Reliability, Factor Validity, and Neuropsychological Correlates of the Child Concentration Inventory – 2 in a Community Sample of Italian Adolescents

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The final version of this paper is available at:

Somma, A., Becker, S. P., Leitner, C., & Fossati, A. (2022). Reliability, Factor Validity, and Neuropsychological Correlates of the Child Concentration Inventory-2 in a Community Sample of Italian Adolescents. *Assessment*, *29*(8), 1842–1857. https://doi.org/10.1177/10731911211033349

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Abstract

Sluggish cognitive tempo (SCT) has been less frequently studied in adolescents compared to school-aged youth, few studies have examined youth self-report of SCT, and no study has examined SCT in Italy. The present study examined the reliability and validity of the Child Concentration Inventory – Version 2 (CCI-2), a youth self-report measure of SCT, in 452 Italian adolescent high school students (37.8% female; mean age = 15.92 years). Adolescents were administered Italian translations of the CCI-2 and the Attention Deficit/Hyperactivity Disorder (ADHD) Self-Report Scale (ASRS). School performance variables (i.e., teacher-rated grades and teachers' disciplinary ratings) were also collected. A random sub-sample (n = 88) of participants was also administered the Mackworth Clock Test, a short version of the Attention Network Test (CRSD-ANT), and the Stop-Signal Task. In our study, all CCI-2 items showed adequate convergent-discriminant validity, and the CCI-2 scale score showed adequate internal consistency reliability. Confirmatory factor analysis (CFA) results suggested the adequacy of a one-factor model of the CCI-2 items, which showed to be invariant across sex. Confirmatory factor analyses supported the dissociability of SCT from ADHD-Inattention and ADHD-Impulsivity. SCT was significantly and negatively associated with adolescents' average school grades, whereas ADHD was also significantly and negatively associated with adolescents' disciplinary ratings. In the random sub-sample, the CCI-2 total score was positively, significantly, and uniquely associated with overall reaction time on the Attention Network Task, but not other neurocognitive variables. This study provides further support for the reliability and validity of self-reported SCT in adolescence.

Keywords: Child Concentration Inventory – Version 2; Sluggish Cognitive Tempo; neuropsychological tasks; validity; adolescence.

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There is growing awareness that attention problems represent a heterogeneous domain. Based on an extensive meta-analysis of studies that included roughly 19,000 participants, Becker and colleagues (2016) demonstrated that a set of inattentive features could be consistently differentiated from attention-deficit/hyperactivity disorder (ADHD) inattentive symptoms. These inattentive characteristics include daydreaming, staring, mental fogginess/confusion, and slowed behavior/thinking; the term sluggish cognitive tempo (SCT; Becker, Marshall, & McBurnett, 2014) has been used to define this clinical picture. A substantial body of evidence documented that SCT is associated with a number of impairments and adjustment problems, over and above the effect of co-occurring ADHD (e.g., Barkley, 2014, 2016; Becker, 2017; Becker et al., 2016). In particular, loneliness and social withdrawal, anxiety/depression, low self-esteem, academic difficulties, poor emotion regulation, and heightened suicide risk seemed to significantly characterize subjects who met criteria for SCT (Becker et al., 2016). Thus, available evidence suggests that SCT is likely to represent a separate construct in its own right, with diagnostic and cross-diagnostic clinical relevance (Barkley, 2014, 2016; Becker et al., 2016).

Notwithstanding the relevance of the SCT construct, research on SCT has been hampered by the lack of an agreed-upon set of observable indicators (i.e., core features) of the SCT construct, and consequently by the huge variation in the number and type of SCT symptoms that were included in the different SCT measures (Becker et al., 2016). In their meta-analysis, Becker and colleagues (2016) reported that previous studies had relied on more than 150 different items for assessing SCT, which were deemed to measure 18 core features of SCT. Interestingly, Becker and colleagues (2016) found that 13 of these 18 core features consistently loaded on an SCT factor that was distinct from the ADHD-IN factor in exploratory factor analyses, thus representing optimal indicators of the SCT construct. Interestingly, McBurnett and colleagues (2014) reported that an additional set of items assessing mental confusion were also specific to SCT.

Against this background, Saéz and colleagues (2019b) revised the self-report Child Concentration Inventory (CCI) to include the 13 optimal SCT items identified in Becker and colleagues' (2016) meta-analysis and the three mental confusion items that were found to be specific of SCT in McBurnett and colleagues' (2014) study. This revised self-report measure of SCT, the Child Concentration Inventory – Version 2 (CCI-2) represents a 16-item, Likert-type self-report measure that was specifically designed to assess SCT in children (Saéz et al., 2019b). The CCI-2 provides one item for each SCT core feature *plus* the three mental confusion items; each CCI-2 SCT item is rated on a four-point ordinal scale (from *0 = never* to *3 = always*). Notably, Sáez and colleagues (2019b) relied on a school-based sample of children and a multi-informant design to examine child self-reported SCT and provided initial empirical support for the reliability and validity of the CCI-2 in children (ages 8-13 years). Specifically, Sáez and colleagues (2019b) showed that the CCI-2 was provided with good reliability with 15 SCT symptoms showing moderate to strong loadings on a SCT latent factor; moreover, the child self-report SCT factor also showed moderate convergent validity with mother, father, and teacher ratings of children's SCT. In a recent study, Becker and colleagues (2020a) examined the internal and external validity of the CCI-2 in a sample of adolescents (ages 12-14 years) with (n = 162) and without (n = 140) ADHD and showed that 13 of the 16 CCI-2 items demonstrated convergent and discriminant validity from ADHD inattention; moreover, the CCI-2 showed invariance across the ADHD and comparison groups and across sex (Becker et al., 2020a).

Despite a recent increase in research attention and the possibility that self-report of SCT may be especially important (see Becker, 2020, for a review), few studies have examined self-reported SCT in adolescents (Becker et al., 2020a; Sáez et al., 2019b; Smith, Eadeh, Breaux, & Langberg, 2019; Smith & Langberg, 2017; Jung, Lee, Burns, & Becker, 2020). In addition, even fewer studies (Smith & Suhr, 2021) have examined SCT in relation to neurocognitive function in adolescents (Becker & Langberg, 2014; Becker et al., 2020b; Jarrett, Rapport, Rondon, & Becker, 2017). In their study, Becker and Langberg (2014) found that SCT was significantly associated with daily life executive functioning ratings in a sample of adolescents (ages 12-16) diagnosed with ADHD when parent ratings of SCT were used; however, these findings were not observed when teacher ratings were considered. Interestingly, Jarrett and colleagues (2017) examined the associations between self-reported SCT and executive functioning tasks in a sample of college students aged 17-25 years and found that participants with clinically elevated SCT symptoms do not show neuropsychological deficits on laboratory tasks (Jarrett et al., 2017). However, it should be observed that these findings were observed in a sample of emerging adults who were able to function within a college setting and therefore participants may be somewhat less neuropsychologically impaired than community samples (Jarrett et al., 2017). In another study, Jacobson et al. (2017) found SCT symptoms to be associated with slower processing speed in younger children, but not older children and adolescents. However, recent data suggest that it may be especially important to examine adolescent self-report of SCT symptoms in relation to speeded test performance. In a preliminary study of 80 adolescents with ADHD, clearer evidence was found for adolescent self-reported SCT than for parent-reported SCT in relation to slower processing speed (Becker et al., 2020b). Moreover, to extend previous data on the associations between SCT and neurocognitive function, it may be useful to examine these relations in non-ADHD samples (Becker & Barkley, 2018).

