Sleepy/Tired, ADHD-IN, and ADHD-HI Measurement Model* A confirmatory factor analysis was applied to Daydreams, Working Memory Problems, Sleepy/Tired, ADHD-IN and ADHD-HI five-factor model. The items were again treated as ordered categories (WLSMV estimation). The fit of the five-factor model was reasonable for parents' and teachers' ratings (i.e., parents:  $\chi^2(485)=761$ , CFI=0.948, RMSEA=0.059 (0.051–0.067); teachers:  $\chi^2(485)=733$ , CFI=0.971, RMSEA=0.056 (0.048–0.064). Table 1 shows the standardized factor loadings. All the SCT items had substantial loadings on their respective factors (i.e., greater than 0.75) with the ADHD-IN and ADHD-HI also being reasonable, especially given that the selection procedures for the children restricted the range on the ADHD-IN (not many low scores) and ADHD-HI (not many high scores).

The correlations among the Daydreams, Working Memory Problems, Sleepy/Tired, ADHD-IN and ADHD-HI are shown in Table 2 for parents and teachers' ratings. The correlations among the three SCT factors provided support for the discriminant validity of these factors (i.e., all these correlations  $<0.55$  for parents and teachers). Although ADHD-IN was significantly related to the three SCT factors, all these factor correlations were also  $<0.52$  (i.e., range=0.25 to 0.51), thus indicating good discriminant validity between the SCT and ADHD-IN factors. Finally, the three SCT factors were not related to ADHD-HI for parents and teachers' ratings. Given the steps used to select the final set of SCT items for the three SCT factors, it will be important to replicate the results from the confirmatory factor analysis with a new sample. These results, however, do support the convergent and discriminant validity of the Daydreams, Working Memory Problems and Sleepy/Tired SCT Factors.

*Comparison to Previous SCT Literature: Regression of Impairment and Comorbidity on ADHD Factors and Total SCT scores* In order to provide comparisons to previous literature that used SCT as a unitary construct (rather than SCT factors), we conducted simultaneous regressions of impairment and comorbidity on total SCT scores, even though these models are partially redundant with our models with SCT factors

**Table 1** Standardized symptom-factor loadings (Standard errors) from Confirmatory Factor Analysis

Symptoms	Parents Loadings (SE)	Teachers Loadings (SE)
<b>Daydreaming factor</b>		
Daydreams	0.76 (0.04)	0.92 (0.02)
Stares into space	0.91 (0.02)	0.93 (0.02)
Spaces out	0.89 (0.02)	0.94 (0.01)
Off in own world	0.87 (0.02)	0.91 (0.01)
Lost in thought	0.81 (0.02)	0.89 (0.02)
Mind drifts off	0.84 (0.03)	0.92 (0.02)
<b>Working memory factor</b>		
Forgets what was going to say	0.87 (0.03)	0.84 (0.03)
Loses train of thought	0.85 (0.03)	0.88 (0.02)
Gets “tongue-tied”	0.77 (0.04)	0.76 (0.04)
Gets mixed up	0.95 (0.02)	0.96 (0.02)
Gets confused	0.87 (0.03)	0.95 (0.02)
<b>Sleepy/low energy factor</b>		
Seems drowsy (during the daytime)	0.90 (0.04)	0.88 (0.03)
Yawns	0.75 (0.06)	0.84 (0.05)
Lacks energy	0.93 (0.03)	0.93 (0.03)
Gets tired easily	0.95 (0.03)	0.94 (0.03)
<b>ADHD-inattention factor</b>		
Careless mistakes	0.49 (0.06)	0.65 (0.08)
Difficulty paying attention	0.67 (0.04)	0.62 (0.08)
Doesn't listen	0.70 (0.05)	0.80 (0.05)
Fails to finish things	0.77 (0.04)	0.63 (0.08)
Difficulty organizing tasks	0.75 (0.05)	0.59 (0.08)
Avoids tasks that require mental effort	0.65 (0.05)	0.58 (0.08)
Loses things	0.65 (0.05)	0.60 (0.08)
Easily distracted	0.60 (0.06)	0.58 (0.09)
Forgetful in daily activities	0.66 (0.05)	0.85 (0.05)
<b>ADHD-hyperactivity/impulsivity factor</b>		
Fidgets	0.65 (0.06)	0.63 (0.06)
Difficulty remaining seated	0.82 (0.04)	0.67 (0.06)
Runs, climbs	0.79 (0.04)	0.73 (0.07)
Difficulty playing quietly	0.66 (0.06)	0.72 (0.06)
On the go	0.75 (0.05)	0.74 (0.06)
Talks excessively	0.59 (0.06)	0.76 (0.06)
Blurts out answers	0.72 (0.05)	0.80 (0.05)
Difficulty waiting turn	0.78 (0.04)	0.77 (0.05)
Interrupts	0.67 (0.05)	0.78 (0.05)

