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Advancing the Multi-Informant Assessment of Sluggish Cognitive Tempo: Child Self-Report in Relation to Parent and Teacher Ratings of SCT and Impairment

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Abstract

Despite increasing interest in sluggish cognitive tempo (SCT) in children and advancements in its measurement, little research has examined child self-reported SCT. Child self-report of SCT is important for the multi-informant assessment of SCT. The current study used a large, school-based sample of children and a multi-informant design to examine child self-reported SCT using the *Child Concentration Inventory – Version 2* (CCI-2) which was recently revised based on meta-analytic findings and parallels the item content of validated parent and teacher rating scales. The study involved 2142 unique children (ages 8–13 years, 50.51% males). Children ($n = 1980$) completed measures of SCT, loneliness, and preference for solitude. Mothers ($n = 1648$), fathers ($n = 1358$), and teachers ($n = 1773$) completed measures of SCT, attention-deficit/hyperactivity disorder-IN (ADHD-IN), academic impairment, social impairment, and conflicted shyness. Children's self-reported SCT demonstrated good reliability with the 15 SCT symptoms showing moderate to strong loadings on the SCT factor. The child self-report SCT factor also showed moderate convergent validity with mother, father, and teacher ratings of children's SCT. In addition, higher child-reported SCT predicted greater mother, father, and teacher ratings of children's academic impairment even after controlling for mother, father, and teacher ratings of children's SCT and ADHD-IN. Higher child-rated SCT also predicted greater mother ratings of children's social impairment after controlling for mother ratings of children's SCT and ADHD-IN. The present study provides initial empirical support for the reliability and validity of child-reported SCT as part of the multi-informant assessment of SCT. A key direction for future research includes evaluating the unique contributions of different informants and their utility within specific contexts to guide evidence-based recommendations for assessing SCT.

Keywords ADHD · Assessment · Child Concentration Inventory · CCI-2 · Inattention · Multiple informants · Sluggish cognitive tempo · Validity

Although sluggish cognitive tempo (SCT) – a set of attentional symptoms characterized by excessive daydreaming, mental confusion or fogginess, drowsiness, and slowed behavior/thinking – has been studied to varying degrees since the mid-1980s (Lahey et al. 1985), only recently has there been serious consideration of the measurement and assessment of SCT. Most SCT measurement work to date has focused on parent and teacher rating scales (Barkley 2013; Jacobson et al. 2012; Lee et al. 2014; McBurnett et al. 2014; Penny et al. 2009). Consistent with this, a recent meta-analysis of SCT found that the vast majority of studies of SCT have used parent and teacher ratings (Becker et al. 2016a). However, there is increasing interest in youth self-report of SCT, and the present study adds to the small body of literature examining children's self-report of SCT as part of the multi-informant assessment of SCT.

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The primary rationale for child self-report of SCT comes from converging lines of research suggesting that SCT may fall under the internalizing rather than externalizing umbrella of psychopathology (for a review, see Becker and Willcutt 2018). Although definitive conclusions regarding this possibility cannot yet be made, research indicates that SCT (1) is more strongly associated with anxiety and depression than with oppositionality and aggression (Becker et al. 2016a), (2) is often unassociated or even negatively associated with externalizing and disruptive behaviors when controlling for attention-deficit/hyperactivity disorder inattention (ADHD-IN) (Becker et al. 2014; Bernad et al. 2016; Penny et al. 2009), (3) is more strongly associated than ADHD symptoms with suicide risk (Becker et al. 2016b, 2018), (4) is linked to social withdrawal and peer isolation (Becker et al. 2017c; Carlson and Mann 2002; Marshall et al. 2014; Willcutt et al. 2014), (5) is associated with punishment sensitivity (Becker et al. 2013), and (6) does not fit within an bi-factor model of ADHD/oppositional defiant disorder (Lee et al. 2016). Given these findings, and if SCT is indeed ultimately conceptualized as an internalizing psychopathology, "it is possible that youth self-report may be the ideal for measuring what is largely an internal state" (Smith and Langberg 2017, p. 1141).

To date, only three published studies have examined self-reported SCT in children and adolescents. First, Becker et al. (2015) modified the parent/teacher rating scale by Penny et al. (2009) for child self-report, providing initial psychometric validation of the *Child Concentration Inventory* (CCI). Specifically, in a community sample of 124 children in third through sixth grades (ages 8–13 years), child-rated SCT was distinct from child-rated anxiety and depression as well as teacher-rated ADHD. Child-rated SCT was also strongly correlated with teacher-rated SCT ($r = 0.53$). Further, above and beyond student demographics, teacher-rated SCT, and other psychopathology symptoms (e.g., ADHD, depression), scores on the CCI were significantly associated with poorer child-reported academic/social functioning, lower self-worth, and increased loneliness and emotion dysregulation (Becker et al. 2015).

Two other studies have recently been published that similarly used a self-report version of the Penny et al. (2009) measure. Using the same sample of 262 young adolescents with ADHD, one study focused on the measurement of self-reported SCT (Smith et al. 2018) and the other study focused on the external validity of self-reported SCT (Smith and Langberg 2017). The measurement study found empirical support for youth self-reported SCT and also found that youth and parent ratings of SCT were only modestly correlated, suggesting that "it will be important to assess ratings from both parents and youth, as informants may differentially predict outcomes or have incremental validity" (Smith et al. 2018, p. 107). In line with this possibility, additional analyses found that parent-reported SCT was most useful for predicting academic impairment whereas youth-reported SCT was most useful for predicting internalizing symptoms (Smith and Langberg 2017).