Starting from these premises, to extend previous findings to adolescents and adolescents from a different cultural context, the current study tested the psychometric properties of the Italian translation of the 16-item version of the CCI-2 in a sample of community-dwelling Italian adolescents. The availability of assessment instruments like the CCI-2, which has recently shown to be reliable and valid measure of SCT not only in the US (e.g., Becker et al., 2020a) but also in Spain and South Korea (Jung, Lee, Burns, & Becker, 2020; Sáez et al., 2019b), will help to establish the transcultural validity of SCT and better understand its phenomenology, development, and functional impact (Becker, 2019). From this perspective, extending previous knowledge on the CCI-2 in Italian adolescents may be particularly useful in further clarifying if there are different cultural attributions for SCT behaviors (e.g., daydreaming), that could in turn have important implications for preventing and treating SCT (Becker, 2019).

In the present study, we relied on a sample of adolescent high school students because 95.8% of the Italian general population adolescents are high school students (ISTAT, 2017). In order to extend the findings of previous studies examining the CCI-2 (Becker et al., 2020a; Jung et al., 2020; Sáez et al., 2019b) findings, we focused our attention on the 16 CCI-2 items included in the original version of the instrument. In particular, our study had the following major aims:

1. carrying out CCI-2 item analyses according to a convergent-discriminant validity approach in the full sample, as well as in male and female adolescent sub-samples. Item-total correlations corrected for part-whole overlap were used to evaluate the CCI-2 item convergent validity, whereas the correlations between each CCI-2 SCT item with the total scores of a self-report measure of ADHD that were previously validated in Italy (Somma, Borroni, & Fossati, 2019) was used to assess the CCI-2 item discriminant validity. Although establishing the convergent and discriminant validity of the individual CCI-2 SCT items in relation to internalizing symptoms is important (Becker et al., 2018), we focused our attention only on ADHD measures because the SCT construct has been developed to capture the inattentive features that are not adequately explained by the ADHD construct (Becker et al., 2016). Moreover, in terms of nomological network validity, consistent and sound data showed that SCT features may be sharply differentiated from ADHD inattentive criteria (Becker et al., 2016);

2. carrying out confirmatory factor analysis (CFA) of the 16 CCI-2 SCT items to evaluate (a) if all the SCT items measured a single latent dimension, (b) if this one-factor structure of the 16 CCI-2 items was provided with measurement invariance across male and female adolescent sub-samples. The measurement invariance of the CCI-2 items across male and female sub-samples was carried out to extend Becker and colleagues' (2020a) findings in a different cultural context; and (c) if the 16 CCI-2 items could be dissociated from ADHD items;

3. testing if the CCI-2 total score was significantly associated with teacher-rated indices of adolescent's functioning at school (i.e., school grades and behavior). In particular, we expected that CCI-2 scores would be related negatively and significantly with the adolescents' school grades (e.g., Becker et al., 2014; Willcutt et al., 2014), but not with the adolescents' rule breaking behaviors (i.e., disciplinary ratings; Jung et al., 2020). In contrast, self-report ADHD scores were expected to show negative, moderate, and significant associations with both adolescents' school grades and behavior (e.g., Evans, Van der Oord, &, Rogers, 2020);

4. in a random sub-sample of adolescents, carrying out neuropsychological laboratory tasks of attention, vigilance, and response inhibition blind to the adolescents' CCI-2 and ADHD scores. We expected positive and significant correlations of the CCI-2 total scores with poor performance on attention measures, with no significant association with response inhibition task results (e.g., Willcutt et al., 2014). In order to evaluate the neuropsychological correlates of SCT considering the overlap between some ADHD and SCT symptoms (e.g., Kofler et al., 2019), we also assessed the associations between attention task performance and CCI-2 scores even after controlling for ADHD symptoms.

Methods

Participants

A sample of 458 community-dwelling adolescents (38.2% female, mean age = 15.93 years, *SD* = 1.45 years) who were receiving professional education at public professional schools in the North of Italy were originally asked to take part in the present study. However, six participants were excluded from the final sample because they did not speak Italian as their first language and experienced difficulties in completing the questionnaires. Thus, the study sample was composed of 452 community-dwelling adolescents; all participants included in the sample completed the self-report measures. In our sample, 145 adolescents (32.1%) reported at least one school failure in the preceding years; because of confidentiality reasons, no information regarding student's diagnosis (e.g., ADHD, other psychiatric conditions) was available. One hundred seventy-one participants

(37.8%) were female and 281 (62.2%) were male, with a mean age of 15.92 years, *SD* = 1.46 years (range = 13 – 19 years).

Because it was unfeasible to individually administer laboratory neuropsychological tasks to all participants (due to the amount of school time required), a random sample of 100 (22.1%) participants was selected from to the original sample to be administered neuropsychological tasks. This method choice was related to the dimensional latent structure of the large majority of child and adolescents' mental disorders (e.g., Coghill & Sonuga-Barke, 2012; Demontis et al., 2019). Of the random subsample, 3 participants were not administered the measures because they moved to another school during the study. Nine participants could not be included in the final sample because they provided incomplete responses ($n = 4$) or because the assumptions of the independent race model (see Verbruggen et al., 2019) for the Stop Signal Task were not satisfied ($n = 5$).

Thus, the final sub-sample was composed of 88 adolescents, with a mean age of 15.83 years, *SD* = 1.61 years. Fifty-six (63.6%) participants were male and 32 (36.4%) participants were female. The 88 participants who completed the neuropsychological laboratory tasks did not significantly differ from the remaining 364 participants who were not randomly selected to participate in the second phase of the study on mean age, $t(450) = -0.62$, $p = .536$, $d = -0.07$, gender, $\chi^2(1) = 0.10$, $p = .752$, $\varphi = -.02$, mean CCI-2 total score, $t(450) = -0.11$, $p = .914$, $d = -0.01$, or mean ADHD Self-Report Scale total score, $t(450) = 0.14$, $p = .989$, $d = 0.00$.

Procedures

After obtaining Institutional Review Board approval from the university and the principals of the schools, researchers (i.e., graduate research assistants) recruited adolescents from classrooms. Written informed parent consent and adolescent assent were obtained prior to study participation. In order to participate in the present study, participants were required to speak Italian as their first language in order to avoid cultural and lexical bias in questionnaire responses.

All the self-reported measures were administered in random order and scored anonymously in April 2019. In order to be able to contact a random subsample of participants for administering neuropsychological tasks, each participant was assigned an alphanumeric code by a graduate research assistant who was kept masked to the participants' scores. The neuropsychological tasks were administered in May 2019. For each participant the order of administration of the individual neuropsychological tasks was randomized within the test battery. Participants were administered the neuropsychological tasks individually in a silent room at school during schooltime; the administration lasted 1 hour for each student. Researchers administering and scoring the self-report measures were unaware of the aims of the study; similarly, graduate research assistants who administered and scored the neuropsychological tasks where unaware of the scores obtained by each participant on the self-report measures and of the aims of the study.