(below). For parents, total SCT was not a significant predictor of ODD, anxiety, social skills, homework problems, or global impairment, when Inattention and Hyperactivity-Impulsivity were included in the model. SCT was a significant predictor of problem social behavior (partial standardized regression coefficient=0.21,  $p=0.008$ ) and organizational skills (0.21,  $p=$

0.005). SCT showed a marginally significant association with depression (0.14,  $p=0.08$ ). For teachers, total SCT was not a significant predictor of ODD or global impairment. SCT was a significant predictor of depression (partial standardized regression coefficient=0.45,  $p<0.001$ ), anxiety (0.23,  $p=0.008$ ), social skills ( $-0.25$ ,  $p=0.002$ ), problem social behavior (0.33,  $p<0.001$ ), organizational skills (0.30,  $p<0.001$ ), and academic enablers ( $-0.31$ ,  $p<0.001$ ), even when Inattention and Hyperactivity-Impulsivity were included as predictors.

*Zero-Order Pearson Correlations Between Predictors and Outcomes for Parents* Correlations between these scales and a number of domains were examined as evidence of convergent and discriminant validity (see Table 3 for Pearson correlation coefficients). Notably, all of the SCT scales were associated with more severe inattention and organizational problems, but none was correlated with hyperactivity-impulsivity. Among the SCT factors, only Sleepy/Tired was significantly correlated with more severe depression, while only Working Memory Problems were significantly correlated with poorer social skills. Daydreaming and Sleepy/Tired were both significantly correlated with more problem behaviors and homework problems, while Daydreaming and Working Memory Problems were significantly correlated with worse global impairment.

*Discriminant Validity of ADHD and SCT Factors: Regression of Outcomes on Predictors for Parents* Table 4 shows the results from these regression analyses. All regression models were statistically significant, with the exception of the model predicting social skills, and effect sizes ranged from medium to large in magnitude. Although most scales were correlated with more organizational and homework problems, only inattention and Sleepy/Tired were associated with more organizational problems in the multiple regression model, and only inattention was associated with more homework problems. As expected, hyperactivity-impulsivity was the only predictor that was associated with more severe oppositional-defiance and problem behaviors in the regression models (Sleepy/Tired was marginally associated with more problem behaviors). Unexpectedly, hyperactivity-impulsivity was also the only variable with a unique positive association with generalized anxiety. Sleepy/Tired was the only variable that was significantly associated with more severe depression. Finally, Daydreaming and Inattention both uniquely and significantly predicted worse global impairment. The same multiple regression models were re-conducted in order to control for depressive symptom severity and the results remained unchanged. Minor changes occurred when only Depression (and not ADHD factors) were included as predictors: Working Memory became a significant predictor of better Social Skills and less Global Impairment (Table 7).