Although important, these studies examining child-reported SCT are limited in a number of ways. First, none of the existing child self-report studies were informed by the meta-analysis that identified optimal items for SCT as separable from ADHD-IN. The Penny et al. (2009) measure specifically – which was modified for use in the three child self-report studies to date – includes some items assessing low initiative and poor task effort ("Slow" subscale) that have not shown discriminant validity from ADHD-IN symptoms (Barkley 2013; Becker et al. 2016a; Jacobson et al. 2012; Lee et al. 2014; Penny et al. 2009). It is therefore possible that the SCT-relevant findings reported in those studies are not specific to SCT but are instead attributable to a particularly high degree of construct overlap with ADHD-IN (Becker et al. 2015; Smith et al. 2018; Smith and Langberg 2017). Second, the Becker et al. (2015) study had a small sample size recruited from a single elementary school, whereas the other two studies (Smith et al. 2018; Smith and Langberg 2017) included a sample of young adolescents diagnosed with ADHD. It has been argued that SCT may operate differently in ADHD vs. non-ADHD samples (Barkley 2014), and so it is remains important to examine SCT in larger, community-based samples.

Given limitations of existing studies and the recent meta-analytic findings in particular, the CCI was revised to include the 13 items identified in the meta-analysis as optimal for assessing SCT (Becker et al. 2016a). In addition, three items assessing mental confusion that demonstrated promise in recent SCT measurement research (McBurnett et al. 2014) were also included. Furthermore, this revised self-report measure of SCT, the *Child Concentration Inventory – Version 2* (CCI-2), parallels the SCT items on the parent/teacher-reported *Child and Adolescent Behavior Inventory* (CABI). The SCT module of the parent/teacher CABI was similarly revised following the meta-analysis and has promising psychometric support (Becker et al. 2017b; Sáez et al. 2018). Thus, support for the CCI-2 would provide the field with a set of scales with a parallel item set across parent-report, teacher-report, and child self-report. The current study provides the first examination of the CCI-2 measure.

The Present Study

The present study had four objectives. The first objective was to determine the convergent validity of the 15 SCT symptoms on the CCI-2. This objective first evaluated the loadings of the SCT symptoms on the child self-report SCT factor. It was expected that the SCT symptoms would have moderate loadings on the child SCT factor (e.g., 0.40 to 0.60). This objective

then determined the correlation of the child self-report SCT factor with the mother-, father, and teacher-rated child SCT factor. Based on previous literature of cross-informant agreement (De Los Reyes et al. 2015) as well as extant studies of SCT specifically (Becker et al. 2016a; Smith et al. 2018), it was expected that these convergent factor correlations would be moderate (e.g., 0.30 to 0.40).

The second objective was to determine the discriminant validity of three child self-report factors: SCT, loneliness, and preference for solitude. We hypothesized that the child SCT factor would show discriminant validity (e.g., factor correlations less than 0.60) with the child loneliness and preference for solitude factors. In addition, one of the most consistent correlates of SCT is social withdrawal (Becker et al. 2017c; Carlson and Mann 2002; Marshall et al. 2014; Willcutt et al. 2014), and we sought to explore whether SCT is more strongly associated with loneliness than with a preference for solitude as this distinction is both theoretically and clinically meaningful (Coplan and Armer 2007; Marcoen and Goossens 1993).

The third objective was to determine if child self-report SCT would still predict mother, father, and teacher ratings of children's academic and social impairment even after controlling for mothers', fathers', and teachers' ratings of children's SCT and ADHD-IN (i.e., a separate structural regression analysis for each adult source). Finding child self-reported SCT to predict mother, father, and teacher perceptions of children's academic and social impairment even after controlling for adult perceptions of children's SCT and ADHD-IN would significantly increase the support for the validity of the child self-report SCT measure (i.e., objective three represents a stringent test of the validity of the child self-report SCT measure).

The fourth objective was to determine if SCT was correlated with child sex and/or age. It was predicted that the correlations of SCT with child sex and age would be non-significant or, if significant, of trivial magnitude (i.e., correlations less than 0.10) (Barkley 2013; Becker et al. 2016a). In other words, regardless of the source of the SCT ratings (i.e., children, mothers, fathers, and teachers), it was predicted that the child sex and age correlations with the SCT factor would be of a trivial-to-small magnitude. The age prediction was also based on the narrow age range of our sample (8 to 13 years), particularly as our study did not include later adolescence or adulthood when SCT symptoms may increase (Barkley 2012; Leopold et al. 2016).

Methods

Participants and Procedures

All 257 elementary schools on the Balearic Islands (Spain) were invited to participate in the study (approved by the Research Ethics Committee [Institutional Review Board] of the University of the Balearic Islands). A total of 48 schools expressed an interest in the study with 37 schools randomly selected from these 48 schools for additional contact. The investigators met with the principals of these 37 schools to determine the interest and ability of the schools to participate in the study (e.g., expected level of participation of mothers, fathers, and teachers and available school space to facilitate data collection). A total of 32 of these 37 schools were then selected for the study. There were 5376 3rd-6th grade children in these 32 schools. The principals next provided study staff with a list of the teachers from these 32 schools that indicated an interest in the study (e.g., If a teacher indicated no interest in the project, then this eliminated the students in the teacher's class from consideration for the project). The school was also asked to exclude children who did not speak Spanish or had severe special education needs (e.g., educated in a self-contained classroom). These exclusionary criteria resulted in 3855 children whose parents were contacted by the researchers.

