ORIGINAL ARTICLE

Psychometric properties of a sluggish cognitive tempo scale in Japanese adults with and without ADHD

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Abstract

This study examined the psychometric properties, convergent validity, and divergent validity of a Japanese translation of Barkley (The Barkley adult ADHD rating scale–IV, Guilford Press, New York, 2011) rating scale for assessing sluggish cognitive tempo (SCT) in adults. In total, 429 Japanese adults participated across three samples: 26 diagnosed with attention-deficit/hyperactivity disorder (ADHD; ages 19–50), 81 adults without ADHD (ages 22–65), and 322 university students (ages 18–27). All participants completed rating scales of SCT, ADHD, anxiety, and depressive symptoms. A subset of participants completed the SCT measure at two time points two weeks apart. The SCT measure (5 items) showed acceptable levels of internal consistency and test–retest reliability. This scale also demonstrated convergent and discriminant validity, as evidenced by factor analyses between SCT and ADHD inattention (ADHD-IN) symptoms as well as adequate fit of a four-factor model involving SCT, ADHD-IN, ADHD-hyperactivity/impulsivity (ADHD-HI), and internalizing symptoms. Additionally, SCT and ADHD-IN dimensions were differentially associated with ADHD-HI and internalizing factors. The ADHD group scored higher on SCT ratings compared to the student and adult non-ADHD groups even after controlling for the severity of ADHD and internalizing symptoms. The 5-item SCT measure appears reliable and demonstrates preliminary evidence of validity in Japanese adults, providing initial support for the transcultural validity of the SCT construct. Additional studies are needed to further evaluate the SCT items that did not meet criteria for convergent and discriminant validity in the current study, and to examine functional outcomes of individuals recruited based on clinically elevated SCT symptoms.

Keywords Attention-deficit/hyperactivity disorder (ADHD) · Adult ADHD · Japan · Sluggish cognitive tempo · Rating scale

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Introduction

Despite not being included in the Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-5; American Psychiatric Association 2013), sluggish cognitive tempo (SCT) has been increasingly researched. A meta-analysis found SCT symptoms to be empirically distinct from attention-deficit/hyperactivity disorder inattention (ADHD-IN) in exploratory factor analyses (Becker et al. 2016). Thus, research suggests that SCT is a distinct construct from the ADHD-IN symptom dimension, as well as other symptom dimensions (e.g., anxiety, depression; Becker et al. 2016, 2018; Lee et al. 2016; Leopold et al. 2015). SCT also differs in its associations with other symptom dimensions compared to ADHD-IN. SCT symptoms are more often linked to internalizing symptoms (e.g., depression and anxiety) than ADHD-IN, whereas ADHD-hyperactivity/impulsivity symptoms (ADHD-HI) are less related, or even unrelated, to

internalizing disorders after controlling for SCT symptoms (Becker et al. 2014, 2016). Although SCT is correlated with ADHD-HI and other externalizing behavior, this association is likely because ADHD-IN is linked with ADHD-HI, and ADHD is routinely linked to externalizing psychopathology. After controlling for ADHD-IN, SCT has no association (or even a negative association) with externalizing behaviors (Becker et al. 2016). The inverse is not true: after controlling for SCT, ADHD-IN remains associated with externalizing behavior. These findings establish that SCT and ADHD have differential associations with other psychopathology symptoms, and recent studies also show that SCT is related to significant functional impairment in several important domains even after controlling for ADHD symptoms (for reviews, see Barkley 2014; Becker and Barkley 2018; Becker et al. 2016).

Most research examining SCT has been in North America or Western Europe (Becker et al. 2016; Becker 2017), with some studies of children from Chile, South Korea, and Nepal (Belmar et al. 2017; Khadka et al. 2016; Lee et al. 2017, 2018). The social and developmental context influences the identification of normal and disordered behavior (Canino and Alegria 2008; Kirmayer and Young 1999; Rescorla et al. 2007; Wakefield et al. 2002). Most SCT research has occurred in countries with predominantly individualist cultures (Becker et al. 2014a, b, 2016; Lee et al. 2018). Japanese culture is strongly influenced by Confucian, Daoist, Buddhist, and Shinto philosophies that emphasize interpersonal harmony, behavioral restraint, compliance, and norms against standing out from others (Davis et al. 2011; Nitobe 1905; Tseng et al. 2005). Such a collectivist orientation may yield different external correlates of SCT than in western cultures. For example, SCT is linked to social withdrawal and reticence (Becker et al. 2017; Marshall et al. 2014; Servera et al. 2018), which are more clearly associated with global peer difficulties in North America, Europe, and Australia compared to Asia. Thus, the nature of the SCT construct and its associations with functioning may differ cross-culturally (Becker in press). To investigate the validity of SCT as a clinical entity, further international research is imperative.