Measures

All participants included in the present study were administered the following measures. Internal consistency reliability estimates for the CCI-2 and the ADHD Self-Report Scale are listed in the Results section.

Child Concentration Inventory – Version 2 (CCI-2; Sáez et al., 2019b). The Child Concentration Inventory (CCI; Becker et al., 2015) was developed as a youth self-report measure of SCT; the CCI was thoroughly revised following a meta-analysis of SCT (Becker et al., 2016), resulting in the CCI-2. The CCI-2 consists of 16 items which are rated on a four-point scale (from *0 = never* to *3 = always*) in reference to the past six months. Recently, Becker and colleagues (2020a) provided evidence for the reliability and validity of the CCI-2 in a large sample of adolescents with and without ADHD.

ADHD Self-Report Scale (ASRS; Kessler et al., 2005). The ASRS includes 6 items, which were explicitly designed to assess ADHD based on the *DSM-IV* criteria. Specifically, the ASRS (Kessler et al., 2005) includes four inattention items ('does not follow through', 'difficulty organizing tasks', 'forgetful', and 'reluctant to engage in mental tasks'), and two hyperactivity items ('fidgets' and 'always on the go'). The response options of the 6 items are arranged on a 5-point Likert scale. Kessler and colleagues (2007) showed that 5-point scores rather than dichotomous scores should be used in rating ASRS items. The ASRS items are summed to yield a total score; the higher the ASRS score, the higher the likelihood of an ADHD diagnosis (e.g., Adler & Newcorn, 2011). Previous data (Green et al., 2019) showed that the ASRS showed good internal consistency and factor validity in a sample of middle and high school students (N = 2,472). Consistent with the other existing translations of the ASRS, the scale has been translated into Italian using the standard WHO translation and back-translation protocol (Somma et al., 2019), and it was recently validated in Italian community-dwelling adolescents (Somma et al., 2019).

School performance variables. The current year school grade averaged across subjects and the current year disciplinary ratings (i.e., behavior) were used as adolescent's school performance variables. Schools in Italy use a 10-point scale that can be divided into failing (0 to 5) and passing (6 to 10) grades. A behavior score lower than 8 indicates severe problem behavior at school and in the case of a score of 6 or even 7, failure may occur. School performance variables were rated by the adolescents' teachers.

Neuropsychological Laboratory Tasks. Participants included in the random subsample were administered the following laboratory tasks.

Centre for Research on Safe Driving-Attention Network Test (CRSD-ANT; Weaver, Bédard, & McAuliffe, 2013). The ANT (Fan, McCandliss, Sommer, Raz, & Posner, 2002) is a computerized attentive test providing measures of alerting (i.e., achieving and maintaining a state of high sensitivity to incoming stimuli), orienting (i.e., the selection of information from sensory input), and executive attention (i.e., mechanisms for monitoring and resolving conflict among thoughts, feelings, and responses; Posner & Rothbart, 2007), as well as an overall reaction time (Bédard et al., 2013). Participants are presented 5 arrows either directly above or below a fixation cross and have to decide whether the arrow is pointed right or left. Arrows may be flanked by other stimuli and different cue conditions may alert the participants that the arrows are about to come on screen. Differences in mean reaction times in the different cue/flanker conditions are used to calculate three attentional network effects, namely, alerting effect (i.e., effect of achieving and maintaining alertness), orienting effect (i.e., effect of orienting attention towards a specific location of information), and conflict effect (i.e., effect of resolving conflict between several possible responses). In the present study we relied on a shorter version of the original ANT (i.e., the CRSD-ANT; Weaver et al., 2013) that is freely available (http://crsd.lakeheadu.ca/crsd-ant/). The CRSD-ANT takes about 10 minutes to complete; response time measures from the CRSD-ANT correlated very highly with the original ANT with Pearson *r* values ranging from .88 to .92. Recently, the CRSD-ANT has been translated into Italian; previous studies on the Italian ANT supported its validity as a measure of attentional functions (e.g., Martella, Casagrande, & Lupiáñez, 2011).

Mackworth Clock Test (MCT; Mackworth, 1948). The MCT is an experimental procedure used to study the effects of long-term vigilance on the detection of signals. It was originally created by Norman Mackworth as an experimental simulation of long-term monitoring by radar operators in the British Air Force during World War II (Lichstein, Riedel, & Richman, 2000). In the present study we relied on the Psychology Experiment Building Language (PEBL; Mueller & Piper, 2014) MCT computerized version (Mueller & Piper, 2014). In the PEBL MCT participants had to watch a large black pointer in a large circular background like a clock; the pointer moves in short jumps like the second hand of an analog clock, approximately every second. At infrequent and irregular intervals, the hand makes a double jump; the task is to detect when the double jumps occur by pressing a button. The PEBL MCT is used to study the effects of vigilance on the detection of signals; the PEBL MCT has 60 one-second trials. Recently, the PEBL MCT has been translated into Italian; notably, a previous study showed that the MCT represents an adequate measure of vigilance (Lichstein et al., 2000).

Stop-signal task (SST; Verbruggen et al., 2019). The SST is a task developed to assess response inhibition, the ability to stop an ongoing response (Matzke, Verbuggen, & Logan, 2018). In the stop-signal paradigm (Logan & Cowan, 1984; Lappin & Eriksen, 1966), participants perform a two-choice visual response time task, such as responding to the shape of the stimuli. In the present study, we relied on an open-source software to execute the SST and analyze the resulting data in a way that complies with the recommendations described in Verbruggen and colleagues' (2019) consensus guide to the SST. The stop-signal reaction time (SSRT; i.e., the latency of the unobservable stop response) was considered as a measure of response inhibition (Verbruggen et al., 2019); it was estimated based on the independent horse-race model (Logan, 1994; Matzke et al., 2018; Verbruggen et al., 2019). In the present study, stop-signal reaction times (SSRTs) were estimated using both the mean method, and the integration method with replacement of go omissions (i.e. the method that came out on top in the other set of simulations; Verbruggen et al., 2019). Recently, the SST has been translated into Italian, and it has been used in a preliminary study in a sample of Italian University students (Gialdi, Somma, Manara, & Fossati, 2020).

Measure Translation Procedures

Equivalence with the original meaning of the items was the guiding principle in the translation process (Denissen, Geenen, van Aken, Gosling, & Potter, 2008). First, the CCI-2 was independently translated into Italian by one of the authors, and by two other clinical psychologists who were fluent in English. After reaching a consensus, we had an English mother-tongue professional translator translate the Italian version back into English, and this English back-translation (Cha, Kim & Erlen, 2007; Van De Vijver & Hambleton, 1996; Geisinger, 1994) was sent to the author of the CCI-2. If the latest version differed from the English original, the translators came to an agreement on the definitive Italian translation. The authors followed the same procedure of translation concerning the ASRS and all neuropsychological laboratory tasks; different teams of co-translators participated in the translation of the measures.

