



Internal and External Validity of Self-Report and Parent-Report Measures of Sluggish Cognitive Tempo in South Korean Adolescents

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Abstract

This study evaluated the internal and external validity of self-report and parent-report measures of sluggish cognitive tempo (SCT) in South Korean adolescents. Adolescents ($N = 469$, ages 13–17 years; 50.2% boys) completed self-report measures of SCT and attention-deficit/hyperactivity disorder inattention (ADHD-IN) in addition to measures of internalizing and externalizing psychopathology, social problems, and grades. Parents rated adolescents on SCT, ADHD-IN, internalizing and externalizing psychopathology, and social problems. Using adolescent self-report, 11 of 15 SCT symptoms showed convergent and discriminant validity with ADHD-IN. Using parent-report, all 15 SCT symptoms showed convergent and discriminant validity with ADHD-IN. For within source analyses, SCT showed unique and stronger associations than ADHD-IN with internalizing psychopathology whereas ADHD-IN showed unique and stronger associations than SCT with externalizing psychopathology. SCT and ADHD-IN showed similar unique associations with social problems, whereas ADHD-IN was more strongly related than SCT to grades. Across source analyses also supported the differential unique associations of SCT and ADHD-IN with internalizing and externalizing psychopathologies. This study provides initial evidence for the internal and external validity of SCT with South Korean adolescents, extending support for the transcultural validity of SCT to the important developmental period of adolescence.

Keywords Sluggish cognitive tempo · ADHD · Attention deficit disorder · Functional impairment · Adolescents · South Korea

Sluggish cognitive tempo (SCT) is characterized by daydreaming (e.g., *gets lost in own thoughts, spaces or zones out*), mental confusion (e.g., *easily confused, difficulty expressing thoughts, loses train of thoughts*), and under arousal (e.g., *low level of activity, easily tired or fatigued, sleepy during the day*) (Becker, Leopold, et al., 2016b). Initial studies on SCT faced a dilemma related to a lack of a standard symptom set for assessing SCT. Researchers were forced to use two to

five ad hoc SCT items, often selected from broadband rating scales. SCT-specific rating scales developed using careful psychometric analysis began to emerge in 2009 (Penny, Waschbusch, Klein, Corkum, & Eskes, 2009). Although the scores from the various SCT measures yielded initial support for the reliability and validity of the construct, each measure contained a varying number of items, in addition to varying support for the convergent and discriminant validity of some putative SCT items from the attention-deficit/hyperactivity disorder inattentive (ADHD-IN) symptoms (see Lee, Burns, Snell, & McBurnett, 2014, Table 1 for a list of SCT measures and items on each measure in 2014).

For research on SCT to advance in a more systematic manner, it was necessary to identify the best items to represent the SCT construct. A meta-analysis of SCT found that none of the existing SCT measures included all of the optimal SCT items (Becker, Leopold, et al., 2016b). This meta-analysis suggested 13 optimal SCT symptoms yet no existing measure of SCT included all 13 symptoms. In addition to these 13 symptoms, three items assessing mental confusion also appeared relevant to SCT (McBurnett et al., 2014). These 16 SCT items were then evaluated with mother, father, and teacher ratings of

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children in large community samples or nationally representative samples in Spain and the United States (Becker, Burns, Schmitt, Epstein, & Tamm, 2019a; Burns & Becker, 2019; Sáez, Servera, Becker, & Burns, 2019a; Servera, Saez, Burns, & Becker, 2018). Fifteen of the 16 SCT symptoms consistently showed strong convergent validity (substantial loadings on the SCT factor) as well as strong discriminant validity (larger loadings on the SCT factor than the ADHD-IN factor). The measure of SCT also demonstrated unique external validity relative to the measure of ADHD-IN in these studies. The 15 items on this parent/teacher rating scale are shown in Table 1.¹ There are also now national norms for this 15-item measure of SCT for mother ratings of children in the United States (Burns & Becker, 2019).

To further advance the study of SCT, a self-report measure of SCT symptoms was necessary (Barkley, 2012; Becker, Burns, Garner, et al., 2018a; Becker, Luebbe, & Joyce, 2015; Sáez, Servera, Burns, & Becker, 2019b; Smith et al., 2018). These initial self-report measures, however, did not include all of the optimal SCT symptoms identified in the meta-analysis (Becker, Leopold, et al., 2016b). The Child Concentration Inventory (Becker et al., 2015), a youth self-report measure of SCT, was thus revised to include the same SCT items as on the parent/teacher rating scales measures of SCT. The 15 SCT items on this self-report measure are also shown in Table 1.

An initial study provided evidence for the internal consistency of the 15-item self-report SCT scale in adolescents with ADHD, though the sample size was too small ($N=48$) to examine the scale's convergent and discriminant validity with adolescent self-reported ADHD-IN (Becker, Epstein, et al., 2019b). An additional study using a large sample of young adolescents with and without ADHD ($N=302$) found 13 of the 15 SCT symptoms to show convergent validity as well as discriminant validity with the ADHD-IN factor (i.e., SCT items *I am slow at doing things* and *I am not very active* showed poor convergent validity as well as weak discriminant validity with ADHD-IN) (Becker, Burns, Smith, & Langberg, 2020). The self-report measure of SCT also showed unique external validity relative to the self-report measure of ADHD-IN, with self-reported SCT symptoms but not ADHD-IN symptoms being uniquely associated with greater adolescent-reported internalizing symptoms and suicidal ideation (Becker et al., 2020). The study thus provided the first support for the differentiation of adolescent-reported SCT and ADHD-IN, both in relation to each other and in relation to other psychopathologies.