Far fewer studies have examined SCT in adults compared to children (Becker et al. 2016), and the majority of studies of SCT in adults relied solely on college student participants (Becker et al. 2014a, b, 2018; Flannery et al. 2016a, b; Jarrett et al. 2017; Wood et al. 2017a, b). Although certainly important, studies are needed that also recruit from the adult population more broadly. Only three studies to our knowledge have examined SCT in non-college adult samples (Barkley 2012; Leikauf and Solanto 2017; Lunsford-Avery et al. 2018). Together, these studies in college and non-college samples have similarly found SCT to be distinct from ADHD-IN and uniquely associated with internalizing symptoms and socioemotional impairments. However, we

are not aware of any studies that have examined SCT in adults outside of the USA in either college or non-college populations. It is thus important to evaluate SCT symptoms in different cultural contexts, just as "there is a clear need for studies that examine SCT in adult samples not wholly comprised of college students" (Becker 2017, p. 6).

Current study

This study examined the psychometric properties of a Japanese translation of Barkley's (2011, 2012) rating scale for assessing SCT in adults. We use Barkley's SCT scale since it was based on a nationally representative sample of US adults and is one of the only available measures of self-reported SCT in adults. The study evaluated the Japanese version of this SCT scale with adults with and without ADHD as well as university students.

The first objective was to evaluate the internal validity of SCT symptoms in comparison with ADHD-IN symptoms. SCT symptoms were predicted to have high loadings on the SCT factor (convergent validity) and low loadings on the ADHD-IN factor (discriminant validity), and ADHD-IN symptoms were predicted to have high loadings on the ADHD-IN factor and low loadings on the SCT factor. Factor analysis was used in establishing convergent and discriminant validity. The internal consistency and test–retest reliability of the refined SCT questionnaire (retaining only those items that demonstrated adequate convergent and discriminant validity from ADHD-IN) were also evaluated.

The second objective was to assess the fit of an SCT, ADHD-IN, ADHD-HI, and internalizing symptoms (anxiety/depression) four-factor model. We predicted a strong fit of this four-factor model, and that the SCT factor would correlate more strongly than ADHD-IN with the internalizing factor, while the ADHD-IN factor would correlate more strongly than the SCT factor with the ADHD-HI factor. Given research demonstrating that depression and anxiety significantly co-occur (e.g., Clark and Watson 1991), anxiety and depression were expected to both be part of the internalizing symptoms factor. Additional analyses examined associations of these factors with age and gender.

The third objective focused on replicating the differential associations of SCT and ADHD-IN symptoms in relation to ADHD-HI and internalizing symptoms. It was hypothesized that higher ADHD-IN would predict higher ADHD-HI after controlling for SCT, while higher SCT would predict *lower* ADHD-HI after controlling for ADHD-IN. We also predicted that higher SCT and ADHD-IN would both predict higher internalizing symptoms after controlling for the other, but this unique association would be stronger for SCT than ADHD-IN.

The fourth objective was to evaluate the hypothesis that adults with a diagnosis of ADHD would have higher SCT

scores than adults without a diagnosis of ADHD, even after controlling for ADHD-IN, ADHD-HI, and internalizing symptoms.

Methods

Participants

The present study, approved by the university ethics committee, involved 429 participants from three groups to increase diversity of samples and generalizability of results beyond non-student populations: (1) adult ADHD group (26 adults diagnosed with ADHD, 14 males, $M_{age} = 31.65$ years, $SD_{age} = 9.25$, age range = 19–50); (2) adult non-ADHD group (81 adults, 24 males, $M_{age} = 41.84$ years, $SD_{age} = 11.01$, age range = 22–65); and (3) student group (322 university students, 141 males, $M_{age} = 20.37$ years, $SD_{age} = 1.24$, age range = 18–27). The student group was recruited from a university. The adult non-ADHD group was recruited from Japanese companies and facilities. The ADHD group was recruited from outpatients at the clinics where the first author was working.