**Table 2** Parents (above diagonal) and teachers (below diagonal) factor correlations among daydreams, working memory, sleepy/tired, ADHD-IN and ADHD-HI factors

	Daydreams	Working memory	Sleepy/tired	ADHD-IN	ADHD-HI
Daydreams	–	0.36 (0.07)**	0.46 (0.07)**	0.42 (0.08)**	0.00 (0.08)
Working memory	0.41 (0.07)**	–	0.41 (0.08)**	0.37 (0.07)**	0.01 (0.08)
Sleepy/tired	0.54 (0.07)**	0.38 (0.07)**	–	0.25 (0.09)*	–0.06 (0.09)
ADHD-IN	0.46 (0.08)**	0.51 (0.08)**	0.44 (0.09)	–	0.31 (0.08)**
ADHD-HI	–0.15 (0.10)	0.07 (0.10)	–0.12 (0.10)	0.14 (0.10)	–

\*\* $p < 0.001$ . \* $p < 0.01$

*Zero-Order Pearson Correlations between Predictors and Outcomes for Teachers* Correlations between these scales and a number of domains were examined as evidence of convergent and discriminant validity (see Table 5 for correlation coefficients). As noted for parents, all of the SCT scales were associated with more severe inattention and organizational problems, but none was correlated with hyperactivity-impulsivity. All SCT scales were also correlated with worse academic enablers and more severe depression, problem behaviors, and global impairment. Only Sleepy/Tired was significantly correlated with poorer social skills and more severe oppositional-defiance and generalized anxiety, although Working Memory Problems were marginally associated with poorer social skills and more severe generalized anxiety also.

*Discriminant Validity of ADHD and SCT Factors: Regression of Outcomes on Predictors for Teachers* Multiple regression analyses, analogous to those reported above for the parent reported variables, were conducted in MPlus version 7. Table 6 shows the results from these regression analyses. All regression models were statistically significant and effect sizes ranged from medium to large in magnitude. Sleepy/Tired was the only significant predictor of more severe depression (strong association) and poorer social skills (medium association). Hyperactivity-impulsivity was marginally significantly associated with poorer social skills. Inattention and daydreaming significant predicted worse global impairment. Inattention and hyperactivity-

impulsivity both predicted more severe oppositional-defiance and problem behaviors, while daydreaming predicted less severe oppositional-defiance and Sleepy/Tired predicted more problem behaviors. Inattention, Working Memory Problems, and Sleepy/Tired all predicted more organizational problems. Working Memory Problems and Hyperactivity-impulsivity both significantly predicted more severe generalized anxiety.

*Discriminant Validity of Depression and SCT* The same multiple regression models were re-conducted in order to control for depressive symptom severity. Although the results remained largely unchanged, some associations noted above were no longer significant and others became significant. When only Depression (and not ADHD factors) was included (Tables 7 and 8), Sleepy/Tired scales tended to be more frequently predictive of problems with organization and academic functioning, and less frequently predictive of comorbidities, social skills, and global functioning.

**Discussion**

This study evaluated an expanded set of 44 SCT items, all of which are linked in content to SCT items that have been used in the past. Analyses reduced the pool to 15 items grouped into factors of Daydreaming, Working Memory Problems, and Sleepy/Tired. The factors bear some similarity to previous

**Table 3** Zero-order Pearson correlations between predictors and outcomes for parents

	Inattention severity	Hyperactivity severity	Daydreams	Working memory problems	Sleepy/tired
Organization problems	0.54**	0.17*	0.27**	29**	0.36***
Homework problems	0.48***	0.19*	0.19*	0.12	0.22**
Inattention Severity	1	0.24*	0.28**	0.37***	0.32***
Hyperactivity severity	0.24*	1	0.07	–0.02	0
ODD severity	0.22*	0.35***	0.10	0.03	0.09
Depression severity	0.17*	0.07	0.10	0	0.33***
GAD severity	0.22**	0.26**	0.13	0.12	0.14
Social skills	–0.22**	–0.09	–0.13	–0.19*	–0.14
Problem behaviors	0.13	0.29**	0.18*	0.09	0.17*
Clinical global impression	0.34***	0.03	0.21**	17*	0.06