At this point, no other studies have examined the psychometrics of the 15-item self-report SCT measure with

Table 1 Items on the Sluggish Cognitive Tempo (SCT) Self-Report and Rating Scale Scales

Parent Rating Scale Items
1. Behavior is slow (sluggish)
2. Lost in a fog
3. Stares blankly into space
4. Drowsy or sleepy (yawns) during the day
5. Daydreams
6. Loses train of thought
7. Low level of activity (underactive)
8. Gets lost in own thoughts
9. Easily tired or fatigued
10. Forgets what was going to say
11. Easily confused
12. Spaces or zones out
13. Gets mixed up
14. Thinking is slow
15. Difficulty expressing thoughts (e.g., gets “tongue-tied”)
Self-Report Items
1. I am slow at doing things
2. My mind feels like it is in a fog
3. I stare off into space
4. I feel sleepy or drowsy during the day
5. I daydream
6. I lose my train of thought
7. I am not very active
8. I get lost in my own thoughts
9. I get tired easily
10. I forget what I was going to say
11. I feel confused
12. I zone or space out
13. My mind gets mixed up
14. My thinking seems slow or slowed down
15. I have hard time putting my thoughts into words

adolescents. In addition, although two earlier studies examined the psychometric properties an earlier version of the parent-report rating scale measure with South Korean children (Lee, Burns, & Becker, 2017, 2018), no study have examined the psychometric properties of the new 15-item parent rating scale with South Korean parents. It is thus unknown if the findings from United States adolescents with the 15-item self-report measure of SCT will generalize to South Korean adolescents, or whether the findings from United States and Spanish parents with the 15-item parent-report measure of SCT will generalize to parents of South Korean adolescents. In addition, Korean adolescents are under tremendous academic pressure and stress due to preparation of the college entrance exam and are highly susceptible to psychological difficulties (Kim, Kim, & Jung, 2014a). These pressures could

¹ The SCT item *lacks motivation to complete tasks* (e.g., *apathetic*) consistently showed a stronger loading on the ADHD-IN than the SCT factor, thus this item was not retained in the final set of 15 SCT items shown in Table 1.

extend to the domain of SCT, and a community-based study of adults has found SCT symptoms to be uniquely associated with greater stress (Combs, Canu, Broman-Fulks, Rocheleau, & Nieman, 2015). It is thus important to examine the construct and transcultural validity of the SCT construct within South Korean adolescents.

Objectives

To further examine the validity of the scores from the 15-item self- and parent-report measures of SCT, the objectives of the current study were to determine (1) the convergent and discriminant validity of self-reported and parent-rated SCT and ADHD-IN symptoms in South Korean adolescents; (2) the correlations of self-reported and parent-rated SCT and ADHD-IN with self-reported and parent-rated internalizing, externalizing, and social problems as well as grades; and (3) the unique associations of self-reported and parent-rated SCT and ADHD-IN with self-reported and parent-rated internalizing problems, externalizing problems, and social problems as well as grades for South Korean adolescents. The hypotheses were:

1. Based on the earlier study with the 15-item SCT self-report measure with adolescents in the United States (Becker et al., 2020), we expected that 13 of the 15 SCT items would demonstrate convergent and discriminant validity with adolescent self-reported ADHD-IN (SCT items *I am slow at doing things* and *I am not very active* were expected to have poor convergent validity as well as weak discriminant validity with ADHD-IN given the results from Becker et al. (2020). In contrast, all 15 SCT items on the parent-rated SCT measure were expected to show convergent and discriminant validity from parent-rated ADHD-IN (Becker, Burns, et al., 2019a; Burns & Becker, 2019; Sáez, Servera, Becker, et al., 2019a).

2. Given earlier findings for the adolescent self-report and parent-rated SCT measure (e.g., Becker et al., 2020; Burns & Becker, 2019; Sáez, Servera, Becker, et al., 2019a; Servera et al., 2018), we expected adolescent self-report and parent-ratings of SCT to have stronger correlations than ADHD-IN with internalizing psychopathology whereas ADHD-IN would have stronger correlations than SCT with externalizing psychopathology. SCT and ADHD-IN were hypothesized to have equal correlations with social problems, self-esteem, and grades. These hypotheses were for within source correlations (adolescent self-report of SCT and ADHD-IN to adolescent self-report measures; parent-rated SCT and ADHD-IN to parent-rated measures). The across-source correlations were expected to be much smaller with these correlations being more exploratory (e.g., Would the across source correlations show the same pattern of findings as the within source correlations?).

3. Given the findings from the four earlier studies with the 15 item adolescent self-report and parent-rating SCT measures (Becker et al., 2020; Burns & Becker, 2019; Sáez, Servera, Becker, et al., 2019a; Servera et al., 2018), we hypothesized that SCT would have a stronger unique associations than ADHD-IN with internalizing psychopathology whereas ADHD-IN would have a stronger unique association than SCT with externalizing psychopathology as well as grades. The unique associations of SCT and ADHD-IN with social problems and self-esteem were expected to be similar. The across-source unique associations were expected to be much smaller with these analyses being more exploratory (e.g., Would the across source unique associations be similar to the within source unique associations?).

Methods

Participants and Procedures

With approval of the schools and university IRB, 600 adolescents and their parents were invited to participate from three schools (7th–11th grades, ages 13–17 years) in the cities of Namyangju, Uijeongbu, and Incheon, South Korea. Participation was voluntary and anonymous. Information was available on 469 unique adolescents (466 adolescent self-report ratings, 358 mother, 35 father, and 7 other caretaker ratings; 50.2% boys with 98% Korean and <2% from multinational families). There were 77, 87, 87, 112, and 95 adolescents in the seventh, eighth, ninth, tenth, and eleventh grades, respectively (grade information was missing for 8 students). Socioeconomic status was not collected for the families.

Measures

Adolescents and parents both completed a number of measures. Supplemental Table S2 shows the descriptive information for all the measures.

Child Concentration Inventory, Second Edition (CCI-2)

Adolescents completed the CCI-2 (Becker, 2015). SCT items were rated on a four-point scale (0 = never, 1 = sometimes, 2 = often, and 3 = always). Initially comprised of 16 items, one item related to motivation failed to show discriminant validity in previous studies using adult ratings (Becker, Burns, et al., 2019a; Sáez, Servera, Becker, et al., 2019a) and self-report ratings (Becker et al., 2020) and was therefore not used in this study, resulting in a 15-item SCT scale.