An informed consent form was given to the parents of the 3855 children and with parental written approval a similar informed consent form was given to the teachers. Assent was obtained from children with parental permission to participate in the study. This procedure could result in the completion of the rating scales only by mothers, fathers, teachers, or children along with the various combinations. Information (i.e., a mother rating, father rating, teacher rating, or child self-report) was available on 2142 unique children (50.51% boys with the sex ratio being similar within each grade) from the 32 schools (i.e., 1648 mother ratings, 1358 father rating, 1773 teacher rating [196 teachers rated an average of 10.93 (SD = 1.21) children], and 1980 child self-report ratings). The number of children from the third, fourth, fifth, and sixth grades were 598, 616, 400, and 528, respectively, with the mean age of the children being 10.30 (SD = 1.21, range = 8 to 13) years. Although race information was not collected on the individual children in this study, participating schools indicated that their student populations were approximately 90% White and 10% North African.

Diagnostic Characteristics of the Children Parents were asked to indicate (i.e., to write the diagnostic label or labels in the space provided for such) if their child had an official diagnosis (i.e., a diagnosis recognized by the medical, psychological or educational profession). Parents indicated that a total of 14.10% of 1777 children rated by mothers or fathers had such a condition with 5.13% having an ADHD diagnosis. The other conditions indicated by parents were learning disabilities (LD; 4.86%), medical problems (3.84%, asthma was the most common), pervasive developmental disorders (0.72%), tics (0.12%), intellectual disability (0.24%), and enuresis (0.06%).

Characteristics of Mothers and Fathers A total of 84% of the mothers and 86% of the fathers were married with 62% of the mothers and 71% of the fathers with permanent employment (13% and 12%, respectively, reported occasional employment). For mothers (fathers) 17% (25%) reported 10 grades of education, 19% (22%) twelve grades, 23% (21%) vocational training (e.g., electricians, plumbers, mechanics, and administrators with 3 to 5 years of education beyond the high school diploma) and 37% (29%) a university degree (approximately 4% missing).

Measures

We first describe the child self-report measures and then the mother, father, and teacher rating scales, with descriptive information for study variables summarized in Table S1. We then explain the procedures used to increase the likelihood of meaningful self-report information from the children. Finally, we describe the procedures used to translate the measures from English to Spanish.

Child Concentration Inventory – Version 2 (CCI-2) The *Child Concentration Inventory* (CCI) (Becker et al. 2015) was developed as a child self-report measure of SCT based on the parent/teacher SCT scale by Penny et al. (2009). An initial study with the CCI with children ages 8 to 13 (3rd–6th grades) found child-rated SCT to be reliable, distinct from teacher-rated ADHD and child-rated internalizing symptoms, and associated with poorer socio-emotional functioning (Becker et al. 2015). As described above, the CCI was thoroughly revised following a recent meta-analysis of SCT (Becker et al. 2016a), resulting in the CCI-2 examined in this study (Becker 2015). The CCI-2 consists of 16 SCT symptoms rated on a four-point scale (0 = *never*, 1 = *sometimes*, 2 = *often*, and 3 = *always*), but the "*I am not motivated to do things*" symptom was not used in the current study because this SCT item had a much higher loading on the ADHD-IN factor than the SCT factor in earlier research with mothers, fathers, and teachers using the parallel CABI SCT module (Becker et al. 2017b; Sáez et al. 2018). SCT items similar to the *lacks motivation* item (e.g., *is unmotivated*, has *difficulty getting motivated*) have also demonstrated poor discriminant validity with the ADHD-IN factor in several other studies (Barkley 2013; Jacobson et al. 2012; McBurnett et al. 2014; Penny et al. 2009). The 15 CCI-2 items used in the current study are shown in Table 1. Cronbach's alpha for the 15 SCT symptoms was 0.80 with the values for the third, fourth, fifth, and sixth grades being 0.79, 0.80, 0.80, and 0.82, respectively.

Loneliness Questionnaire (LQ) Children completed the LQ (Asher et al. 1984). Initially consisting of 24 items, a shortened nine-item version with superior psychometric properties (Ebesutani et al. 2012) was used in the present study. These nine items (e.g., "It's hard for me to make friends at school") are rated on a three-point scale (0 = *no*, 1 = *sometimes*, 2 = *yes*) such that higher scores reflect greater loneliness. Both child- and teacher-rated SCT were significantly correlated with this measure of loneliness in the initial validation study of the CCI (*r*s = 0.52 and 0.35, respectively) (Becker et al. 2015). In the present study, Cronbach's alpha was 0.78.

Child Social Preference Questionnaire (CSPQ) The CSPQ consists of seven items assessing a child's preference to spend time alone (Coplan et al. 2013). Each item (e.g., "I enjoy playing by myself") is rated on a five-point scale (0 = *not ever*, 1 = *hardly ever*, 2 = *sometimes*, 3 = *most of the time*, and 4 = *all of the time*) with higher scores indicating greater preference for solitude. Cronbach's alpha for the measure was 0.77.

Child and Adolescent Behavior Inventory (CABI) Parents and teachers completed their respective versions of the CABI (Burns et al. 2015a, b). This study used four subscales from the CABI –SCT (15 symptoms), ADHD-IN (nine symptoms), social impairment (four items for parents [quality of interactions with parents, other adults, siblings, and peers] and two items for teachers [quality of interactions with adults and peers at school], and academic impairment (five items: quality of homework/classwork, reading skills, arithmetic skills, writing skills, and global academic skills). Wording for the 15 SCT items on the CABI can be found in Becker et al. (2017b), though these items are parallel to the items on the CCI-2 as shown in Table 1.