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

**Table 4** Discriminant validity of ADHD and SCT factors: standardized partial regression coefficients for outcomes on predictors for parents

Outcomes	Model R <sup>2</sup>	Inattention severity	Hyperactivity severity	Daydreams	Working memory problems	Sleepy/Tired
Organization problems	0.34***	0.43***	0.08	0.07	0.03	0.19*
Homework problems	0.24***	0.43***	0.11	0.05	-0.12	0.11
ODD severity	0.15**	0.13	0.33***	0.03	-0.05	0.10
Depression severity	0.14*	0.11	0.08	0	-0.17 <sup>†</sup>	0.36**
Generalized anxiety severity	0.11*	0.13	0.23**	0.05	0.02	0.09
Social skills	0.06	-0.12	-0.06	-0.05	-0.10	-0.05
Problem behaviors	0.15**	-0.03	0.32***	0.11	0	0.16 <sup>†</sup>
Clinical global impression	0.16**	0.33***	-0.06	0.19*	0.09	-0.17 <sup>†</sup>

<sup>†</sup>  $p < 0.06$ , \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

findings of the structure of SCT (Jacobson et al. 2012; Penny et al. 2009) in that daydreaming and sleepy behaviors contributed to the constructs. However, unlike previous studies, our methods did not justify a Slow construct or a Low Initiative/Low Persistence construct. This disparity is not likely to be the result of semantic differences alone (i.e., we did not extract factors similar to those in previous studies while assigning them different names). We have some evidence that slowness and low initiative are not good empirical indicators for the SCT construct. First, two previous studies have found low initiative to load problematically high on Inattention (Barkley 2013; Lee et al. 2013), and a recent study found “slow to complete tasks” also to load on Inattention (Barkley 2013). Second, as shown in the Appendix, our original item pool contained several items descriptive of slowness and low initiative/low persistence that did not survive our requirements for convergent and discriminant validity across informants. Even items previously thought to be cardinal indicators of SCT (e. g., “sluggish” and several items containing the word “slow”) were not retained. This finding in itself is not evidence that children rated high on SCT are not “slower” than other children, only that slowness in these data is not an empirically derivable factor that is unique to SCT. Parents and teachers

sometimes characterize children who are hyperactive as being slow because of dawdling and distractibility. It is quite possible that parents and teachers who are frustrated by children who fail to initiate or finish tasks according to adult timetables may rate them as slow or as having low initiative, even though those children may be less deserving of such attributions than children who have SCT and truly pervasive psychomotor slowness and passivity.

A discovery that has not been previously reported is the factor that we termed *Working Memory Problems*. Almost assuredly, this is an effect of including multiple items related to confusion and immediate forgetfulness, items which, as previously observed (Skirbekk et al. 2011), are not found in the scale that was used in previous studies of the latent structure of SCT (Barkley 2013; Jacobson et al. 2012; Penny et al. 2009). Most other SCT studies have used scales that include the item of “confused” (Carlson and Mann 2002; Hartman et al. 2004; Pffiffer et al. 2007), which suggests that the observation that working memory problems are related to SCT is not entirely novel. We conclude that the addition of sufficient numbers of items for potential extraction of confusion or working memory problem factors will help advance the

**Table 5** Zero-order Pearson correlations between predictors and outcomes for teachers

	Inattention severity	Hyperactivity severity	Daydreams	Working memory problems	Sleepy/tired
Organizational problems	0.62***	0.14	0.37***	0.41***	0.44***
Academic enablers	-0.48***	-0.12	-0.36***	-0.30***	-0.48***
Inattention severity	1	0.15	0.37***	0.33***	0.35***
Hyperactivity severity	0.15	1	0.01	0.03	0.05
ODD severity	0.21**	0.41***	-0.03	0	0.17*
Depression severity	0.27***	-0.01	0.20*	0.19*	0.56***
GAD severity	0.12	0.32***	0.08	0.15 <sup>†</sup>	0.20*
Social skills	-0.22**	-0.21**	-0.14	-0.15 <sup>†</sup>	-0.36***
Problem behaviors	0.36***	0.48***	0.32***	0.23**	0.43***
Clinical global impressions	0.46***	0.18*	0.34***	0.24**	0.20*