The ADHD group was composed of 20 participants with ADHD-I and 6 participants with ADHD, combined presentation (ADHD-C). Comorbidities in the ADHD group were: 5 with major depressive disorder; 5 with dysthymic disorder; 1 with social anxiety disorder; 2 with obsessive–compulsive disorder, 1 with generalized anxiety disorder, and 1 with major depressive disorder. Each person could have more than one comorbid disorder.

Procedures

Participants in all three groups completed a battery of questionnaires, described below. The SCT measure was administered twice to 32 participants after a two-week interval to assess test–retest reliability. The participants who completed the SCT measure twice were composed of 15 participants from the university group (10 females), 14 participants from the ADHD group (6 females), and 3 adults in the adult non-ADHD group (2 females). Participants in the ADHD group were diagnosed by the first author using the Assessment System for Individuals with ADHD (ASIA; Takeda et al. 2015). Adults in the ADHD group were also screened for IQ on the Japanese version of the Wechsler Adult Intelligence Scale-III (WAIS-III; Japanese WAIS-III Publication Committee 2006). These adults had a Full Scale IQ above 85 ($M = 93.90$, SD = 9.21, range = 87–112). Those in the ADHD group also completed the Japanese version of the Mini-International Neuropsychiatric Interview (MINI; Otsubo et al. 2005) to assess for other psychiatric disorders.

Measures

Assessment System for Individuals with ADHD (ASIA; Takeda et al. 2015)

The ASIA is a Japanese semi-structured diagnostic interview for adult ADHD. The ASIA ADHD criteria A, corresponding to DSM-5 ADHD criteria A, are comprised of 144 questions that assess nine inattention symptoms and nine hyperactivity/impulsivity symptoms in childhood and adulthood on a 3-point scale (0 = never, 1 = sometimes, 2 = often/always). The ASIA ADHD criteria B to E, corresponding to DSM-5 ADHD criteria B to E, are evaluated on a 2-point scale (0 = no, 1 = yes). The ASIA shows acceptable reliability and validity (Takeda et al. 2015).

Mini-International Neuropsychiatric Interview (MINI; Otsubo et al. 2005)

The MINI is a structured interview used to diagnose 17 DSM disorders (Lecrubier et al. 1997). It is composed of 130 questions with adequate psychometric properties for the English version (Lecrubier et al. 1997). This measure was validated with a Japanese sample, with adequate levels of reliability and validity (Otsubo et al. 2005).

Wechsler Adult Intelligence Scale-III (WAIS-III; Japanese WAIS-III Publication Committee 2006)

The WAIS-III is a standardized test of intellectual ability in adults and yields a Full Scale IQ score. The Japanese version of the WAIS-III was used, with excellent psychometric properties (Japanese WAIS-III Publication Committee 2006).

Adult ADHD Self-Report Scale—Japanese version (ASRS-J)

The ASRS-J parallels the English version of the ASRS (Kessler et al. 2007) and consists of 18 items assessing ADHD symptoms rated on a 5-point scale (0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = very often). The ASRS-J shows acceptable psychometric properties (Takeda et al. 2017).

Barkley Adult SCT Scale—Japanese version

A Japanese translation of Barkley's (2011, 2012) adult SCT scale from the Barkley Adult ADHD Rating Scale-IV (BAARS-IV) was used. The BAARS-IV SCT scale includes nine SCT items confirmed by factor analyses (Barkley 2011, 2012). These nine SCT items are: (1) prone to daydreaming when I should be concentrating; (2) have trouble staying alert or awake in boring situations; (3) easily confused; (4) easily bored; (5) spacey or in a fog; (6) lethargic, more tired than others; (7) underactive or have less energy than others;

(8) slow moving; and (9) I don't seem to process information as quickly or as accurately as others. Each question measures the frequency of symptoms on a 4-point Likert scale (1 = never or rarely, 2 = sometimes, 3 = often, 4 = very often). Reliability and validity were demonstrated in the BAARS-IV with a US normative sample (Barkley 2011, 2012).

Based on the nine SCT items of the BAARS-IV (Barkley 2011), the first draft of the Japanese version of the adult SCT scale was created through several revisions by the first author. Then, it was back-translated into English by professional translators. The back-translated English version was reviewed by the author of the original English adult SCT rating scale and was further revised by the first author in response to the comments of the original author. It was then administered to the first author's colleagues, students, and patients with ADHD for further revision. The Japanese translation of the Barkley (2011) adult SCT scale is available upon request from the corresponding author.