Parents and teachers were instructed to base their ratings on the past month. Parents were also told to make their ratings independently. The SCT and ADHD-IN items were rated on a 6-point scale (i.e., 0 = *almost never [never or about once per month],* 1 = *seldom [about once per week],* 2 = *sometimes [several times per week],* 3 = *often [about once per day],* 4 = *very often [several times per day],* and 5 = *almost always [many times per day]*. A 7-point scale was use for the academic and social impairment items (i.e., 0 = *severe difficulty*, 1 = *moderate difficulty*, 2 = *slight difficulty*, 3 = *average performance* [*average interactions*] *for grade level*, 4 = *slightly above average*, 5 = *moderately above average*, and 6 = *excellent performance* [*excellent interactions*] *for grade level*). The impairment items were reverse keyed so that higher scores represent greater impairment.

Earlier studies provide support for the reliability (internal consistency, test-retest, inter-rater) and validity of scores from the SCT, ADHD-IN, social impairment, and academic impairment CABI subscales (Becker et al. 2017b; Belmar et al. 2017; Bernad et al. 2016; Khadka et al. 2016; Lee et al. 2018; Seijas et al. 2017). In the current study, Cronbach's alpha (mothers, fathers, and teachers) was excellent for SCT (0.93, 0.92, 0.97), ADHD-IN (0.95, 0.95, 0.97), social impairment (0.90, 0.91, 0.87), and academic impairment (0.94, 0.95,

Table 1 Standardized loadings (standard errors) for sluggish cognitive tempo symptoms for child self-report and adult ratings of children

	Children	Mothers	Fathers	Teachers
1. I am slow at doing things	0.56 (0.03)	0.66 (0.02)	0.65 (0.02)	0.79 (0.01)
2. My mind feels like it is in a fog	0.68 (0.03)	0.82 (0.01)	0.82 (0.01)	0.95 (0.01)
3. I stare off into space	0.49 (0.02)	0.76 (0.02)	0.76 (0.02)	0.93 (0.01)
4. I feel sleepy or drowsy during the day	0.42 (0.03)	0.63 (0.02)	0.64 (0.03)	0.86 (0.01)
5. I daydream	0.40 (0.04)	0.63 (0.02)	0.57 (0.03)	0.86 (0.01)
6. I lose my train of thought	0.54 (0.03)	0.83 (0.01)	0.82 (0.01)	0.92 (0.01)
7. I am not very active	0.38 (0.04)	0.67 (0.02)	0.65 (0.03)	0.86 (0.01)
8. I get lost in my own thoughts	0.51 (0.03)	0.82 (0.01)	0.83 (0.02)	0.93 (0.01)
9. I get tired easily	0.44 (0.03)	0.65 (0.02)	0.60 (0.02)	0.84 (0.01)
10. I forget what I am going to say	0.49 (0.03)	0.80 (0.01)	0.81 (0.01)	0.89 (0.01)
11. I feel confused	0.56 (0.03)	0.85 (0.01)	0.86 (0.01)	0.94 (0.01)
12. I zone out or space out	0.57 (0.03)	0.84 (0.01)	0.84 (0.01)	0.94 (0.01)
13. My mind gets mixed up	0.62 (0.03)	0.87 (0.01)	0.86 (0.01)	0.94 (0.01)
14. My thinking seems slow or slowed down	0.68 (0.03)	0.86 (0.01)	0.84 (0.01)	0.91 (0.01)
15. I have hard time putting my thoughts into words	0.47 (0.03)	0.80 (0.01)	0.79 (0.01)	0.87 (0.01)

Wording of sluggish cognitive tempo symptoms is for the child self-report measure. All loadings significant at $p < 0.001$

0.97) scores. Inter-rater factor correlations for mothers with fathers for SCT, ADHD-IN, social impairment, and academic impairment were 0.81, 0.83, 0.70, and 0.87, mothers with teachers 0.43, 0.55, 0.18, and 0.72, and fathers with teachers 0.42, 0.54, 0.14, and 0.69, respectively.

Child Social Preference Scale (CSPS) The CSPS (Coplan et al. 2004) was developed as a parent-report measure of children's conflicted shyness (experiencing social fears/withdrawal despite a desire to interact socially) and social disinterest (lacking a strong motivation to engage in social interaction). Only the conflicted shyness subscale (7 items; e.g., "My child will turn down social initiations from other children because he/she is shy") was used in the current study. Previous research supports the reliability and validity of the CSPS conflicted shyness scale, including associations with temperamental wariness of social novelty, teacher-rated anxiety and behavioral withdrawal, and observed reticent behavior and parallel play during free play with peers (Coplan et al. 2004). For the present study, the CSPS was adapted for completion by teachers (changing "My child…" to "This child…"). For each item, parents (teachers) responded to the question "How much is your child (this child) like that?" on a five-point scale (ranging from 1 = *not at all* to 5 = *a lot*). The alpha values ranged from 0.78 to 0.87 with the interrater correlation for mothers with fathers being 0.75 and the values for mothers with teachers and fathers with teachers being 0.16 and 0.20, respectively.