Two advanced child psychology students translated the SCT measures for youth and parents from English to Korean and two individuals with English fluency and psychological knowledge back-translated the measures. One of the authors with advanced degrees in child-clinical

psychology with previous experience in the translation of parent and teacher rating scales from English to Korean also participated in a translation and back-translation process. In addition, given the importance of a meaningful translation of SCT symptoms, seven seventh graders and three eighth graders were asked to rate the clarity of the SCT symptoms (1 = very confusing to 5 = perfectly clear). The 15 SCT items were rated at least “very clear” ($M = 4.15$) and, subsequently, only a few changes were made to improve clarity. Recent studies with Spanish children and United States adolescents with and without ADHD provide initial support for the reliability and validity of scores from the CCI-2 (Becker et al., 2020; Becker, Epstein, et al., 2019b; Sáez, Servera, Burns, et al., 2019b). The reliability coefficient (α) for the 15 self-report SCT items was .90 in this sample. Table 1 shows the 15 SCT items on the self-report measure, and the Korean translation is available from the authors.

Child and Adolescent Behavior Inventory (CABI) SCT Module

The SCT module from the CABI has 16 SCT items (Burns, Lee, Servera, McBurnett, & Becker, 2015). However, as noted above, one item related to motivation was not used in this study given its failure to demonstrate discriminant validity in previous studies (Becker, Burns, et al., 2019a; Burns & Becker, 2019; Sáez, Servera, Becker, et al., 2019a). Parents rated the remaining 15 items on a six-point scale (0 = almost never [never or about once per month] to 5 = almost always [many times per day]). Recent research supports the reliability and validity of the scores on the SCT scale symptoms (Becker, Burns, et al., 2019a; Burns & Becker, 2019; Sáez, Servera, Becker, et al., 2019a). Earlier studies with a 10-item version of the SCT scale also found support for the reliability and validity scores with Korean preschoolers and children (Lee et al., 2017, 2018). The α for scores on the 15 SCT items was .92. Table 1 shows the 15 SCT items on the parent rating scale measure, and the Korean translation is available from the authors.

ADHD Self-Report and Parent-Report Rating Scales

Adolescents reported the occurrence of the nine ADHD-IN and nine ADHD-HI symptoms on a four-point scale (0 = never to 3 = always) (We & Chae, 2004). The scores from this ADHD rating scale have demonstrated adequate psychometric properties with Korean children (We & Chae, 2004). The α values for the ADHD-IN and ADHD-HI scores were .83 and .85, respectively, in this study. Parents also rated the occurrence of the nine ADHD-IN and nine ADHD-HI items on a 4-point scale (0 = never or rarely to 3 = very often) (DuPaul et al., 1998). An earlier study with Korean children provided support for the psychometric properties of this scale (Kim et al., 2003). Cronbach’s α for the ADHD-IN and ADHD-HI scores were .88 and .83, respectively, in the present study.

Supplemental Table S1 shows the 9 ADHD-IN items on the self-report and parent-report measures.

Korean-Beck Depression Inventory, Second Edition (K-BDI-II)

Adolescents completed the K-BDI-II (Beck, Steer, & Brown, 1996). The 21 symptoms were rated on a four-point scale (e.g., 0 = *I do not feel sad* to 3 = *I am so sad*). Scores from this scale have been validated in Korea (Kim, Lee, Hwang, & Hong, 2014b). The α value for K-BDI-II in this study was .90.

Korean-Youth Self-Report (K-YSR)

The Anxious/Depressed (13 items), Withdrawn/Depressed (7 items), Somatic Complains (10 items), Social Problems (11 items), Rule-Breaking Behavior (15 items), Aggressive Behavior (17 items), and the ODD (5 items) scales of the YSR were used in the current study (Achenbach & Rescorla, 2001). Three items of K-YSR were excluded due to overlap with SCT items (i.e., feel confused or in a fog, daydreams a lot, and don’t have much energy). Adolescents rated the occurrence of each item on a three-point scale (0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true). The YSR has been validated in Korea (Oh, Kim, Ha, Lee, & Hong, 2010). In this study, α was .85, .73, .81, .73, .75, .83, and .68 for the scores on the Anxious/Depressed, Withdrawn/Depressed, Somatic Complains, Social Problems, Rule-Breaking Behavior, Aggressive Behavior, and ODD subscales, respectively.

Korean-Child Behavior Checklist for Ages 6–18 (K-CBCL 6–18)

The Anxious/Depressed (13 items), Withdrawn/Depressed (7 items), Somatic Complains (11 items), Social Problems (11 items), Rule-breaking Behavior (17 items), Aggressive Behavior (18 items), and ODD (5 items) scales of the CBCL 6–18 were used in the current study (Achenbach & Rescorla, 2001). Four items were excluded due to overlap with SCT items (i.e., confused or seems to be in a fog, daydreams or gets lost in his/her thought, stares blankly, and underactive, slow moving, or lacks energy).² Parents rated the occurrence of each item on a three-point scale (0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true) with scores from the CBCL having been validated in Korea (Oh et al., 2010). In this study, α was .77, .71, .68, .69, .53, .76, and .63 for the scores on the Anxious/Depressed, Withdrawn/Depressed, Somatic Complains, Social Problems, Rule-breaking Behavior, Aggressive Behavior, and ODD subscales, respectively.

² The correlations of youth self-reported of the 11 SCT symptoms with the 3 YSR SCT items and 4 CBCL SCT items were .55 ($p < .001$) and .22 ($p < .001$), respectively. The correlations of the 15 parent-reported SCT symptoms with the 4 CBCL SCT items and 3 YSR SCT items were .51 ($p < .001$) and .17 ($p < .01$), respectively. The correlation of the 3 YSR SCT items with the 4 CBCL SCT items was .21 ($p < .001$).

Rosenberg Self-Esteem Scale (RSES) The RSES (Rosenberg, 1965) was used to measure adolescents' self-reported self-esteem. The 10 items were rated on a four-point scale (1 = strongly disagree to 4 strongly agree) with the scores from the scale having been validated in Korea (Lee, Nam, Lee, Lee, & Lee, 2009). The α was .83 in this sample.

School Grades Adolescents were asked their average school grade based on a three-point scale (0 = below 40 scores, 1 = 50 to 70 scores, 2 = above 70 scores). Higher scores indicate better grades.