New Mood Inventory (Sakano et al. 1994)

The New Mood Inventory measures an individual's mood state with 40 items on a scale of 1 to 4 (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). There are five subscales: tension and excitement, refreshing mood, fatigue, depressive mood, and anxious mood. This measure demonstrates acceptable levels of reliability and validity (Sakano et al. 1994), and the depressive mood (8 items) and anxious mood (8 items) scales were used in this study.

Data analysis plan

*M*plus version 7.4 was used to conduct factor analyses and structural regression analyses (Muthén and Muthén 1998-2014). Symptom ratings were treated as order-categorical indicators, and these analyses used the robust weighted least squares estimator (WLSMR). Global model fit was evaluated with the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the root-mean-square error of approximation (RMSEA) (Little 2013).

The first analysis applied a two-factor model to the SCT and ADHD-IN symptoms to determine the convergent and discriminant validity of these symptoms (i.e., the analysis was restricted to two factors with cross-loadings allowed). All three groups of participants were pooled for this factor analysis. SCT symptoms had to show convergent validity (i.e., loading on the SCT factor of at least 0.50) and discriminant validity (i.e., loadings on the ADHD-IN factor of less than 0.30) to be used in the subsequent analyses. The value of 0.50 for convergent validity was chosen because such is considered a minimum value for good convergent validity, and the value of 0.30 for the cross-loading was chosen because such is often considered a maximum value

for a cross (or secondary) loadings not being too high (e.g., Tabachnick and Fidell 2006).

All subsequent analyses after the factor analysis used the 5-item SCT scale described in Results section. Next, test–retest reliability was assessed using paired *t* tests and Pearson's correlations. Then, confirmatory factor analysis (CFA) evaluated the global fit of an SCT, ADHD-IN, ADHD-HI, and internalizing (anxiety/depression symptoms) four-factor model. The symptom-factor loadings and discriminant validity among the four factors were calculated. This analysis also allowed us to determine whether the SCT factor had a stronger correlation than the ADHD-IN factor with the internalizing factor, and whether the ADHD-IN factor had a stronger correlation than the SCT factor with the ADHD-HI factor. Further, structural regression analyses were used to evaluate the unique associations of the SCT and ADHD-IN factors with ADHD-HI and internalizing factors. Correlations with age and gender were examined using Pearson's correlations. Further analyses examined group differences in SCT by regressing the SCT factor on ADHD diagnosis (present or absent) after controlling for the ADHD-IN, ADHD-HI, and internalizing factors. The *M*plus model constraint procedure (Little 2013) was used to perform significance tests on factor correlations and partial standardized regression coefficients. Significance levels were set at 0.05 for all analyses.

Results

Convergent and discriminant validity of SCT and ADHD-IN symptoms

Five of the nine SCT items showed loadings from 0.52 to 0.92 on the SCT factor; $M = 0.71$, SD = 0.16, and loadings from -0.01 to 0.29 on the ADHD-IN factor; $M = 0.14$, SD = 0.14. See Table 1 for more details. These five SCT symptoms were *daydreams*, *spacey*, *lethargic*, *underactive*, and *slow moving*. The other four SCT symptoms (*trouble staying alert*, *easily confused*, *easily bored,* and *I don't seem to process information as quickly or as accurately as others*) had low loadings on the SCT factor (less than 0.50) in conjunction with high loadings on the ADHD-IN factor (greater than 0.30). The five SCT items that exceeded the criteria set for convergent and discriminant validity were subsequently used to define the SCT construct in this study. All nine ADHD-IN symptoms had loadings from 0.63 to 0.77 on the ADHD-IN factor; $M = 0.69$, SD = 0.05, and loadings from -0.13 to 0.12 on the SCT factor; $M = 0.01$, SD = 0.07, demonstrating convergent and discriminant validity.