Data Analysis

CCI-2 Descriptive Statistics, Reliability and Convergent-Discriminant Validity. Cronbach's alpha coefficient and mean interitem correlation (MIC) were used to assess the internal consistency of the scales; considering that only 6 items composed the ASRS we relied on item response theory graded response model (Samejima, 2016) to obtain an estimate of internal consistency reliability of the ASRS (see also Sharp, Steinberg, Temple, & Newlin, 2014). CCI-2 item analyses were carried out according to a multitrait paradigm (Nunnally & Bernstein, 1994), which involved the computation of two distinct item-total correlation coefficients for each CCI-2 item. Item analyses were carried out in the whole sample as well as in the male and female subsamples. In each group, CCI-2 item convergent validity was assessed through computation of item–total correlations corrected for item–total overlap ($r_{i\text{-}t}$) between each item and the CCI-2 total score. CCI-2 item discriminant validity was evaluated by correlating each CCI-2 item with the total score of the ASRS. Multitrait analysis determines the extent to which items correlate more strongly with their own domain (i.e., SCT) than with other domains (i.e., ADHD). Differences in excess of twice the typical error of the correlation coefficient — that is, $2 * 1/\sqrt{N-3}$ — indicate the strength of the association (e.g., Virtues-Ortega, Segui-Duran, Descalzo-Quero, Carnerero, & Martin, 2010).

CCI-2 Confirmatory Factor Analysis, Measurement Invariance Models, and Dissociability from ASRS Items. In order to assess the factor structure of the CCI-2, we relied on confirmatory factor analysis (CFA); given the ordinal nature of the CCI-2 items, we used the weighted least square mean and variance adjusted (WLSMV) estimator. In the present study we tested a one-factor model of the CCI-2 item polychoric correlation matrix. In WLSMV CFA, we used several measures to identify model fit, including the χ^2 goodness-of-fit statistic, the root mean square error of approximation (RMSEA), the Tucker–Lewis index (TLI), the comparative fit index (CFI), and the standardized root mean square residual (SRMSR). Following Hu and Bentler's (1999) suggestions, TLI and CFI values ≥.95, RMSEA values close to .06, and SRSMR <.08 were considered as indicating good model fit, whereas TLI and CFI values of .90 and higher, and an RMSEA of .08 and lower are indications of an adequate fit.

If the one-factor model of the CCI-2 items showed to be provided with adequate goodness-of-fit indices, we relied on multiple-group WLSMV CFA in order to test the replicability of the one-factor structure of the CCI-2 items across subgroups based on participants' gender. In particular, we tested the following invariance models: (a) a configural invariance model with invariant factor loading pattern; (b) a metric invariance model with invariant factor loadings, and,

(c) a scalar invariance model with invariant factor loadings and thresholds. The DIFFTEST procedure (Muthén & Muthén, 1998-2019), and differences in CFI (*Δ*CFI; Cheung & Renswold, 2002) were used to evaluate the presence of significant differences in goodness-of-fit function between nested models (Muthén & Muthén, 1998-2019). Although care should be used in relying on *Δ*fit indices in assessing measurement invariance of ordinal indicators (Sass, 2011), the relevance of the change in fit index values between the two models was assessed using Cheung and Rensvold (2002) critical values in the light of Sass's (2011) findings concerning factor invariance models with categorical indicators. Values of *Δ*CFI ≤ –0.01 were considered to reject the hypothesis of metric and scalar invariance (Cheung & Rensvold, 2002; Sass, 2011).

The dissociability of CCI-2 items assessing SCT from ASRS items assessing ADHD was tested using WLSMV CFA. In evaluating model fit, we relied on the same fit indices described above (Hu & Bentler, 1999). In particular, we tested the following models: (a) a unidimensional model where all CCI-2 and ASRS items loaded on the same factor; (b) a two correlated factor model when CCI-2 items were assigned to a SCT factor and ASRS items were assigned to an ADHD factor; and (c) a three correlated factor model where all CCI-2 items were assigned to a SCT factor, whereas the first four ASRS items were assigned to an ADHD-Inattentive factor and the last two ASRS items were assigned to an ADHD-Impulsive factor.

CCI-2 Association with Demographics and School Ratings. Independent-sample Student's *t*-test was used to evaluate the significance of gender comparisons on the mean CCI-2 total score; the Cohen's *d* coefficient was used to estimate the effect size of mean differences. Spearman *r* coefficient was used to estimate the significance and strength of the associations between the CCI-2, ASRS total scores, and adolescents' average school grades and behavior ratings (i.e., disciplinary rating); Pearson *r* coefficient was used to evaluate the significance and strength of the relationship between the CCI-2, and ASRS total scores, and adolescents' age. The nominal significance level (i.e., two-tailed p <.05) was corrected according to the Bonferroni procedure.

Association Between CCI-2 and Neuropsychological Laboratory Task Indices. Considering the relatively small size of the random sub-sample, the significance and strength of the associations between the CCI-2 total scores and the neuropsychological laboratory task index values (as well as among the neuropsychological laboratory task index values) were assessed using the Spearman *r* coefficient. Partial Spearman *r* coefficient was used to evaluate the significance and strength of the correlations between the CCI-2 total scores and the neuropsychological laboratory task index values holding constant the effect of the ASRS total score.

Software. WLSMV CFA analyses were carried out using M*Plus* 8.3 (Muthén & Muthén, 2012-2019). All other statistical analyses were carried out using *R* computer program (R Core Team, 2019).

Results

CCI-2 Descriptive Statistics, Reliability and Convergent-Discriminant Validity

CCI-2 item descriptive statistics and item-total *r* coefficient values in the full sample and broken down by gender are listed in Table 1. Table 2 summarizes the CCI-2 item discriminant validity coefficients with respect to the ASRS total score in the full sample and in gender sub-groups. Bold text indicates convergent validities (i.e., r_{i-t} values) that were in excess of twice the typical error of the correlation coefficient with respect to both discriminant validities (Virtues-Ortega et al., 2010). In the present study, the critical values for a relevant difference were .09, .12, and .15 in the full sample, in the male sub-sample, and female sub-sample, respectively. As shown in Table 2, all 16 CCI-2 items showed adequate convergent (i.e., item-total *r*s corrected for part-whole overlap) and discriminant validity.

CCI-2 Confirmatory Factor Analysis, Measurement Invariance Models, and Dissociability from ASRS Items

When we tested the one-factor model of the 16 CCI-2 items (polychoric correlation matrix) in the full sample using WLSMV CFA, goodness-of-fit indices were as follows: WLSMV goodness-of-fit $\chi^2(104) = 419.59$, $p < .001$, RMSEA = .082, 90% confidence interval for RMSEA =

.074, .090, CFI = .917, TLI = 0.904, SRMSR = .058. The goodness-of-fit index values for the measurement invariance models of the CCI-2 items across male and female sub-groups are summarized in Table 3. As it can be observed in Table 3, the difference in CFI values between the metric and scalar models was not significant (Cheung & Rensvold, 2002), suggesting that the CCI-2 was provided with measurement invariance across male and female adolescents. Table 4 summarized the goodness-of-fit values for the WLSMV CFA models assessing the dissociability of the CCI-2 items from ADHD items. As shown in Table 4, the best fitting models were the models hypothesizing the distinction between SCT and ADHD, with slightly better fit indices for the model postulating one SCT factor, one ADHD-Inattention factor, and one ADHD-Impulsivity factor. Notably, in this model, the ADHD-Inattention and ADHD-Impulsivity factor correlation was .54, $p <.001$. Thus, we retained the model proposing one SCT factor, one ADHD-Inattention factor, and one ADHD-Impulsivity factor; WLSMV CFA standardized factor loadings for this model in the full sample are listed in Table 5. All 16 CCI-2 items significantly and substantially loaded on the latent SCT dimension; moreover, both ADHD-Inattention and ADHD-Impulsivity items loaded on two different factors different from the latent SCT dimension.