Collection of Child Self-Report Information Prior to the collection of the child self-report data, the research assistants carefully explained each scale format and provided examples on the board along with instructions on how to answer the questions. There were always two research assistants present in the classroom (and sometimes there was also an assistant teacher or the school psychologist). The children were also told to raise their hand if they had any questions.

Translation of English Measures to Spanish Individuals with degrees in child clinical psychology and psychiatry who were fluent in Spanish and English performed the forward and back-translations of the measures. These individuals also had significant previous experience with the translation of rating scales from English to Spanish for research and clinical purposes.

Analytic Approach

Estimation and Clustering The analyses used the Mplus statistical software, version 8.0 (Muthén and Muthén 1998–2017). The items were treated as categorical indicators with the use of the robust weighted least squares estimator (WLSMV). Given the children were clustered within teachers, the Mplus type = complex option was used to correct the standard errors. The software was also used to determine the descriptive information on the SCT manifest variable for the four sources (i.e., full information maximum likelihood estimation to make use of all the information). Finally, the Mplus model constraint procedure was used to compare the factor correlations for significant differences.

Criteria for Model Fit Global fit was evaluated with the comparative fit index (CFI; close fit ≥0.95), Tucker Lewis Index

(TLI; close fit ≥0.95), and the root-mean-square error of approximation (RMSEA; and close fit ≤0.05) (Little 2013). These procedures were used to evaluate global model fit given the chi-square value is not a practical measure of fit with large samples (Little 2013).

Study Objective 1: Convergent Validity of Child Self-Report SCT A confirmatory factor analysis (CFA) was applied to the child self-report, mother-, father-, and teacher-rated child SCT symptoms. This analysis allowed for the evaluation of the SCT symptoms' loadings on the SCT factor along with the convergent validity for the SCT factor among the four sources.

Study Objective 2: Discriminant Validity of Child-Rated SCT from Child-Rated Loneliness and Preference for Solitude A CFA was applied to the items on the child self-report SCT, loneliness, and preference for solitude scales. This analysis allowed us to determine if the child SCT factor was distinct from the child loneliness and preference for solitude factors as well as explore whether SCT was more strongly associated with loneliness or preference for solitude.

Study Objective 3: Unique Relationship of Child Self-Report SCT with Adult Ratings of Children's Academic and Social Impairment The mother-rated child academic impairment, mother-rated child social impairment, and mother-rated child shyness factors were regressed on the child self-report SCT, mother-rated child SCT, and mother-rated child ADHD-IN factors. This analysis allowed us to determine if child-rated SCT would uniquely predict mother-rated impairment (i.e., academic, social, and shyness) after controlling for mother-rated child SCT and mother-rated child ADHD-IN. The same structural regression analysis was also repeated with father and teacher ratings.

Study Objective 4: Correlation of SCT with Child Sex and Age A CFA was used to determine the correlations of child self-report SCT, mother-rated child SCT, father-rated child SCT, and teacher-rated child SCT with children's sex and age.

Results

Missing Information

Covariance coverage was greater than 99% for all variances and covariances for each source separately. Covariance coverage for the analyses with children, mothers, fathers and teachers simultaneously varied from 51% to 92% with the coverage for the analyses of children with mothers, children with fathers, and children with teachers varying from 78% to 97%, 64% to 97%, and 77% to 93%, respectively. The WLSMV uses a pairwise approach to missing information (i.e., the analyses are performed on the polychoric correlation matrix with each correlation based on the maximum amount of information).

Convergent Validity of SCT Across Children, Mothers, Fathers, and Teachers

The results from the CFA on the 15 SCT symptoms for the four sources (i.e., an SCT factor for children, mothers, fathers, and teachers) resulted in a close fit, $\chi^2(1704) = 5705$, $p < 0.001$, CFI = 0.97, TLI = 0.96, and RMSEA = 0.033 (0.032, 0.034). Table 1 shows the standardized loadings for the 15 SCT symptoms for the four sources. The loadings for the child self-report measure ranged from 0.38 (*I am not very active*) to 0.68 (*My mind feels like it is in a fog* and *My thinking seems slow or slowed down*) with the average loading being 0.52 ($SD = 0.09$). The SCT symptom loadings for mothers varied from 0.63 to 0.87 ($M = 0.77$, $SD = 0.09$), fathers from 0.57 to 0.86 ($M = 0.76$, $SD = 0.10$), and teachers from 0.79 to 0.95 ($M = 0.90$, $SD = 0.05$). Higher scores on the child self-report SCT factor were associated with significantly ($ps < 0.001$) higher scores on the mother-, father-, and teacher-rated child SCT factor (i.e., $r = 0.36$, $SE = 0.03$, $r = 0.36$, $SE = 0.03$, and $r = 0.29$, $SE = 0.03$, respectively). The SCT factor correlations for mothers with fathers, mothers with teachers, and fathers with teachers were 0.88 ($SE = 0.01$), 0.44 ($SE = 0.02$), and 0.42 ($SE = 0.03$), respectively.

Discriminant Validity of Child Self-Report SCT, Loneliness, and Preference for Solitude Factors

A CFA on the child SCT, loneliness, and preference for solitude three-factor model resulted in a close fit, $\chi^2(431) = 1125$, $p < 0.001$, CFI = 0.95, TLI = 0.95, and RMSEA = 0.029 (0.026, 0.031). Higher scores on the SCT factor were associated with significantly ($ps < 0.001$) higher scores on the loneliness ($r = 0.53$, $SE = 0.03$) and preference for solitude ($r = 0.33$, $SE = 0.03$) factors with the former correlation being significantly ($p < 0.001$) larger than the latter. The loneliness and preference for solitude factors were also significantly correlated ($r = 0.44$, $SE = 0.03$, $p < 0.001$). Child self-reported SCT thus showed good discriminant validity from child self-reported loneliness and child self-report preference for solitude.