Analytic Strategy

All primary analyses were conducted in Mplus v.8.3 (Muthén & Muthén, 1998–2018). An a priori SCT and ADHD-IN two-factor model was applied to the 15 SCT items and 9 ADHD-IN items adolescent self-report and parent ratings (a separate analysis for adolescent self-report and parent-ratings). Items were allowed to have cross-loadings. The purpose was to identify SCT symptoms with substantial loadings on the SCT factor (convergent validity) and substantially higher loadings on the SCT factor than the ADHD-IN factor (discriminant validity). SCT items were required to load higher than .50 on the SCT factor and lower than .30 on the ADHD-IN factor to be retained as indicators of the SCT construct. This analysis treated SCT and ADHD-IN item ratings as ordered categories and used the robust weighted least squares (WLSMV) estimator (Mplus v.8.3) (Muthén & Muthén, 1998–2018). The second set of analyses calculated the correlations of the SCT and ADHD-IN measures with the other symptom and impairment measures within and across sources. The third set of analyses determined the unique associations of the SCT and ADHD-IN measures with the other symptom and impairment measures within and across sources (i.e., the regression of the symptom and impairment measures on the SCT and ADHD-IN measures). The second and third analyses treated the measures as manifest variables rather than latent variables due to the large number of items relative to sample size. The correlation and regression analyses used the robust maximum likelihood estimator (MLR estimator). Covariance coverage was 83% or higher for the items so there were few items left blank. The MLR estimator retains all participants. The Mplus model constraint procedure was used to determine if correlations and regression coefficients differed significantly.

Results

Convergent and Discriminant Validity of SCT and ADHD-IN Symptoms

Adolescent Self-Report SCT items 2, 3, 4, 5, 6, 7, 8, 9, 10, 12 and 13 showed convergent validity (loadings from 0.53 to 0.86 on SCT factor, $M = .73$, $SD = .05$) and discriminant

validity (loadings from -0.28 to 0.19 on ADHD-IN factor, $M = -.03$, $SD = .06$). These 11 SCT items had an α of .87. SCT items *I am slow at doing things*, *I feel confused*, *My mind seems slow or slowed down*, and *I have a hard time putting my thoughts into words* failed to show convergent and discriminant validity. The nine ADHD-IN symptoms also showed reasonable to good convergent validity (loadings from 0.41 to 0.80 on ADHD-IN factor, $M = .59$, $SD = .06$) and discriminant validity (loadings from -0.09 to 0.30 on SCT factor, $M = .10$, $SD = .06$). All nine ADHD-IN items were retained for subsequent analyses to be consistent with the validated ADHD self-report scale in Korea as well as the DSM ADHD-IN symptoms, although loadings of two ADHD items were not higher than .50. Table 2 shows these results.

Parents Ratings All 15 SCT items showed convergent validity (loadings from 0.54 to 0.86 on SCT, $M = .75$, $SD = .05$) and discriminant validity (loadings from -0.13 to 0.23 on ADHD-IN, $M = .01$, $SD = .06$). The nine ADHD-IN symptoms also showed convergent validity (loadings from 0.66 to 0.88 on ADHD-IN, $M = .77$, $SD = .06$) and discriminant validity (loadings from -0.14 to 0.16 on SCT, $M = .02$, $SD = .06$). Table 2 shows these results.

Correlations of SCT and ADHD-IN with Other Symptom and Impairment Dimensions

Adolescent Self-Report Measures to Adolescent Self-Report Measures Higher SCT and ADHD-IN were significantly ($ps < .01$) associated with higher ADHD-HI, ODD, Rule-Breaking Behavior, Aggressive Behavior, depression (BDI), Anxiety/Depression, Withdrawal/Depression, Somatic Complaints, and Social Problems as well as lower self-esteem and lower grades. SCT had significantly ($ps < .05$) higher correlations than ADHD-IN with depression (BDI), Withdrawal/Depression, and Somatic Complaints while ADHD-IN had significantly ($ps < .01$) higher correlations than SCT with ADHD-HI, ODD, and Aggressive Behavior. SCT and ADHD-IN did not differ significantly ($ps > .05$) in their associations with Anxiety/Depression, Rule-Breaking Behavior, Social Problems, self-esteem, and grades. Table 3 shows these correlations.

Parent Rating Measures to Parent Rating Measures Higher SCT and ADHD-IN were associated with significantly ($ps < .01$) higher ADHD-HI, ODD, Rule-Breaking Behavior, Aggressive Behavior, Anxiety/Depression, Withdrawal/Depression, Somatic Complaints, and Social Problems. SCT had a significantly ($p < .05$) larger correlation than ADHD-IN with Anxiety/Depression with the difference for Withdrawal/Depression marginal ($p = .06$). ADHD-IN had a significantly ($p < .001$) larger correlation than SCT with ADHD-HI. All other correlations did not differ significantly. Table 4 shows these correlations.

Table 2 Exploratory Factor Analyses of SCT and ADHD-Inattention (ADHD-IN)

Item	Adolescent Self-Report		Parent-Report	
	Factor 1 SCT	Factor 2 ADHD-IN	Factor 1 SCT	Factor 2 ADHD-IN
SCT1	.39***	.28***	.68***	-.01
SCT2	.82***	-.12*	.78***	.03
SCT3	.82***	-.18**	.86***	-.07
SCT4	.86***	-.28***	.66***	-.07
SCT5	.77***	-.13*	.78***	-.06
SCT6	.59***	.16**	.76***	.03
SCT7	.63***	.01	.69***	-.14
SCT8	.67***	.04	.83***	-.13
SCT9	.75***	-.09	.78***	-.10
SCT10	.53***	.19**	.71***	.08
SCT11	.45***	.34***	.85***	.03
SCT12	.85***	-.01	.77***	.14**
SCT13	.75***	.02	.82***	.06
SCT14	.44***	.34***	.76***	.10
SCT15	.33***	.41***	.54***	.23**
ADHD-IN1	.14**	.55***	.06	.73***
ADHD-IN2	.12*	.59***	.02	.82***
ADHD-IN3	.02	.68***	.16*	.67***
ADHD-IN4	.01	.73***	-.06	.88***
ADHD-IN5	-.09	.80***	.04	.80***
ADHD-IN6	.07	.62***	.09	.66***
ADHD-IN7	.16*	.41***	-.14*	.83***
ADHD-IN8	.19**	.51***	.05	.70***
ADHD-IN9	.30***	.47***	-.03	.82***

Note. SCT and ADHD-IN items in bold showed convergent and discriminant validity. SCT = sluggish cognitive tempo; ADHD-IN = attention-deficit/hyperactivity disorder inattention

* $p < .05$, ** $p < .01$, *** $p < .001$,

Adolescent Self-Report Measures to Parent Rating Measures

Higher adolescent SCT was associated with significantly ($ps < .05$) higher parent-rated Withdrawal/Depression, ODD, Aggressive Behavior, and Social Problems, while higher adolescent ADHD-IN was associated with significantly ($ps < .05$) higher parent-rated ADHD-HI, ODD, Aggressive Behavior, Withdrawal/Depression, and Social Problems. The correlation of adolescent ADHD-IN with parent ADHD-HI was significantly ($p < .05$) larger than the correlation of adolescent SCT with parent ADHD-HI. Table 3 shows these correlations.