CCI-2 Association with School and Behavior Ratings

Descriptive statistics, internal consistency reliability indices, and gender comparisons for the CCI-2 are presented in Table 6, whereas the correlations of the adolescents' average school grade, behavior rating, and age with the CCI-2 and ASRS total scores, respectively, are listed in Table 7. As indicated in Table 7, SCT symptoms were significantly negatively associated with school grades, whereas ADHD symptoms were significantly negatively associated with both school grades and school behavior. When the effect of the ASRS scores was held constant in partial *r* correlation analyses, the association between SCT symptoms and school grades remained significant (partial $r = .12$, $p <.0083$); similarly, CCI-2 scores remained independent from school behavior, partial $r = .08$, $p > .10$. A Pearson *r* values of .41, $p <.001$, was observed for the associations between the ASRS and the CCI-2 total score.

Association Between CCI-2 and Neuropsychological Laboratory Task Indices

The descriptive statistics and inter-correlations (i.e., Spearman *r* coefficient values) for the ANT, Mackworth Clock Test and SST index values in the random sub-sample (n = 88) are listed in Table 8. Finally, the Spearman *r* and partial Spearman *r* (holding constant the effect of the ASRS total score) coefficient values assessing the associations between the CCI-2 total score with the Attention Network Task, Mackworth Clock Test, and SST index values in the random sub-sample are reported in Table 9. As shown, CCI-2 scores were significantly associated with higher reaction time on the Attention Network Test, but CCI-2 scores were not significantly associated with any of the other task indices.

Discussion

Few studies have examined self-reported SCT in adolescence, particularly using carefully developed measures of SCT and laboratory neurocognitive tasks. Although a recent systematic review identified the CCI-2 as a strong measure for assessing youth self-reported SCT, it was also noted that additional studies are needed to confirm and extend existing findings (Becker, 2020). The present study found the CCI-2 to be a reliable and valid measure of SCT in a community sample of Italian adolescents. In our study, all 16 CCI-2 items showed adequate convergent validities (i.e., item-total *r*s corrected for part-whole overlap). In terms of discriminant validity, in the full sample all 16 CCI-2 items showed r_{i-t} values (i.e., convergent validities) that were in excess of twice the typical error of the correlation coefficient with respect to the corresponding correlations with the ASRS total score.

Only in our female sub-sample five CCI-2 items (namely, CCI-2 item 1, item 9, item 12, item 15, and item 16) seemed to show problem discriminant validity with respect to self-reported ADHD, although they showed adequate convergent validity (i.e., r_{i-t} coefficient) values. It should be observed that the relatively lower number of female participants than male participants that was observed in our sample of adolescents may have influenced our findings. Indeed, the value for the difference between the r_{i-t} value and the corresponding *r* value with the ASRS total score had to attain to consider "significant" the discriminant validity of a given CCI-2 item had to be 66.7% larger in the female sub-sample than in the full sample (i.e., .12 vs. .09), and 25.0% larger in the female sub-sample than in the male sub-sample (i.e., .15 vs. .12). Further studies on possible gender effects on the CCI-2 item discriminant validity are necessary before drawing conclusions regarding our findings.

Confirming and extending Becker and colleagues' (2020a) and Sáez and colleagues' (2019a,b) factor analytic findings, our WLSMV CFA results suggested that the polychoric correlations among the 16 CCI-2 items purportedly assessing SCT were adequately explained by a single common latent dimension. Although care should be used in evaluating measurement invariance results when the groups are of different size (Sass & Schmidt, 2013), our findings suggest that the CCI-2 items were provided with adequate measurement invariance properties across male and female adolescents. Although the DIFFTEST value for the comparison between the scalar invariance model and the metric invariance model was significant, the difference in CFI values between the two models was far from being significant according to the percentile values reported in Cheung and Rensvold's (2002) simulation study. Thus, our findings suggest that the CCI-2 items were highly likely to measure the same latent construct (i.e., SCT) across male and female adolescents, thus allowing the use of CCI-2 scores in comparing these groups.

Also consistent with previous research conducted in the United States (Becker et al., 2020a) and Spain (Sáez et al., 2019b), our WLSMV CFA findings confirmed that among community-dwelling Italian adolescents the SCT latent dimension which all 16 CCI-2 items significantly and substantially loaded on could be sharply separated from both ADHD-Inattention and ADHD-Impulsivity latent dimensions. Thus, also when they were administered to Italian adolescents in its Italian translation, the 16 CCI-2 items seemed to measure a single latent dimension that could be dissociated from the general ADHD latent factor, as well as by the ADHD-Inattention and ADHD-Impulsivity sub-dimensions, at least when the ASRS was used to assess ADHD. Interestingly, in our study no modification index values suggested the existence of significant cross-loadings between SCT and ADHD factors, thus stressing that all CCI-2 items were provided with adequate discriminant validity in our full sample of community-dwelling adolescents.

The one finding in the present study that differs from previous research is that the motivation item ("I am not motivated to do things") did load on the SCT factor, whereas previous research using parent- or teacher-rated SCT has routinely found the motivation item to load with ADHD inattention (Becker et al., 2019; Jacobson et al., 2012; Penny et al., 2009; Sáez et al., 2019b). However, Dvorsky et al. (2019) did find "apathetic or unmotivated" to strongly load with SCT using both parent and teacher ratings in a community sample of young children. Of note, neither Sáez et al. (2019b) nor Becker et al. (2020a) included the motivation item in their studies examining youth self-reported SCT. Thus, findings from the present study suggest that youth self-report of motivation may fall within the SCT construct, though replication will be important given previous studies' findings related to this item.

In addition to support for the convergent and discriminant validity, the CCI-2 total score proved highly reliable among Italian adolescents, with internal consistency reliability estimates (i.e., Cronbach's α and MIC values) that further support its use in both male and female adolescents. In line with Becker and colleagues' (2018) results, our data indicated that female adolescents scored significantly, albeit moderately, higher than male adolescents on the CCI-2.

Consistent with our a priori research hypotheses and previous research (Becker et al., 2014; Langberg et al., 2014; Willcutt et al., 2014), the CCI-2 total score was significantly and negatively related with adolescent's average school grade as reported by teachers, although the size of the correlation value was in the small-to-moderate range by conventional standards (Cohen, 1988). In any case, these correlations were roughly of the same size of those that were observed for the ADHD self-report measure. The relatively small effect size for the association between CCI-2 scores and school grades in adolescence was somewhat expected for a number of reasons, ranging from different sources of information to assess SCT and school performance, to the fact that poor school performance in adolescence does not necessarily implies the presence of dysfunctional characteristics such as SCT or ADHD. Interestingly, in our study the CCI-2 total score showed no significant relationship with the adolescents' school behavior (i.e., teachers' disciplinary ratings), with Spearman *r* values very close to 0. At the opposite, the ADHD self-report measure was significantly and negatively (albeit modestly) associated with adolescents' behavior ratings. This finding seemed to be somewhat consistent with previous studies suggesting that SCT is more clearly associated with internalizing problems than with disruptive behavior problems (Becker et al., 2016; Becker & Willcutt, 2019). Interestingly, in our study neither SCT nor ADHD scores were significantly associated with adolescent participants' age, though the limited age range restricted our ability to test for differences across ages.