Unique Association of Child Self-Report SCT to Adult-Rated Child Academic and Social Impairment

A CFA on child self-report SCT, adult-rated child SCT, adult-rated child ADHD-IN, and adult-rated child academic impairment, adult-rated child social impairment, and adult-

rated conflicted shyness yielded a close fit for the mother, father, and teacher models (i.e., a separate model for each adult source, mothers: $\chi^2(1393) = 3733$, $p < 0.001$, CFI = 0.98, TLI = 0.98, and RMSEA = 0.029 (0.028, 0.030); fathers: $\chi^2(1393) = 2949$, $p < 0.001$, CFI = 0.98, TLI = 0.98, and RMSEA = 0.023 (0.022, 0.025); teachers: $\chi^2(1288) = 3689$, $p < 0.001$, CFI = 0.99, TLI = 0.99, and RMSEA = 0.030 (0.029, 0.031). Higher scores on the child-rated SCT factor were associated with significantly ($ps < 0.001$) higher scores on mother-, father-, and teacher-rated child academic impairment, social impairment, and conflicted shyness factors. The child-rated SCT with the mother-, father, and teacher-rated child academic impairment factor correlations were also significantly ($ps < 0.001$) larger than the child-rated SCT factor with mother-, father, and teacher-rated child social impairment and child shyness factor correlations. Table 2 shows these correlations.

Table 3 shows the partial standardized regression coefficients from the regression of the mother-, father-, and teacher-rated child academic impairment, social impairment, and conflicted shyness factors on the child-rated SCT and adult (mother-, father, and teacher)-rated child SCT and child ADHD-IN factors (i.e., a separate analysis for each adult source). The fit of these three structural regression models was the same as the three measurement models in the preceding paragraph. Higher scores on the child-rated SCT factor still predicted significantly ($ps < 0.05$) higher scores on the mother-, father-, and teacher-rated child academic impairment factor even after controlling for mother-, father-, and teacher-rated child SCT and ADHD-IN factors. In addition, higher scores on the child-rated SCT factor still predicted significantly ($p < 0.05$) higher scores on the mother-rated child social impairment factor after controlling for mother-rated child SCT and ADHD-IN factors. Child-rated SCT was no longer significantly associated with father- and teacher-rated child social impairment after controlling for father- and teacher-rated child SCT and ADHD-IN. Child-rated SCT did not have a unique association with adult-rated child shyness after controlling for adult-rated child SCT and ADHD-IN.

These three structural regression analyses were repeated controlling only for mother-, father-, and teacher-rated child SCT. All the unique effects for child-rated SCT remained significant with one new significant unique effect for child-rated SCT. In the analysis with father-rated impairment, higher scores on the child-rated SCT now significantly ($p < 0.05$) predicted higher scores on the father-rated child social impairment factor even after controlling for father-rated child SCT.[1]

[1] We also repeated the three structural regression analyses controlling for parent-report of ADHD and LD status. All the significant and non-significant results for the structural regression analyses remained the same after also controlling for ADHD and LD status as reported by parents.

Correlations of SCT Factor for Four Sources with Child Sex and Age

Child-rated SCT was not significantly related to either child sex or age with these correlations close to zero. Mother-, father-, and teacher-rated child SCT factors were significantly ($ps < 0.05$) correlated with child sex, though effects were small (i.e., $rs = 0.06$ to 0.14). The adult-rated child SCT factors had small correlations with child age (i.e., $rs = 0.04$ to 0.06), with only father ratings of children's SCT being significantly positively associated with child age ($r = 0.06$, $p < 0.05$).

Descriptive Information on Manifest Variables of SCT Across Four Sources

Table 4 shows the descriptive information on the SCT manifest variable for children, mothers, fathers, and teachers (i.e., the average score on the 0 to 5-point scale for the 15 SCT symptoms for adult ratings and the 0 to 3 point scale for the child self-report ratings). Mean ratings by mothers, fathers, and teachers of the children on the SCT scale showed the full (or nearly so) range (i.e., 0 to 5) of SCT scores (i.e., 0 to 4.3, 0 to 4.4, and 0 to 5.0, respectively). The child self-report of SCT also showed the full range of SCT scores (i.e., 0 to 2.9). Table 4 also shows the SCT scores that correspond to the 90th and 95th percentiles for each of the four sources.

Discussion

Although there is an increasing interest in SCT in children, most studies to date have assessed SCT using parent and/or teacher rating scales (Becker et al. 2016a). Although certainly important, youths' self-reports of their own SCT symptoms are also important to consider within a multi-informant approach to SCT assessment. Only three previous studies have used child self-reported SCT (Becker et al. 2015; Smith et al. 2018; Smith and Langberg 2017). The current study builds from these initial studies by using a large, school-based sample of children and a multi-informant design that includes child, mother, father, and teacher ratings to examine child self-reported SCT and important preliminary psychometric support for the *Child Concentration Inventory-Version 2* (CCI-2).