Parent Rating Measures to Adolescent Self-Report Measures

Higher parent SCT was associated with significantly ($ps < .05$) higher adolescent depression (BDI), Anxiety/Depression, Withdrawal/Depression, Somatic Complaints, ODD, Aggressive Behavior, Social Problems, and lower

Table 3 Correlations of Adolescent Self-Report SCT and ADHD-IN Measures with Other Symptom and Impairment Measures

	Adolescent SCT		Adolescent ADHD-IN	
	<i>r</i>	<i>SE</i>	<i>r</i>	<i>SE</i>
<i>Adolescent Self-Report Measures</i>				
ADHD-HI	.48***a	.04	.65***b	.04
BDI	.63***a	.04	.55***b	.04
YSR ADEP	.47***a	.04	.43***a	.04
YSR WDEP	.50***a	.04	.40***b	.04
YSR SOMA	.47***a	.04	.34***b	.05
YSR RULE	.31***a	.04	.39***a	.05
YSR AGG	.41***a	.04	.54***b	.04
YSR ODD	.35***a	.04	.46***b	.04
YSR SP	.46***a	.04	.49***a	.04
Self-esteem	-.44***a	.04	-.40***a	.04
Grades	-.14***a	.05	-.21***a	.05
<i>Parent-Rated Measures</i>				
ADHD-HI	.11 ^a	.07	.21***b	.06
CBCL ADEP	.10 ^a	.05	.09 ^a	.05
CBCL WDEP	.11***a	.05	.12***a	.05
CBCL SOMA	.08 ^a	.05	.03 ^a	.05
CBCL RULE	.05 ^a	.04	.08 ^a	.05
CBCL AGG	.12***a	.05	.18***a	.05
CBCL ODD	.13***a	.05	.16***a	.05
CBCL SP	.11***a	.05	.17***a	.05

Note. Row correlations with different superscripts significantly at $p < .05$. Correlations without an * were non-significant ($p > .05$). SCT = sluggish cognitive tempo; ADHD-IN = attention-deficit hyperactivity disorder-inattention; ADHD-HI = attention-deficit hyperactivity disorder-hyperactivity/impulsivity; BDI = Beck Depression Inventory; YSR = Youth Self Report; CBCL = Child Behavior Checklist; ADEP = Anxious/Depressed; WDEP = Withdrawn/Depressed; SOMA = Somatic Complaints; SP = Social Problems; RULE = Rule-Breaking Behavior; AGG = Aggressive Behavior; ODD = Oppositional Defiant Disorder

* $p < .05$, ** $p < .01$

self-esteem along with lower grades. Higher ADHD-IN was associated with significantly ($ps < .05$) higher adolescent ADHD-HI, ODD, Rule-Breaking Behavior, Aggressive Behavior, depression (BDI), Withdrawal/Depression, Somatic Complaints, Social Problems, and lower self-esteem along with lower grades. Parent ADHD-IN had a significantly larger correlation than parent SCT with adolescent ADHD-HI ($p < .001$) and grades ($p < .05$). Table 4 shows these correlations.

Unique Associations of SCT and ADHD-IN with Other Symptom and Impairment Dimensions

Tables 5 and 6 show the unique standardized associations of adolescent self-report and parent ratings of SCT and ADHD-

Table 4 Correlations of Parent-Rated SCT and ADHD-IN Measures with Other Symptom and Impairment Measures

	Parent-Rated SCT		Parent-Rated ADHD-IN	
	<i>r</i>	<i>SE</i>	<i>r</i>	<i>SE</i>
<i>Adolescent Self-Report Measures</i>				
ADHD-HI	.12 ^a	.06	.27 ^{**b}	.06
BDI	.22 ^{**a}	.05	.22 ^{**a}	.05
YSR ADEP	.11 ^{*a}	.05	.08 ^a	.05
YSR WDEP	.17 ^{**a}	.05	.12 ^{**a}	.05
YSR SOMA	.11 ^{*a}	.05	.09 ^{*a}	.04
YSR RULE	.10 ^a	.06	.16 ^{*a}	.06
YSR AGG	.14 ^{*a}	.05	.20 ^{**a}	.05
YSR ODD	.11 ^{*a}	.05	.19 ^{**a}	.05
YSR SP	.13 ^{*a}	.05	.17 ^{**a}	.05
Self-esteem	−.14 ^{**a}	.05	−.14 ^{**a}	.05
Grades	−.16 ^{**a}	.05	−.27 ^{**b}	.05
<i>Parent-Rated Measures</i>				
ADHD-HI	.51 ^{**a}	.05	.74 ^{**b}	.03
CBCL ADEP	.40 ^{**a}	.05	.31 ^{**b}	.05
CBCL WDEP	.41 ^{**a}	.05	.33 ^{**a}	.05
CBCL SOMA	.24 ^{**a}	.05	.16 ^{**a}	.05
CBCL RULE	.29 ^{**a}	.08	.30 ^{**a}	.07
CBCL AGG	.43 ^{**a}	.06	.42 ^{**a}	.06
CBCL ODD	.39 ^{**a}	.05	.41 ^{**a}	.06
CBCL SP	.39 ^{**a}	.05	.45 ^{**a}	.06

Note. Row correlations with different superscripts significantly at $p < .05$. Correlations without an * were non-significant ($p > .05$). SCT = sluggish cognitive tempo; ADHD-IN = attention-deficit hyperactivity disorder-inattention; ADHD-HI = attention-deficit hyperactivity disorder-hyperactivity/impulsivity; BDI = Beck Depression Inventory; YSR = Youth Self Report; CBCL = Child Behavior Checklist; ADEP = Anxious/Depressed; WDEP = Withdrawn/Depressed; SOMA = Somatic Complains; SP = Social Problems; RULE = Rule-Breaking Behavior; AGG = Aggressive Behavior; ODD = Oppositional Defiant Disorder

* $p < .05$, ** $p < .01$

IN with adolescent self-report and parent ratings of the other symptom and impairment dimensions.