Considering that in our study adolescent participants had to be administered the neuropsychological tasks individually at school, we were able to carry out the laboratory assessment of attention, vigilance, and response inhibition only in a random sub-sample of participants. Although 12 adolescents in the random sub-sample were unable to provide valid data, nonetheless the remaining 88 adolescent participants in the random sub-sample did not show any significant difference on demographic, CCI-2, and ADHD variables when compared with the adolescents who were not included in the random sub-sample. Even keeping these limitations in mind, we feel that using neuropsychological laboratory tasks to evaluate the nomological network validity of the CCI-2 total scores in adolescence is an important contribution given that very few studies have examined youth self-reported SCT symptoms in relation to neuropsychological test performance. Consistent with our a priori research hypothesis, the CCI-2 total score was positively, significantly, and uniquely associated with poor overall performance on the CRSD-ANT task. Thus, higher information processing speed, as measured by the CRSD-ANT reaction time, seemed to represent a subtle information processing deficit associated uniquely to SCT. Conversely, in our sample, neither SCT nor ADHD as reported by adolescents were significantly associated with response inhibition. Overall, findings suggest that adolescent self-report of SCT, as well as ADHD, may not be consistently or strongly associated with neuropsychological test performance, though the limited sample size for these analyses and few neuropsychological measures included indicate that more work will be needed before drawing strong conclusions.

Limitations and Future Directions

Results of our study should be considered in the light of several limitations. Our sample was composed of high school student adolescents who volunteered to participate in the study, rather than of adolescents who were randomly selected from the Italian adolescent population. Thus, our sample was more akin to a convenience study group than to a random sample representative of the adolescents in the Italian general population. Moreover, all participants in our study were community-dwelling adolescents; thus, our findings should not be extended to adolescents from clinical or forensic settings.

In the present study, in order to assess measurement invariance of the CCI-2 one-factor model, we relied on both DIFFTEST and changes in approximate fit indexes (i.e., ΔCFI). We are aware that the WLSMV estimator does not allow for a direct comparison between models and, therefore, the change in practical/approximate model fit statistics should be interpreted cautiously (Sass & Schmitt, 2013), particularly for those models with smaller sample sizes and smaller degrees of noninvariance (Sass, Schmitt, & Marsh, 2014). However, it should be observed that our sample sizes were moderately large, and Sass and colleagues (2014) suggested that these cutoff criteria might be acceptable.

Although the ASRS was provided with reliability and validity data in Italian community-dwelling participants (Somma et al., 2018), other measures exist to assess ADHD in adolescents that capture all *DSM* symptoms of ADHD, and we are aware that their use might lead to different findings. Additionally, we relied on self-reported measures to assess both SCT and ADHD; thus, shared method variance could have inflated our findings. In the present study, we relied on the ASRS (i.e., a 6-item rating scale) to evaluate the presence of ADHD symptoms; of course, future studies based on ADHD clinical diagnoses are necessary. Moreover, the ASRS includes only two items to assess ADHD impulsivity symptoms and no items assessing hyperactivity. These aspects limit the generalizability of our finding to other measures of ADHD. In our study, we relied on a multi-trait paradigm (Nunnally & Bernstein, 1994) to assess the convergent-discriminant validity of the CCI-2 with respect to ADHD; future studies based on a multitrait-multimethod approach (Nunnally & Bernstein, 1994) may be particularly useful in order to extend our data to other SCT measures.

Of course, gathering large amount of data when laboratory tasks are at issue may be unrealistic; however, this should not lead to overlooking the problems associated with small sample size (e.g., sample representativeness, precision of estimates, replicability). Moreover, we relied on sound computer-administered tasks in order to assess neuropsychological task indices. However, we were able to administer only one task for each construct (i.e., vigilance, attention, and response inhibition); the use of different measures of the same constructs might lead to different findings. For instance, time considerations lead us to administer the CRSD-ANT; however, we are aware that the ANT did not come without limitations (e.g., MacLeod et al., 2010; McConnell & Shore, 2011). Moreover, in the present study, in order to compute the SSRTs we relied on sound parametric estimation method (i.e., the integration method; Verbruggen et al., 2019), as well as on the mean method for comparison reasons (see, for instance, Willcutt et al., 2014). Thus, we did not rely on parametric methods (e.g., Matzke, Curley, Gong, & Heathcote 2019) to estimate SSRTs because different models are currently available (Matzke et al., 2019) and they are less used in applied research (e.g., Verbruggen et al., 2019).

All these considerations inherently limit the generalizability of our finding and stress the need for further studies before accepting our conclusions. Even keeping the limitations of our study in mind, our findings make an important contribution to the existing literature by providing additional support for the SCT construct in adolescence, as well as the self-report of SCT by adolescence themselves, and further extend previous research by examining neuropsychological task performance and a cultural context where SCT has previously not been examined. Moreover, our findings indicate that the CCI-2 may be a useful measure of SCT in community-dwelling adolescents, including in its Italian translation.

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Table 1.

Child Concentration Inventory – Version 2: Item Descriptive Statistics and Item-Total Correlations Corrected for Part-Whole Overlap in the Full Sample (N = 452) and Broken Down by Gender.

	Full Sample (N = 452)				Male Sub-Sample (n = 281)				Female Sub-Sample (n = 171)			
Child Concentration Inventory – Version 2	*M*	*Mdn*	*SD*	r_{i-t}	*M*	*Mdn*	*SD*	r_{i-t}	*M*	*Mdn*	*SD*	r_{i-t}
1. I am slow at doing things.	1.06	1.00	0.71	.36	1.01	1.00	0.73	.37	1.13	1.00	0.68	.32
2. My mind feels like it is in a fog.	1.02	1.00	0.83	.58	0.94	1.00	0.80	.57	1.15	1.00	0.87	.58
3. I stare off into space.	1.10	1.00	0.89	.59	0.99	1.00	0.90	.61	1.27	1.00	0.86	.54
4. I feel sleepy or drowsy during the day.	1.46	1.00	0.88	.46	1.34	1.00	0.91	.42	1.65	2.00	0.81	.45
5. I lose my train of thought.	0.92	1.00	0.83	.55	0.81	1.00	0.80	.46	1.12	1.00	0.85	.62
6. I am not very active.	0.82	1.00	0.80	.43	0.68	1.00	0.74	.33	1.05	1.00	0.85	.48
7. I get lost in my own thoughts.	1.39	1.00	0.91	.58	1.24	1.00	0.89	.52	1.63	2.00	0.89	.61
8. I get tired easily.	1.11	1.00	0.95	.44	0.98	1.00	0.92	.38	1.32	1.00	0.96	.45
9. I forget what I was going to say.	1.14	1.00	0.82	.43	1.00	1.00	0.78	.41	1.37	1.00	0.83	.37
10. I feel confused.	0.91	1.00	0.88	.64	0.74	1.00	0.81	.58	1.19	1.00	0.92	.65
11. I am not motivated to do things.	0.99	1.00	0.88	.44	0.89	1.00	0.85	.32	1.15	1.00	0.91	.54
12. I zone out or space out.	1.30	1.00	0.83	.49	1.24	1.00	0.82	.45	1.41	1.00	0.84	.54
13. My mind gets mixed up.	0.96	1.00	0.85	.65	0.81	1.00	0.77	.55	1.19	1.00	0.93	.73
14. My thinking seems slow ...	0.61	0.00	0.73	.49	0.57	0.00	0.71	.44	0.67	1.00	0.75	.57
15. I daydream.	1.23	1.00	1.03	.44	1.07	1.00	1.00	.40	1.49	1.00	1.03	.42
16. I have a hard time putting …	1.20	1.00	1.01	.45	1.12	1.00	0.98	.45	1.32	1.00	1.04	.43

Note. r_{i-t}: Correlation coefficient corrected for part-whole overlap.