For the first time, this study used the same SCT symptom set across four informants – children, mothers, fathers, and teachers. The 15 items examined in this study, which already have promising psychometric support for parent- and teacher-rated SCT (Becker et al. 2017b; Sáez et al. 2018), also demonstrated reliability and validity as child self-report items of SCT. Thus, a major contribution of the current study is that the CCI-2, in tandem with the parent and teacher SCT rating

Table 2 Correlations (standard errors) of child-rated sluggish cognitive tempo factor with adult-rated child impairment factors

	Academic impairment	Social impairment	Shyness
Mother-rated child impairment			
Child-rated SCT	0.39 (0.03)**	0.19 (0.03)**	0.16 (0.03)**
Father-rated child impairment			
Child-rated SCT	0.41 (0.03)**	0.17 (0.03)**	0.14 (0.03)**
Teacher-rated child impairment			
Child-rated SCT	0.37 (0.03)**	0.18 (0.03)**	0.20 (0.04)**

SCT sluggish cognitive tempo

**$p < 0.001$

scales that have the same item content as the CCI-2, provide the field with a measure that can be used across adult and child informants. This is important since SCT may ultimately be conceptualized as an internalizing psychopathology as opposed to an externalizing psychopathology (Becker and Willcutt 2018), and child self-report is considered important in the evidence-based assessment of internalizing problems (Klein et al. 2005; Silverman and Ollendick 2005). In addition, child self-reported SCT was moderately correlated with parent- and teacher-rated SCT, providing support for the convergent validity of the CCI-2. Although the correlations were of moderate magnitude (rs = 0.29–0.36), this is expected for cross-informant correlations and the correspondence we found in this study with SCT is very much in line with child-parent and child-teacher correlations for child psychopathology (De Los Reyes et al. 2015). Our study did not focus on who the "best" rater of SCT may be or how to integrate multiple informants in research or clinical practice. Interestingly, the factor correlations between parent and teacher ratings of SCT were also of moderate magnitude in the current study (rs = 0.42 for father-teacher and 0.44 for mother-teacher). It is possible that SCT manifests differently in home and school contexts, and there is some indication that teachers may be somewhat better able to rate SCT as differentiated from ADHD symptoms/subtypes (Garner et al. 2010; McBurnett et al. 2001) or linked to impairment (Burns et al. 2017). A better understanding of the unique contributions of different informants and their utility within specific contexts will be needed to guide evidence-based recommendations for assessing SCT.

Further support for the validity of child self-reported SCT was found in analyses that controlled for adult ratings of children's SCT and ADHD-IN symptoms. That is, we examined whether child-rated SCT was associated with adult-rated impairment above and beyond adult ratings of children's SCT and ADHD-IN. We found strong support for child-rated SCT remaining associated with adult-rated academic impairment, with results consistent across mother, father, and teacher ratings. Child-rated SCT was also independently associated with mothers' ratings of social impairment. These cross-informant findings are especially noteworthy since the analyses were a stringent test whereby child-reported SCT remained associated with adult-rated impairment above and beyond other adult-report measures including SCT. Previous studies using parent

Table 3 Partial standardized regression coefficients for association of child-rated SCT, adult-rated child SCT, and adult-rated child ADHD-IN factors with adult-rated child impairment factors

Predictors	Academic impairment β (*SE*)	Social impairment β (*SE*)	Shyness β (*SE*)
Mother-rated child impairment			
Child-rated SCT	0.16 (0.02)**	0.08 (0.03)*	0.05 (0.04)ns
Mother-rated SCT	0.01 (0.03)ns	0.13 (0.04)**	0.34 (0.04)**
Mother-rated ADHD-IN	0.63 (0.02)**	0.21 (0.03)**	0.01 (0.04)ns
Father-rated impairment			
Child-rated SCT	0.20 (0.03)**	0.05 (0.04)ns	0.04 (0.04)ns
Father-rated SCT	0.01 (0.05)ns	0.10 (0.05)*	0.40 (0.06)**
Father-rated ADHD-IN	0.62 (0.04)**	0.25 (0.05)**	−0.09 (0.06)ns
Teacher-rated impairment			
Child-rated SCT	0.14 (0.02)**	0.02 (0.03)ns	0.03 (0.03)ns
Teacher-rated SCT	0.07 (0.03)*	0.18 (0.06)**	0.62 (0.05)**
Teacher-rated ADHD-IN	0.72 (0.03)**	0.40 (0.05)**	0.01 (0.05)ns

SCT sluggish cognitive tempo, *ADHD-IN* attention-deficit/hyperactivity disorder-inattention

*$p < 0.05$; **$p < 0.001$; ns = nonsignificant

Table 4 Descriptive information on sluggish cognitive tempo manifest variable

	N	Alpha	*M*	*SD*	90th %	95th %	Mean score range
Child self-report	1980	0.80	0.75	0.43	1.33	1.53	0 to 2.9
Mother ratings	1648	0.93	0.60	0.70	1.53	2.00	0 to 4.3
Father ratings	1358	0.92	0.55	0.64	1.47	1.93	0 to 4.4
Teacher rating	1773	0.97	0.87	1.10	2.60	3.33	0 to 5.0

The possible score range was from 0 to 3 on the child self-report SCT scale and from 0 to 5 on the adult SCT rating scales. The *average* scores on the 15 SCT items showed almost (child self-report, mother rating, father rating) or the complete (teacher rating) range of scores on the scale (i.e., 0 to 3 for child self-report and 0 to 5 for adult ratings)

and teacher ratings of SCT have provided mixed findings when examining whether SCT is associated with academic impairment ratings after controlling for ADHD-IN symptoms (Becker and Langberg 2013; Belmar et al. 2017; Bernad et al. 2016; Jacobson et al. 2012; Khadka et al. 2016; Langberg et al. 2014; Watabe et al. 2014). The two previous studies examining child self-reported SCT also reported mixed evidence for SCT in relation to academic functioning (Becker et al. 2015; Smith and Langberg 2017). As our study did not include a child self-report measure of ADHD symptoms (consistent with most studies of school-aged children), we were unable to examine whether self-reported SCT remained associated with academic functioning when also controlling for self-reported ADHD symptoms, though the cross-rater findings between child-rated SCT and adult-rated academic impairment suggest this is an important area for further inquiry. Studies including self-report ratings of both SCT and ADHD-IN, perhaps in adolescents, would be informative for clarifying interrelations between SCT, ADHD-IN, and academic functioning, as well as other functional outcomes.