Adolescent Self-Report Measures to Adolescent Self-Report Measures Higher levels of SCT and ADHD-IN both had unique associations ($ps < .01$) with higher levels ADHD-HI, Aggressive Behavior, depression (BDI), Anxiety/Depression, Withdrawal/Depression, and Social Problems, and lower self-esteem. Only higher levels of SCT were uniquely associated with higher levels of Somatic Complains, while only higher levels ADHD-IN were uniquely associated with higher ODD and Rule-breaking Behavior and lower grades ($ps < .01$). SCT had significantly stronger unique associations than ADHD-IN with depression (BDI), Withdrawal/Depression, and Somatic Complains ($ps < .05$), while ADHD-IN had significantly

stronger associations than SCT with ADHD-HI, ODD, Rule-Breaking Behavior, and Aggressive Behavior ($ps < .01$).

Parent Rating Measures to Parent Rating Measures Higher SCT and ADHD-IN were both uniquely associated with higher ODD, Aggressive Behavior, and Social Problems ($ps < .05$). Higher levels SCT had unique associations with higher levels of Anxiety/Depression, Withdrawal/Depression, and Somatic Complains while ADHD-IN did not have a significant unique association with these measures. In contrast, higher levels of ADHD-IN had unique associations with higher levels ADHD-HI and Rule-Breaking Behavior ($ps < .01$), while SCT did not have a significant unique association with these measures. In addition, SCT had significantly stronger unique associations than ADHD-IN with Anxiety/Depression and Withdrawal/Depression ($ps < .05$), while ADHD-IN had a significantly stronger unique association than SCT with ADHD-HI ($p < .001$).

Adolescent Self-Report Measures to Parent Ratings Measures Adolescent-rated SCT was not uniquely associated with any of the parent-rated symptom and impairment dimensions ($ps > .05$) while adolescent ADHD-IN was uniquely associated with parent-rated ADHD-HI, Aggression, ODD, and social problems ($ps < .05$). In addition, adolescent-rated ADHD-IN had a significantly stronger association than adolescent-rated SCT with parent-rated ADHD-HI ($p < .05$).

Parent Rating Measures to Adolescent Self-Report Measures Higher levels of parent-rated SCT and ADHD-IN were both uniquely associated with higher levels of adolescent-rated depression ($ps < .05$). In contrast, only parent-rated SCT was uniquely associated with adolescent-rated withdrawn/depressed ($p < .05$) with only parent-rated ADHD-IN being uniquely associated with adolescent-rated ADHD-HI, ODD, Rule-Breaking Behavior, Aggression, Social Problems, and grades. Parent-rated ADHD-IN had significantly stronger unique associations than parent-rated SCT with adolescent-rated ADHD-HI, ODD, and grades ($ps < .05$).

Discussion

The purpose of the present study was to further examine the psychometric properties of a 15-item measure of SCT. Earlier studies with Spanish and American mother, father, and teacher ratings of children with the 15-item SCT measure provided strong support for the psychometric properties of the scores from the measure (Becker, Burns, et al., 2019a; Burns & Becker, 2019; Sáez, Servera, Becker, et al., 2019a; Servera et al., 2018) with the Burns and Becker (2019) study also providing normative information for a nationally representative sample of United States children. However, no published

Table 5 Standardized Unique Associations of Adolescent Self-Report SCT and ADHD-IN with Other Symptom and Impairment Measures

	Adolescent SCT		Adolescent ADHD-IN	
	β	SE	β	SE
<i>Adolescent Self-Report Measures</i>				
ADHD-HI	.13 ^{**a}	.05	.57 ^{***b}	.05
BDI	.46 ^{***a}	.05	.27 ^{***b}	.05
YSR ADEP	.33 ^{***a}	.05	.22 ^{***a}	.06
YSR WDEP	.40 ^{***a}	.05	.16 ^{**b}	.06
YSR SOMA	.43 ^{***a}	.05	.07 ^b	.06
YSR RULE	.11 ^a	.06	.32 ^{***b}	.06
YSR AGG	.13 ^{**a}	.05	.45 ^{***b}	.05
YSR ODD	.11 ^a	.05	.40 ^{***b}	.06
YSR SP	.25 ^{***a}	.05	.34 ^{***a}	.05
Self-esteem	-.31 ^{***a}	.05	-.21 ^{***a}	.05
Grades	-.02 ^a	.06	-.20 ^{***a}	.06
<i>Parent-Rated Measures</i>				
ADHD-HI	-.04 ^a	.07	.21 ^{**b}	.06
CBCL ADEP	.06 ^a	.06	.04 ^a	.06
CBCL WDEP	.05 ^a	.06	.09 ^a	.07
CBCL SOMA	.09 ^a	.07	-.01 ^a	.07
CBCL RULE	.01 ^a	.04	.07 ^a	.05
CBCL AGG	.02 ^a	.06	.16 ^{**a}	.06
CBCL ODD	.04 ^a	.06	.13 ^{**a}	.06
CBCL SP	.02 ^a	.06	.16 ^{**a}	.07

Note. Row regression coefficients with different superscripts significantly at $p < .05$. Regression coefficients without an * were non-significant ($p > .05$). SCT = sluggish cognitive tempo; ADHD-IN = attention-deficit hyperactivity disorder-inattention; ADHD-HI = attention-deficit hyperactivity disorder-hyperactivity/impulsivity; BDI = Beck Depression Inventory; YSR = Youth Self Report; CBCL = Child Behavior Checklist; ADEP = Anxious/Depressed; WDEP = Withdrawn/Depressed; SOMA = Somatic Complaints; SP = Social Problems; RULE = Rule-Breaking Behavior; AGG = Aggressive Behavior; ODD = Oppositional Defiant Disorder