Table 1 Summary of exploratory factor analysis results for the Japanese version of the adult SCT scale and the ASRS-J inattention scale

Item	SCT	Factor loadings	
		SCT	ADHD-IN
1	Daydreams	0.52*	0.29
2	Trouble staying alert[a]	0.49	0.31
3	Easily confused[a]	0.44	0.35
4	Easily bored[a]	0.45	0.30
5	Spacey	0.64*	0.17
6	Lethargic	0.92*	−0.01
7	Underactive	0.87*	−0.01
8	Slow moving	0.60*	0.25
9	Slow information processing[†]	0.48	0.33
	ADHD-IN		
a	Careless mistakes	−0.004	0.77*
b	Difficulty sustaining attention	0.03	0.71*
c	Does not listen	0.03	0.71*
d	Does not follow through	−0.01	0.73*
e	Difficulty organizing	0.06	0.73*
f	Avoids effort	0.12	0.65*
g	Loses things	−0.11	0.67*
h	Easily distracted	−0.03	0.63*
i	Forgetful	−0.13	0.63*

Each letter for inattention items corresponds to the inattention symptom in the DSM-5. $n = 415$

ADHD-IN ADHD inattention, *SCT* sluggish cognitive tempo

*Factor loadings over 0.5. [a]Failed to meet convergent and discriminant validity criteria

Test–retest reliability

The total scores for the 5-item SCT measure at the first and the second rating were 10.59 (4.03) and 10.31 (3.36) ($n = 32$), respectively. There was no significant difference between the first and second ratings by paired t test, $t = 0.52$, $df = 31$, $P = 0.61$. The two-week test–retest Pearson's correlation for the subsample of 32 participants was 0.72, $P < 0.001$.

Four-factor measurement model

The fit indices for the SCT (5 items), ADHD-IN (9 items), ADHD-HI (9 items), and internalizing (16 items) four-factor model were $\chi^2(696) = 1655$, $P < 0.001$, CFI = 0.963, TLI = 0.960, RMSEA = 0.057 (0.053, 0.060). Reliability (omega) coefficients for SCT, ADHD-IN, ADHD-HI, and internalizing factors were 0.84 ($SE = 0.01$), 0.87 ($SE = 01$), 0.81 ($SE = 0.02$), and 0.94 ($SE = 0.01$), respectively. The five SCT symptoms had substantial loadings on the SCT factor (0.72–0.92) with similar results for ADHD-IN (0.54–0.77), ADHD-HI (0.45–0.87), and internalizing (0.52–0.94) factors. The four-factor model showed good fit.

Table 2 shows the correlations among the SCT (5-item), ADHD-IN, ADHD-HI, and internalizing factors. The SCT factor was significantly correlated with the ADHD-IN factor ($r = 0.63$, $SE = 0.04$, $P < 0.001$) with each factor having 60% of their true score variance independent of the other factor. The internalizing and ADHD-HI factors had factor correlations of 0.60 ($SE = 0.04$) and 0.49 ($SE = 0.04$). Compared to the association between SCT and ADHD-HI, the correlation between ADHD-IN and ADHD-HI was higher, $P < 0.001$. Compared to the correlation between ADHD-IN and internalizing factors, the correlation between the SCT factor and the internalizing

Table 2 Correlations (SE) among SCT, ADHD-IN, ADHD-HI, and internalizing factors

	SCT	ADHD-IN	ADHD-HI
SCT			
ADHD-IN	0.63* (0.04)		
ADHD-HI	0.49* (0.04)	0.86* (0.02)	
INT	0.60* (0.04)	0.51* (0.04)	0.49* (0.04)

SCT sluggish cognitive tempo, *ADHD-IN* attention-deficit/hyperactivity disorder inattention, *ADHD-HI* hyperactivity/impulsivity, *INT* internalizing symptoms (anxiety/depression). *$P < 0.001$

factor was higher, $P = 0.04$. These results also demonstrate convergent and discriminant validity.

Associations of SCT and ADHD-IN factors with ADHD-HI and internalizing factors

Table 3 shows the standardized partial regression coefficients for the unique associations of the SCT (5-item) and ADHD-IN factors with ADHD-HI and internalizing factors. Higher scores on the ADHD-IN factor predicted higher scores on the ADHD-HI factor after controlling for SCT, $P < 0.001$, while higher scores on the SCT factor were associated with marginally *lower* scores on the ADHD-HI factor after controlling for ADHD-IN, $P = 0.06$. Higher scores on the SCT and ADHD-IN factors both uniquely predicted higher scores on the internalizing factor, ps < 0.001, with this unique effect being stronger for SCT, $P = 0.04$. Therefore, SCT symptoms were positively associated with internalizing symptoms when controlling for ADHD-IN symptoms, and SCT symptoms are marginally negatively associated with ADHD-HI when controlling for ADHD-IN.