<sup>†</sup>  $p < 0.06$ , \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

**Table 6** Discriminant validity of ADHD and SCT factors: standardized partial regression coefficients for outcomes on predictors for teachers

Outcomes	Model R <sup>2</sup>	Inattention severity	Hyperactivity severity	Daydreams	Working memory problems	Sleepy/tired
Organizational problems	0.49***	0.50***	0.05	0.02	0.18*	0.19**
Academic enablers	0.36***	-0.36***	-0.03	-0.06	-0.08	-0.27***
ODD severity	0.25***	0.20*	0.41***	-0.18*	-0.06	0.16
Depression severity	0.32***	0.09	-0.09	-0.10	0.06	0.55***
Generalized anxiety severity	0.15*	-0.02	0.30***	-0.05	0.14*	0.18
Social skills	0.16*	-0.11	-0.15 <sup>†</sup>	0.09	-0.03	-0.33**
Problem behaviors	0.42***	0.17 <sup>†</sup>	0.42***	0.07	0.08	0.29***
Clinical global impressions	0.26***	0.37***	0.10	0.20*	0.03	-0.01

<sup>†</sup>  $p < 0.06$ , \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

SCT literature. Note that this finding does not invalidate the use of scales with few such items; it only points out limitations and opportunity for improvement.

Our hypotheses drawn from prior findings (see Introduction) were partially supported. Controlling for ADHD factors, total SCT was associated with internalizing disorders in teacher data, and there was a trend toward association with depression in the parent data. When SCT was separated into factors, Sleepy/Tired was a robust predictor of depression across both informants. Thus we suspect that much of the previously-reported associations of SCT with depression may be driven by the association of Sleepy/Tired items with depression, consistent with a previous study of SCT factors (Jacobson et al. 2012). As expected, ODD was positively associated with Hyperactivity-Impulsivity but not with SCT; in fact, Daydreaming was inversely associated with ODD in teacher data. An inverse relationship of ODD and SCT has been previously reported (Lee et al. 2013) when ADHD factors are included as predictors, and it may be that this association is largely determined by an inverse association of Daydreaming items and ODD. This pattern would also fit clinical reports of exceptionally good behavior in children with Primary Disorder of Vigilance (Weinberg et al. 2001;

Weinberg and Brumback 1990). Because we did not extract a Low Initiative factor, we could not evaluate our hypothesis of an association of this factor with academic impairment. Note, however, that total SCT and the Sleepy/Tired factor were inversely associated with academic behaviors in the teacher data, even when controlling for ADHD factors.

Although SCT, and more specifically the Sleepy/Tired factor, were related to Depression, the associations were not sufficiently strong to indicate that these are aspects of the same construct (correlations suggest that Sleepy/Tired and Depression shared 11 % of the variance in parent data and 31 % in teacher data). Even when Depression was included among predictors, one or more SCT factors were significantly associated with organization difficulties, Inattention, social skills, and global impairment in parent data, and with organization difficulties, academic behaviors, Inattention, problem social behaviors, and global impairment in teacher data. These findings argue strongly for the partial independence of SCT and Depression. Future investigations may help determine whether this overlap occurs from (a) methods (e. g., item similarity between these constructs), (b) causal effects of SCT functional

**Table 7** Discriminant validity of SCT and depression: standardized partial regression coefficients for outcomes on predictors for parents