* $p < .05$, ** $p < .01$, *** $p < .001$

study has used the 15-item measure with parent/teacher ratings of adolescents let alone within an Asian culture such as South Korea, leaving it unknown if scores from this measure would demonstrate similar psychometric properties with parent ratings of South Korean adolescents. In addition, only one study has examined the psychometric properties of the 15-item self-report measure with adolescents, using an American sample (Becker et al., 2020). Given the importance of multisource assessment of SCT symptoms, especially with adolescents where self-report and parent/teacher-ratings often yield unique information (De Los Reyes et al., 2015), it was important to further examine the psychometric properties of the scores from the 15-item SCT measure with self-report and parent-report ratings with South Korean adolescents. There is

Table 6 Standardized Unique Associations of Parent-Rated SCT and ADHD-IN with Other Symptom and Impairment Measures

	Parent-Rated SCT		Parent-Rated ADHD-IN	
	β	SE	β	SE
<i>Adolescent Self-Report Measures</i>				
ADHD-HI	-.09 ^a	.06	.33 ^{***b}	.06
BDI	.12 ^{*a}	.06	.14 ^{*a}	.07
YSR ADEP	.10 ^a	.06	.02 ^a	.06
YSR WDEP	.15 ^{*a}	.07	.03 ^a	.06
YSR SOMA	0.09 ^a	.06	.03 ^a	.06
YSR RULE	.01 ^a	.08	.16 ^{*a}	.07
YSR AGG	.02 ^a	.07	.20 ^{**a}	.06
YSR ODD	-.02 ^a	.06	.20 ^{**b}	.06
YSR SP	.03 ^a	.06	.16 ^{*a}	.06
Self-esteem	-.09 ^a	.07	-.08 ^a	.07
Grades	.03 ^a	.07	-.29 ^{***b}	.07
<i>Parent-Rated Measures</i>				
ADHD-HI	.07 ^a	.05	.70 ^{***b}	.05
CBCL ADEP	.33 ^{***a}	.06	.10 ^b	.07
CBCL WDEP	.34 ^{***a}	.07	.12 ^b	.07
CBCL SOMA	.23 ^{***a}	.07	.03 ^a	.07
CBCL RULE	.16 ^a	.09	.21 ^{**a}	.08
CBCL AGG	.26 ^{***a}	.06	.26 ^{***a}	.07
CBCL ODD	.21 ^{**a}	.06	.28 ^{***a}	.07
CBCL SP	.16 ^{*a}	.07	.35 ^{***a}	.08

Note. Row regression coefficients with different superscripts significantly at $p < .05$. Regression coefficients without an * were non-significant ($p > .05$). SCT = sluggish cognitive tempo; ADHD-IN = attention-deficit hyperactivity disorder-inattention; ADHD-HI = attention-deficit hyperactivity disorder-hyperactivity/impulsivity; BDI = Beck Depression Inventory; YSR = Youth Self Report; CBCL = Child Behavior Checklist; ADEP = Anxious/Depressed; WDEP = Withdrawn/Depressed; SOMA = Somatic Complaints; SP = Social Problems; RULE = Rule-Breaking Behavior; AGG = Aggressive Behavior; ODD = Oppositional Defiant Disorder

* $p < .05$, ** $p < .01$, *** $p < .001$

also an important need to examine SCT in different cultural contexts (Becker, 2019), and the current study further extends the limited research examining the transcultural validity of SCT in Asian cultures (e.g., Khadka, Burns, & Becker, 2016; Lee et al., 2017, 2018; Takeda, Burns, Jiang, Becker, & McBurnett, 2019) by being the first study to examine adolescent- and parent-report of SCT among South Korean adolescents.

Internal Validity of the SCT Measures

For parent ratings of the adolescents, all 15 of the SCT symptoms showed convergent validity (strong loadings on the SCT factor) along with discriminant validity (much higher loadings on the

SCT factor than the ADHD-IN factor). These results with the South Korean parents rating adolescents thus replicated and extended the convergent and discriminant validity results with teachers (Becker, Burns, et al., 2019a) and mothers (Burns & Becker, 2019) rating children from the United States as well as mothers, fathers, and teachers rating children from Spain (Sáez, Servera, Becker, et al., 2019a). Given the different cultures, languages, and samples (adolescents vs. children), it is encouraging to find such consistent results for the 15-item SCT measure.

For adolescent self-report, 11 of the 15 SCT symptoms showed substantial loadings on the SCT factor along with substantially higher loadings on the SCT factor than the ADHD-IN factor. The four items that failed to show adequate convergent and discriminant validity were: (1) *I am slow at doing things*; (2) *I feel confused*; (3) *My thinking seems slow or slowed down*; and (4) *I have hard time putting my thoughts into words*. The earlier study with American adolescents also found two of the SCT symptoms (i.e., *I am slow at doing things*, *I am not very active*) lacked convergent and discriminant validity with ADHD-IN (Becker et al., 2020). In addition, an earlier study with the 15-item self-report SCT measure with college students found three of these same items (i.e., *I am slow at doing things*, *My thinking seems slow or slowed down*, *I have hard time putting my thoughts into words*) to lack convergent and discriminant validity with ADHD-IN and internalizing symptoms (Becker, Burns, Garner, et al., 2018a). Using a different self-report SCT scale, a study of adults in Japan also found that items related to confusion and slow information processing lacked convergent and discriminant validity with ADHD-IN (Takeda et al., 2019).

The findings across these self-report studies, including the present study with adolescents from South Korea and previous studies of adolescents and college students from the United States as well as adults from Japan, indicate that four of the 15 SCT symptoms may not be optimal items for self-report measures (*I am slow at doing things*, *My thinking seems slow or slowed down*, *I feel confused*, and *I have hard time putting my thoughts into words*). One possibility is that individuals have more difficulty in the self-evaluation of these symptoms since these four symptoms have consistently shown convergent and discriminant validity with mother, father, and teacher ratings South Korea, Spain, and the United States (the current study in addition to Becker, Burns, et al., 2019a; Burns & Becker, 2019; and Sáez, Servera, Becker, et al., 2019a). Of note, all of these items have to do with slowness and mental confusion, which may be especially apparent to others but perhaps less apparent to individuals themselves. Another possibility is that the wording of these symptoms could be improved to reduce any potential stigma associated with the endorsement of these four SCT symptoms. Future studies might thus try to improve the wording of these SCT items in the self-report measure (e.g., qualitative research with adolescents and adults to better understand the meaning of these SCT behaviors for them and how they are personally experienced).