One particularly novel finding of the present study is that SCT was associated with both loneliness and a preference for solitude, though associations were of modest magnitude and the association was stronger for loneliness. Previous studies have linked SCT to loneliness (Becker et al. 2015, 2017a) and social withdrawal (Becker et al. 2017c; Carlson and Mann 2002; Marshall et al. 2014; Willcutt et al. 2014), but this is the first study to our knowledge to also assess preference for solitude. A social profile is thus emerging whereby children with SCT are isolated from the peer group, a finding of theoretical and clinical importance. For instance, "social isolation is arguably the strongest and most reliable predictor of suicidal ideation, attempts, and lethal suicidal behavior among samples varying in age, nationality, and clinical severity" (Van Orden et al. 2010), and SCT symptoms are consistently associated with isolation and preliminarily associated with suicide risk, even after controlling for depressive and ADHD symptoms (Becker et al. 2016b, 2018). Understanding the developmental and temporal ordering of SCT, isolation, and suicide risk is an important direction for future research. Likewise, although it is increasingly clear that SCT is associated with social isolation, what remains less clear are the *mechanisms* underlying this isolation. Do difficulties in navigating the peer context, including difficulties with emotion regulation (Flannery et al. 2016; Willcutt et al. 2014), contribute to more loneliness and, in turn, withdrawal and a preference for solitude? Or, does shyness or a preference for solitude make it more difficult for children with SCT to gain sufficient, positive peer experiences, ultimately resulting in ignoring by peers and loneliness? Clearly, these are important directions for future longitudinal studies, with answers to these questions having implications for interventions targeting SCT and associated impairments.

Some of the strengths of this study include a large sample size, multi-informant design, and the careful selection of SCT items. Nevertheless, several limitations are important to note and also offer important directions for future research. First, we evaluated the CCI-2 in a nonclinical, school-based sample of children in 3rd-6th grades (ages 8–13 years). It will be important to examine the CCI-2 during other developmental periods of childhood, particularly in adolescence since there is some indication that SCT symptoms may increase slightly across the transition from childhood to adolescence (Leopold et al. 2016). Studies with a larger age span may also examine how development moderates associations between SCT and functional outcomes, as a recent study found age to moderate the association between SCT and processing speed whereas SCT was similarly associated with internalizing symptoms in childhood and adolescence (Jacobson et al. 2018). It will likewise be important to examine the CCI-2 in clinical samples of youth, including ADHD but also other clinical samples. Second, our study used a cross-sectional research design that precludes making any causal inferences. There are not yet any longitudinal studies examining youth self-reported SCT. Longitudinal studies will be necessary for evaluating the test-retest and predictive validity of the CCI-2, as well as to test models that can inform the developmental psychopathology of SCT. Third, our study was limited to rating scale measures of SCT, ADHD-IN, and impairment. Including other measures of functioning, such as other mental health domains (particularly internalizing symptoms), school grades, sociometric nominations, and neuropsychological test

performance, will be important in future research examining the validity of child self-report of SCT. A key direction for future research is to include child self-reported internalizing symptoms – the associations and potential overlap of SCT with internalizing symptoms (particularly depression) is a topic of ongoing interest. Relatedly, it is worth noting that the "I am not very active" item had the lowest factor loading of the CCI-2 items, indicating a need for more research regarding this item including the possible need for rephrasing for child self-report or perhaps that this item more closely aligns with other symptoms such as depression. In addition, the current study focused on academic and social functioning, in part because this has been the focus of previous studies using parent and teacher ratings of SCT. However, it will be important for future studies to extend beyond these domains to other constructs of theoretical (and perhaps clinical) importance, including cognitive processes and information processing. Finally, the CCI-2 and corresponding CABI measure was based on meta-analytic findings (Becker et al. 2016a) as well as novel findings from the evaluation of an expanded SCT symptom set (McBurnett et al. 2014). Although this gives us some degree of confidence in the items used in this study, it should be noted that the SCT symptom set is not firmly established and may need to be further narrowed, expanded, or modified as empirical findings emerge, including findings from intervention research and studies that examine multiple units of analysis (e.g., neuroimaging, neurophysiology, neuropsychology). Despite these considerations, the present study provides further support for children's self-reported SCT symptoms. The CCI-2 specifically provides the field with a child self-report measure of SCT that parallels the item content of recently-validated parent and teacher rating scales that can together be used in the multi-informant assessment of SCT.

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Compliance with Ethical Standards

Conflict of Interest The authors of the current study have no conflicts of interest.

Ethical Approval The research protocol was approved by the Research Ethics Committee (Institutional Review Board [IRB]) of the University of the Balearic Islands.

Informed Consent Mothers, fathers, and teachers provided written informed consent and children provided verbal assent.

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