Table 3 Structural regression of ADHD-hyperactivity/impulsivity and internalizing factors on sluggish cognitive tempo and ADHD inattention factors

	Outcomes			
	ADHD-HI		INT	
Predictors	β	SE	β	SE
SCT	-0.10^*	0.05	0.47^{**}	0.06
ADHD-IN	0.92^{**}	0.04	0.21^{**}	0.06

β Partial standardized regression coefficient, *SCT* sluggish cognitive tempo, *ADHD-IN* attention-deficit/hyperactivity disorder inattention, *ADHD-HI* hyperactivity/impulsivity, *INT* internalizing symptoms (anxiety/depression). $^*P = 0.06$; $^{**}P < 0.001$

Correlations with age and gender and group differences in SCT

Table 4 shows the means and standard deviations along with correlations and standard errors for gender and age in relation to the SCT (5-items), ADHD-IN, ADHD-HI, and INT factors. Higher SCT scores were related to younger ages, whereas SCT was not related to gender. To examine group differences in SCT (5-items), participants diagnosed with ADHD were compared with participants without ADHD, and student participants were compared with non-student participants. Results showed individuals diagnosed with ADHD scored higher (0.81 standard deviations) on the SCT factor compared to those without ADHD even after controlling for the ADHD-IN, ADHD-HI, and internalizing factors, $B = 0.81$, $SE = 0.22$, $P < 0.001$. Among non-clinical populations, the student group had significantly higher SCT scores than the adult non-ADHD group, even after controlling for ADHD-IN, ADHD-HI, and internalizing factors, $B = 0.81$, $SE = 0.13$, $P < 0.001$. These findings show group differences in SCT for the ADHD group and student population.

Discussion

Reliability and validity of the SCT construct in Japanese adults

Through exploratory factor analysis, 5 of the 9 SCT items of the BAARS-IV demonstrated reliability and validity from ADHD-IN in Japanese adults. These five items are among the items that were supported in a recent meta-analysis of SCT (Becker et al. 2016). The other four items in our study did not demonstrate convergent/discriminant validity from ADHD-IN. Indeed, the *easily bored* item also failed to show validity as an optimal SCT item in the meta-analytic review (Becker et al. 2016), as studies with children did not find this item to strongly load on an SCT factor (Lee et al. 2014; McBurnett et al. 2014). Although *slow thinking/processing*

Table 4 Descriptive statistics and correlations among gender, age, SCT, ADHD-IN, ADHD-HI, and internalizing factors

	SCT	ADHD-IN	ADHD-HI	INT
	M (SD)	M (SD)	M (SD)	M (SD)
Male	9.31 (3.66)	14.91 (6.68)	11.19 (5.75)	37.04 (11.57)
Female	9.58 (3.54)	13.86 (6.13)	9.10 (4.70)	36.94 (10.58)
	r (SE)	r (SE)	r (SE)	r (SE)
Gender	0.05 (0.05)	$-0.09^\dagger$ (0.05)	-0.22^* (0.05)	0.00 (0.05)
Age	-0.26^* (0.05)	-0.04 (0.06)	-0.03 (0.06)	-0.19^* (0.05)

SCT sluggish cognitive tempo, *ADHD-IN* attention-deficit/hyperactivity disorder inattention, *ADHD-HI* hyperactivity/impulsivity, *INT* internalizing symptoms (anxiety/depression)

Gender was coded as 0 for male and 1 for female. $^\dagger P < 0.10$. $^*P < 0.001$

was identified in the meta-analysis as an optimal item for assessing SCT, this was only evident in studies of children (see Table 3 in Becker et al. 2016). We also did not find support for *slow thinking/processing* as an SCT item with convergent/discriminant validity in adults in the current study, replicating findings from another recent study of SCT items in young adults from the USA (Becker et al. 2018). Interestingly, the *trouble staying alert* and *easily confused* items did not demonstrate convergent validity in the present study, though similar items (e.g., *I feel sleepy or drowsy during the day*, *I feel confused*) have demonstrated convergent and discriminant validity (Becker et al. 2016), even among adults (Becker et al. 2018). It is unclear whether these items are less optimal for defining the boundaries of the SCT construct, or whether there are cultural differences that may account for these items not demonstrating validity in our sample. It is possible that some SCT items may evoke different meanings in the Japanese culture as compared to the North American culture. Cross-cultural and phenomenological studies are needed to better evaluate SCT both within and across cultures (Becker 2017, in press).