External Validity of the SCT Measures

The external validity results for the adolescent self-report SCT measure and the parent-report SCT measure were remarkably similar even though the self-report measure contained 11 SCT items and the parent-report measure contained 15 SCT items. For the adolescent to adolescent correlations as well as unique effects from the regression analyses, SCT demonstrated stronger as well as more unique associations than ADHD-IN with internalizing psychopathologies whereas ADHD-IN showed stronger as well as more unique associations than SCT with externalizing psychopathologies. The same findings occurred for parent-rating of SCT and ADHD-IN with the parent-rating measures of internalizing and externalizing psychopathologies. Although the effects were weaker, there was still a tendency for this same pattern of findings to occur across sources. SCT and ADHD-IN thus demonstrated unique external correlates within and across sources with such being important for the advancement of the transcultural validity of the SCT. Together, these findings demonstrate that SCT and ADHD-IN, which are themselves strongly correlated, differentially relate to the internalizing and externalizing spectra of psychopathology. These findings echo previous research and have implications for how to best conceptualize SCT within hierarchical models of psychopathology, with our study adding to a growing body of research suggesting that SCT may optimally be conceptualized within the internalizing spectra of psychopathology (Becker & Willcutt, 2019). These findings again emphasize the importance of consistently investigating internal and external validity of SCT in relation to ADHD-IN in order to better understand the importance of SCT for assessment and treatment (Barkley, 2012; Becker, 2019; Becker, Leopold, et al., 2016b).

ADHD-IN had a stronger unique relationship than SCT with grades. Previous studies have reported mixed findings as to whether SCT symptoms (Becker, Langberg, Luebbe, Dvorsky, & Flannery, 2014a) or ADHD-IN symptoms (Willcutt et al., 2014) are more strongly associated with grades. Though additional studies are needed, particularly using data pulled from school records, findings from the present study align with a large body of research showing ADHD inattentive symptoms to have a particularly strong association with academic impairment, including lower grades (Willcutt et al., 2012).

SCT and South Korean Academic Culture

Overall the pattern of findings in the present study of South Korean adolescents aligns with previous SCT-focused research which has been primarily conducted in Europe and North America. However, what has yet to be examined is whether SCT symptoms are similarly or differentially related to functioning across cultural contexts. In South Korea,

adolescents spend most of their school day in the same classroom, which contributes to a smaller peer network of closer friends compared to extensive peer networks often experienced in Australia, European, and North American cultures (Kim, Rapee, Ja Oh, & Moon, 2008). In addition, shyness is not viewed as undesirable in the Korean context as it is in more strongly individualistic cultures, and shyness is likewise not as clearly associated with poorer functioning among South Korean adolescents (Kim et al., 2008). SCT symptoms are strongly associated with both shyness and social withdrawal (Becker, Garner, Tamm, Antonini, & Epstein, 2019c; Marshall, Evans, Eiraldi, Becker, & Power, 2014; Sáez, Servera, Becker, et al., 2019a; Willcutt et al., 2014), and it will be especially important to examine whether SCT has similar associations with these domains in South Korean adolescents. Given the nature of SCT, which includes nondisruptive behaviors that may be perceived as less problematic in the South Korean culture, it is possible that SCT may not be as strongly associated with functional impairment in South Korea compared to other cultural contexts. Conversely, South Korean adolescents experience tremendous academic pressure due to the high importance of college entrance examinations (Chung & Cheon, 2017; Won & Lee, 2019), resulting in South Korean adolescents spending substantial time on academic work (i.e., 8 h in a school and 2.3 h for after-school academic work per day in seventh grade to 10 h in school and 1.3 h for after-school academic work per day in eleventh grade) (Korea Centers for Disease, 2019). This cultural context could result in chronic academic stress as well as sleep deprivation and, in fact, an average sleep duration of the South Korean adolescents has rapidly decreased throughout adolescence (i.e., 7.5 h per day in seventh grade to 5.6 h per day in eleventh grade) (Cho & Lee, 2020; Korea Centers for Disease, 2019). SCT symptoms are associated with sleep problems and daytime sleepiness (Becker, Garner, & Byars, 2016a; Becker, Luebbe, & Langberg, 2014b), and recent experimental work shows shortened sleep to be a causal contributor to SCT symptoms (Becker, Epstein, et al., 2019b; Garner et al., 2016). It is possible that SCT symptoms may be more strongly related to some aspects of functioning (e.g., academic stress, somatic complaints, sleep problems) and less strongly related to other aspects of functioning (e.g., shyness, withdrawal) in the South Korean culture. Cross-cultural studies will be needed to test such possibilities, as well as to more directly test that the SCT construct itself is comparable both within and across diverse cultural contexts.

Limitations and Future Directions

This study provides initial support for newly developed 15-item self-report and parent-rating measures of SCT with South Korean adolescents. It is important, however, to note several limitations. First, even though the study used two sources, we

were unable to collect teacher ratings and it will be important for future research to examine teacher-reported SCT to better understand SCT within the classroom in South Korea. This is especially important since the development and validation of SCT measures for professionals in education and clinical settings would further advance our understanding of SCT. Second, measures of academic stress, sleep difficulties, and the inclusion of objective measures of academic performance would have allowed a better understanding of the validity of SCT for South Korean adolescents. Finally, Cronbach's α for some subscales (i.e., ODD and Rule-breaking Behavior) of the CBCL and YSR were relatively low and relevant results should be interpreted with caution. It will be important for future studies to use other reliable and valid measures for disruptive behaviors to more thoroughly examine relations of the SCT construct with disruptive behaviors. In addition, longitudinal research would be suggested to better understand SCT development across adolescence (Becker, Burns, Leopold, Olson, & Willcutt, 2018b). This is especially important since psychopathology often emerges and changes in adolescence, and adolescents are also prone to experiencing an increase in other difficulties such as sleep problems and academic stress/impairment. The findings with the South Korean adolescents, however, replicate and extend the findings from the Spain and the United States. Given the difficulty with replication within the field of psychology, it is encouraging to find such similar results across the different cultures, languages, and samples.

Compliance with Ethical Standards

Conflict of Interest Author So-Hee Jung, SoYean Lee, G. Leonard Burns, and Stephen Becker declares that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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