Outcomes	Model R <sup>2</sup>	Depression severity	Daydreams	Working memory problems	Sleepy/tired
Organization problems	0.16**	0.04	0.11	0.15	0.25**
Homework problems	0.07	0.14 <sup>†</sup>	0.1	0.02	0.13
Inattention severity	0.23***	0.12 <sup>†</sup>	0.10	0.32***	0.15
Hyperactivity severity	0.03	0.12	0.14	0.02	0.09
ODD severity	0.10	0.31***	0.08	0.03	-0.03
Generalized anxiety severity	0.29***	0.54***	0.08	0.13	-0.11
Social skills	-0.16*	-0.06	-0.06	-0.15*	0.00
Problem behaviors	0.15*	0.34***	0.14	0.04	0.0
Clinical global impression	0.09 <sup>†</sup>	0.05	0.22**	0.20**	-0.13

<sup>†</sup>  $p < 0.06$ , \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

**Table 8** Discriminant validity of SCT and depression: standardized partial regression coefficients for outcomes on predictors for teachers

Outcomes	Model R <sup>2</sup>	Depression severity	Daydreams	Working memory problems	Sleepy/tired
Organization problems	0.29***	0.02	0.14	0.27**	0.27**
Academic enablers	0.29***	−0.21**	−0.17*	−0.12	−0.22*
Inattention severity	0.23***	0.09	0.25**	0.18*	0.14
Hyperactivity severity	0.02	−0.12	−0.01	−0.03	0.01
ODD severity	0.13*	0.37***	−0.11	−0.03	0.01
Generalized anxiety severity	0.33***	0.63***	0.00	0.10	−0.17
Social skills	0.20***	−0.32***	0.04	−0.04	−0.18
Problem behaviors	0.25***	0.19*	0.13	0.12	0.23*
Clinical global impression	0.17***	0.23*	0.30***	0.08	−0.07

†  $p < 0.06$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

problems on mood and self-esteem, (c) causal effects of Depression on cognition and SCT behaviors, or (d) neurobiological etiologies (structural or functional brain variations) common to both manifestations.

Across analyses, there was more evidence of the validity of SCT factors in data from teachers than in data from parents. Because of the difference in behaviors elicited in the home and classroom setting, we cannot assume that teacher and parents have sufficient opportunity to evaluate children on all SCT items. Teachers may in fact be better reporters of SCT, (McBurnett et al. 2001) or they may be better at making fine distinctions among indicators of SCT and ADHD in the context of normal children of the same age. Future research is needed to evaluate differences in item response and latent structure of SCT across informants. Research may also be directed to whether SCT is best measured by brief items on rating scales versus via semi-structured interviews that explain items more thoroughly (or more elaborate behavioral descriptions of SCT behaviors; (Lee et al. 2013)).

#### Limitations

Our sample is not representative of the population of individuals who exhibit high levels of SCT, because we did not recruit on that basis. Clinical samples such as ours have restricted ranges of symptom severity depending on entry requirements; in this study, the ranges of both Inattention and Hyperactivity-Impulsivity were restricted. We recruited a narrow age range of children with a single type of ADHD that has been purported but not proven to have a broad range and high mean level of SCT. Our sample averaged moderate SCT severity and displayed a broad range of educational and socioeconomic attainment that was skewed in the successful direction, compared to the general population. We cannot make strong claims that

our findings will generalize to different populations, and we were limited by sample size in comparing results between sexes. Our sense is that developmental range will be more likely to moderate SCT findings than sex or SES. We look forward to the emergence of similar work with more diverse populations.

Another limitation is that this study was conducted mostly at a descriptive, empirical level. Our predictions were based on patterns of prior findings. There is not yet a theory of the neurobiology of SCT that would allow hypotheses to develop from a theoretical model, as opposed to replicating and perhaps extending prior findings. However, the extraction of SCT factors may prove useful in exploring applications of SCT to theories from neurobiology and cognitive science in the future.