Table 2.

Child Concentration Inventory – Version 2 Items: Convergent (i.e., Item-Total rs Corrected for Part-Whole Overlap) and Discriminant (i.e., Correlations with the Adult ADHD Self-Report Scale Total Score) Validities in the Full Sample (N = 452) and Broken Down by Gender.

	Full Sample (N = 452)		Male Sub-Sample (n = 281)		Female Sub-Sample (n = 171)	
Child Concentration Inventory - Version 2	ASRS	r_{i-t}	ASRS	r_{i-t}	ASRS	r_{i-t}
1. I am slow at doing things.	.21	**.36**	.18	**.37**	.25	.32
2. My mind feels like it is in a fog.	.20	**.58**	.19	**.57**	.21	**.58**
3. I stare off into space.	.28	**.59**	.25	**.61**	.31	**.54**
4. I feel sleepy or drowsy ...	.26	**.46**	.23	**.42**	.32	**.45**
5. I lose my train of thought.	.26	**.55**	.20	**.46**	.35	**.62**
6. I am not very active.	.16	**.43**	.13	**.33**	.19	**.48**
7. I get lost in my own thoughts.	.26	**.58**	.19	**.52**	.36	**.61**
8. I get tired easily.	.26	**.44**	.23	**.38**	.31	**.45**
9. I forget what I was going to say.	.23	**.43**	.19	**.41**	.29	.37
10. I feel confused.	.25	**.64**	.16	**.58**	.36	**.65**
11. I am not motivated to do things.	.25	**.44**	.17	**.32**	.36	**.54**
12. I zone out or space out.	.30	**.49**	.27	**.45**	.34	.54
13. My mind gets mixed up.	.25	**.65**	.15	**.55**	.37	**.73**
14. My thinking seems slow ...	.22	**.49**	.17	**.44**	.29	**.57**
15. I daydream.	.22	**.44**	.16	.40	.30	.42
16. I have a hard time putting …	.22	**.45**	.10	**.45**	.38	.43
M	9.93	--	9.83	--	10.09	--
SD	3.70	--	3.59	--	3.87	--
Cronbach's α	.92 [a]	--	.91 [a]	--	.93 [a]	--
Mean Inter-Item r	.18	--	.15	--	.22	--

Note. ASRS: Adult ADHD Self-Report Scale Total Score; r_{i-t}: Correlation coefficient corrected for part-whole overlap; --: Statistic not computed. For each set of discriminant-convergent validity correlations, the nominal significance level (i.e., p <.05) was corrected according to the Bonferroni procedure and set at p <.00156. Correlation coefficient values ≥ |.15|, ≥ |.19|, and ≥ |.24| were significant at Bonferroni-corrected p-level (i.e., p <.00156) in the full sample, in the male sub-sample, and in the female sub-sample, respectively. Bold highlights convergent validities (i.e., r_{i-t} values) that were in excess of twice the typical error of the correlation coefficient (i.e., $2* 1/\sqrt{N-3}$) with respect to both discriminant validities (e.g., Virtues-Ortega, Segui-Duran, Descalzo-Quero, Carnerero, & Martin, 2010). In the present study, the critical values for a relevant difference were .09, .12, and .15 in the full sample, in the male sub-sample, and female sub-sample, respectively. a: Reliability estimate based on item response theory graded response model.

Table 3.

Weighted Least Square Mean and Variance Adjusted Confirmatory Factor Analysis Measurement Invariance Models of the Child Concentration Inventory – Version 2 Item One-Factor Model Across Male (n = 281) and Female (n = 171) Participants.

Invariance Models	$\chi^2(df)$	$\Delta\chi^2(df)$	CFI	ΔCFI	RMSEA	90% CI
Configural	508.47 (208) ***	--	.916	--	.080	.071, .089
Metric	507.84 (223) ***	16.55 (15)	.920	.004	.075	.067, .084
Scalar	541.22 (254) ***	59.43 (31) **	.920	.000	.071	.062, .079

Note. χ^2: Weighted least square mean and variance adjusted goodness-of-fit; *df*: degrees-of-freedom; $\Delta\chi^2$: Difference in weighted least square mean and variance adjusted goodness-of-fit values; CFI: Comparative fit index; ΔCFI: Difference in CFI value; RMSEA: Root mean square error of approximation; 90% CI: 90% confidence interval for RMSEA; --: Statistic not computed. When a more restrictive model is compared to a less restrictive model (e.g., scalar invariance vs. metric invariance; metric invariance vs. configural invariance), ΔCFI values ≤ –0.01 indicate substantial worsening of model fit (Cheung & Renswold, 2002).

* p <.05

** p <.01

*** p <.001

Table 4.
Dissociability of the of the Child Concentration Inventory – Version 2 Items from the Adult ADHD Self-Report Scale Items: Weighted Least Square Mean and Variance Adjusted Confirmatory Factor Analysis Results in the Full Sample (N = 452).

CFA Models	$\chi^2(df)$	$\Delta\chi^2(df)$	RMSEA	90% CI	CFI	TLI	SRMSR
One Factor (16 CCI-2 items + 6 ASRS items)	644.42 (209) ***	--	.068	.062, .074	.895	0.884	.060
One SCT Factor (16 CCI-2 items) and One ADHD Factor (6 ASRS items)	559.36 (208) ***a	71.43 (3) ***	.061	.055, .067	.915	0.906	.055
One SCT Factor, and One ADHD-Inattention Factor (ASRS Items 1-4) and One ADHD-Impulsivity Factor (ASRS items 5-6)	**548.24 (206) ***b**	**11.81 (2)** **	**.061**	**.055, .067**	**.917**	**0.907**	**.055**

Note. CFA: Confirmatory factor analysis; SCT: Sluggish Cognitive Tempo; ADHD: Attention Deficit Hyperactivity Disorder; CCI-2: Child Concentration Inventory – Version 2; ASRS; Adult ADHD Self-Report Scale; χ^2: Weighted least square mean and variance adjusted goodness-of-fit; *df*: degrees-of-freedom; $\Delta\chi^2$: Difference in weighted least square mean and variance adjusted goodness-of-fit values; CFI: Comparative fit index; TLI: Tucker-Lewis index; RMSEA: Root mean square error of approximation; 90% CI: 90% confidence interval for RMSEA; SRMSR: Standardized Root Mean Square Residual; --: Statistic not computed.
* p <.05; ** p <.01; *** p <.001; a: factor correlation = SCT and ADHD factor correlation = .60, p <.001; b: SCT and ADHD-Inattention factor correlation = .56, p <.001; SCT and ADHD-Impulsivity factor correlation = .44, p <.001; ADHD-Inattention and ADHD-Impulsivity factor correlation = .54, p <.001.

Table 5.

Child Concentration Inventory – Version 2 Item Weighted Least Square Confirmatory Factor Analysis Results: Best-Fitting Model Standardized Factor Loading Matrices (N = 452).

	Confirmatory Factor Analyses			
	CCI-2 Items	CCI-2 Items and ASRS Items		
CCI-2 Items	SCT	ADHD-IN[a]	ADHD-IM	SCT
1. I am slow at doing things.	.43***	--	--	.43***
2. My mind feels like …	.68***	--	--	.67***
3. I stare off into space.	.70***	--	--	.70***
4. I feel sleepy or drowsy ...	.52***	--	--	.53***
5. I lose my train of thought.	.63***	--	--	.64***
6. I am not very active.	.50***	--	--	.50***
7. I get lost in my own …	.68***	--	--	.67***
8. I get tired easily.	.51***	--	--	.51***
9. I forget what I was going …	.50***	--	--	.51***
10. I feel confused.	.78***	--	--	.77***
11. I am not motivated to do ...	.50***	--	--	.51***
12. I zone out or space out.	.55***	--	--	.57***
13. My mind gets mixed up.	.79***	--	--	.78***
14. My thinking seems slow ...	.61***	--	--	.61***
15. I daydream.	.53***	--	--	.53***
16. I have a hard time …	.51***	--	--	.51***
ASRS Items				
1. wrapping up details...	NA	.45***	--	--
2. getting things in order …	NA	.50***	--	--
3. remembering appointments..	NA	.54***	--	--
4. avoid tasks …	NA	.37***	--	--
5. squirm with your hands …	NA	--	.62***	--
6. driven by a motor …	NA	--	.46***	--

Note. CCI-2: Child Concentration Inventory – Version 2; SCT: Sluggish Cognitive Tempo; ADHD: Attention Deficit Hyperactivity Disorder; ADHD-IN: ADHD-Inattention Factor; ADHD-IM: ADHD-Impulsivity Factor; ASRS: Adult ADHD Self-Report Screening Scale; NA: Not Available; --: Factor loading set at zero.

a: Factor correlations: ADHD-IN and ADHD-IM: $r = .54$, $p < .001$, ADHD-IN and SCT: $r = .56$, $p < .001$, ADHD-IM and SCT: $r = .44$, $p < .001$.

*** $p < .001$.

Table 6.

Child Concentration Inventory – Version 2 Total Score: Descriptive Statistics, Internal Consistency Reliability Indices (i.e., Cronbach's Alpha and Mean Inter-Item Correlation), and Gender Comparisons.

	Full Sample (N = 452)			Male Sub-Sample (n = 281)			Female Sub-Sample (n = 171)				
CCI-2	*M*	*SD*	α/MIC	*M*	*SD*	α/MIC	*M*	*SD*	α/MIC	$t(450)$	*d*
Total	1.08	0.50	.87/.29	0.97	0.46	.84/.25	1.26	0.50	.88/.31	-6.25 ***	-0.59

Note. CCI-2: Child Concentration Inventory – Version 2; MIC: Mean inter-item correlation; *d*: Cohen's *d* effect size measure.

* p <.05; ** p <.01; *** p <.001

Table 7.

Child Concentration Inventory – Version 2 Total Score and ADHD Self-Report Scale Total Score: Spearman r Correlations with Adolescent's Average School Grade and Behavior, and Person r Correlations with Adolescent's Age (N = 452).

Total Scores	School Behavior	Average School Grade	Age
Child Concentration Inventory – Version 2	-.02	-.16*	.01
ADHD Self-Report Scale	-.21*	-.15*	-.02
M	6.87	7.75	15.92
Mdn	7.00	8.00	16.00
SD	0.83	1.30	1.46

Note. The nominal significance level (i.e., $p < .05$) was corrected according to the Bonferroni procedure and set at $p < .0083$. Spearman *r* values >|.12| and Pearson *r* values >|.12| are significant at Bonferroni-corrected *p*-level. A Pearson *r* value of .41, $p < .001$, was observed for the associations between the Adult ADHD Self-Report Inventory total score, and the Child Concentration Inventory – Version 2 total score.

* $p < .0083$

Table 8.

Attention Network Task, Mackworth Clock Test and Stop Signal Task Index Values: Descriptive Statistics and Inter-Correlations (i.e., Spearman r Values) in a Random Sub-Sample of Adolescent Participants (N = 88).

Laboratory Task Indices	*M*	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Attention Network Task												
1. Overall (Mean) Reaction Time (*ms*.)	662.51	99.51	--									
2. Alerting Network Score	27.22	34.42	.09	--								
3. Orienting Network Score	57.84	50.43	.13	$.21^{*}$	--							
4. Executive Functioning Network Score	143.17	66.52	$.37^{***}$	.07	.03	--						
Mackworth Clock Test												
5. Misses	5.02	4.01	$.43^{***}$	.19	$.25^{*}$	.07	--					
6. Hits	19.10	5.38	$-.30^{**}$	-.15	-.15	-.01	$-.64^{***}$	--				
7. False Alarms	2.09	2.46	$.29^{**}$	-.01	.04	.11	$.24^{*}$	-.17	--			
8. Mean Reaction Time (*ms*.)	412.14	45.23	$.28^{**}$	$.23^{*}$	.19	.08	$.42^{***}$	$-.47^{***}$	-.02	--		
Stop Signal Task												
9. Stop-Signal Reaction Time (mean method; *ms*.)	248.68	51.00	.16	.04	-.01	.03	$.26^{*}$	-.12	$.28^{**}$	.17	--	
10. Stop-Signal Reaction Time (integration method; *ms*.)	226.75	59.43	.12	-.01	-.02	.07	$.23^{*}$	-.04	.14	.09	$.84^{***}$	--

Note. * p <.05; ** p <.01; *** p <.001

Table 9.

Associations between the Child Concentration Inventory – Version 2 Total Score and Attention Network Task, Mackworth Clock Test and Stop Signal Task Index Values: Spearman r Correlations and Partial Spearman r Coefficient Controlling for the Effect of the Adults ADHD Self-Report Scale Total Score (N = 88).

	Child Concentration Inventory – Version 2 Total Score		
	CCI-2	ASRS	pr_S
Laboratory Task Indices	r_S		pr_S
Attention Network Task			
Overall (Mean) Reaction Time (*ms*.)	.29**	.12	.28**
Alerting Network Score	.17	-.11	.20
Orienting Network Score	-.01	.08	-.03
Executive Functioning Network Score	.16	.17	.13
Mackworth Clock Test			
Misses	.15	.04	.14
Hits	-.10	-.12	-.07
False Alarms	-.10	-.25*	-.05
Mean Reaction Time (*ms*.)	.14	.25*	.09
Stop Signal Task			
Stop-Signal Reaction Time (mean method; *ms*.)	-.03	-.06	-.02
Stop-Signal Reaction Time (integration method; *ms*.)	-.02	-.03	-.01
M	1.07	9.93	--
SD	0.51	3.37	--
Cronbach's α	.88	.92	--
Mean Inter-Item *r* Coefficient	.31	.18	--

Note. CCI-2: Child Concentration Inventory – Version 2; ASRS: ADHD Self-Report Screening Scale.
* $p < .05$; ** $p < .01$; *** $p < .001$