Finally, a chief limitation of this study is its preliminary status. EFA results require independent confirmation, and similar to most published EFA studies, the subject-to-item ratio (3.75 in this study, below a commonly-recommended 5:1 ratio) is insufficient to lend confidence in these exact results (Costello and Osborne 2005). The implication is not only that the obtained factor structures should be regarded as tentative, but also that items discarded in the EFAs should not be prematurely disregarded in future studies. We specifically caution against prematurely discarding slowness from the hypothesized SCT content based only on our methods and findings. Also, we did not correct for multiple tests, as is appropriate in exploratory research (Moran 2003). As a counterargument against the weakness of low subject-item ratio, the findings follow expected empirical directions, and the high “quality” of our data and results (Costello and Osborne 2005) make it unlikely that most findings are spurious. Replication and extension of the findings with larger ADHD, general clinical, and population-based samples will be necessary to determine a final item set of items, describe generalizable structures, and determine replicable external correlates of SCT.

Appendix: Kiddie Sluggish Cognitive Tempo Rating Scale

References

**K-SCT Rating Scale for Parents and Teachers**

ID \_\_\_\_\_ Circle: Mother Father  
 Date \_\_\_\_\_ Teacher Guardian

Administration: 1<sup>st</sup> or 2<sup>nd</sup> (circle one)

Directions: Please rate how often this child seems to be doing each of the behaviors below. Use your best guess if you aren't sure. If you don't understand an item, cross it out with an "X."

	Never or rarely	Sometimes	Often	Very often
<b>Daydreams, variable alertness, drowsy</b>				
1 <sup>st</sup> Daydreams				
2 <sup>nd</sup> Stares into space				
3 <sup>rd</sup> "Spaces out"				
4 <sup>th</sup> Seems to be off in a world of his or her own				
5 <sup>th</sup> Gets lost in thought				
6 <sup>th</sup> Mind seems to drift off				
7 Attention seems to zone in and out				
8 Doesn't hear questions or instructions the first time				
9 Mind seems foggy				
10 <sup>th</sup> Seems drowsy (during the daytime)				
11 Looks as if he or she might fall asleep at any moment (during the daytime)				
12 <sup>th</sup> Yawns				
13 Easily bored				
<b>Working memory slips, loses place</b>				
14 Absent-minded				
15 Mind wanders				
16 <sup>th</sup> Forgets what he/she was going to say				
17 Loses his or her place when working on a task				
<b>Working memory slips, loses place (continued)</b>				
18 <sup>th</sup> Loses train of thought				
19 <sup>th</sup> Gets "tongue-tied"				
20 <sup>th</sup> Gets mixed up				
21 <sup>st</sup> Gets confused				
22 Can't remember things he/she just learned or was told				
23 Forgets what he/she was looking for				
24 Needs to have information repeated to him or her				
25 Quickly forgets what he/she just read				
<b>Slow processing</b>				
26 Takes a long time to make choices or decisions				
27 Takes longer than you expect to respond to questions				
28 Takes several moments before answering you, even when you have his or her full attention				
29 Gets bogged down in his/her work				
<b>Slow behavior and movement</b>				
30 Sluggish				
31 Works at a snail's pace				
32 Is "slow as molasses"				
33 Pauses in the middle of an activity				
34 Is a "slow-poke"				
35 Moves around slowly				
<b>Low initiative, low energy</b>				
36 <sup>th</sup> Lacks energy				
37 <sup>th</sup> Gets tired easily				
38 Has difficulty getting motivated				
39 Needs to "perk up"				
40 Effort fades quickly				
41 Likes to "veg out"				
42 Has trouble getting started to work				
43 Puts things off until the last minute				
44 Likes to do nothing				

◻ = Daydreaming, WS = Working Memory, ST = Sleepy/Tired. Long and short versions available for free download at <http://psych.ucsf.edu/uploadedFiles/KSCTratingScale.docx>.

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