In addition, we note that the four candidate items for SCT that were rejected by our convergent validity criterion (loading of at least 0.50 on the SCT dimension) did not miss that criterion by much. Although we adhere to our a priori criterion, we also note that were it to be relaxed to 0.44, all four remaining items would meet convergent validity criteria (and would also be close to meeting discriminant validity criteria), and thus our findings would more closely match those of previous research. Indeed, it is possible that similar results may be found if our convergent and discriminant validity criteria were relaxed. This is of no small theoretical importance, and we are reluctant to firmly conclude that these four items do not belong among the SCT items for the Japanese SCT measure, particularly the "trouble staying alert" and "easily confused" items which have demonstrated convergent and discriminant validity in both meta-analytic and adult-specific studies (Becker et al. 2016, 2018). It is unclear whether these items did not meet convergent and discriminant thresholds due to cultural factors and/or developmental period. Instead, we consider our findings to be preliminary, and we caution that future research in this area should include all 9 candidate SCT items to allow for confirmation.

Four-factor measurement model

Importantly, the CFA model that included the five-item SCT factor in addition to ADHD-IN, ADHD-HI, and internalizing factors, demonstrated good fit to the data. Most SCT validation studies have employed the stringent criteria of both loadings on the SCT factor of at least 0.50 and loadings on the ADHD-IN factor of less than 0.30 (Belmar et al. 2017;

Bernad et al. 2014; Burns et al. 2013, 2017; McBurnett et al. 2014; Lee et al. 2017). Results support the convergent and divergent validity of the SCT construct in Japanese adults.

Associations of SCT and ADHD-IN with ADHD-HI and internalizing factors

ADHD-IN was positively related to ADHD-HI after controlling for SCT, whereas SCT was negatively related to ADHD-HI after controlling for ADHD-IN. Higher SCT and ADHD-IN both uniquely predicted higher internalizing symptoms, with SCT being more strongly associated than ADHD-IN with internalizing symptoms. Previous studies have shown a "dissociation" of effects, where SCT symptoms remain positively associated with internalizing symptoms when controlling for ADHD-IN symptoms, and SCT symptoms are unassociated or negatively associated with ADHD-HI when controlling for ADHD-IN (Barkley 2014; Becker et al. 2016, 2017). Although there is no more "objective" measure of SCT such as neuropsychological testing, studies showing a "double dissociation" phenomenon are significant because these differential associations underscore the idea of SCT as a distinct construct from ADHD-IN. These studies have also shown that ADHD-IN remains associated with ADHD-HI when controlling for SCT symptoms.

Age, gender, and group differences on SCT

Additional analyses explored the associations between SCT with gender and age. Findings demonstrated no relationship between gender and SCT and a negative relationship between SCT and age. Previous studies have reported mixed findings regarding whether gender is related to SCT in adults (Barkley 2012; Becker et al. 2018; Combs et al. 2014; Flannery et al. 2016b; Leopold et al. 2016). With results similar to ours, Barkley's (2011) initial validity study of the BAARS-IV found that men and women did not differ in their ratings. Studies have found a small but significant positive association between SCT and age (Becker et al. 2016). In Barkley's (2011) study of the BAARS-IV, age did not correlate significantly with the SCT score. However, other studies have found that college students have higher SCT scores compared to other adults (Flannery et al. 2016a; Jarrett et al. 2017; Wood et al. 2017a). There was a difference between student and non-student samples in SCT scores in our sample such that student samples had higher SCT scores. Given the low birth rate in Japan (e.g., Nomura and Koizumi 2016), it may be less competitive for high school students to become accepted into university compared to attaining regular employment. Employees in this sample had been accepted into demanding jobs in a cultural milieu involving competitive work environments (e.g., Piotrowski et al. 2015). Therefore, being in the workforce in this sample may

suggest higher functioning than being a university student in our sample. In addition, adults with ADHD had higher SCT scores than adults without ADHD, which is consistent with the literature demonstrating the co-occurrence between SCT and ADHD (Barkley 2012; Lunsford-Avery et al. 2018).

Limitations and future directions

No clinical assessments were conducted for participants in our student and non-ADHD adult samples; however, these groups completed the ASRS-J, which examined levels of ADHD inattention and hyperactivity/impulsivity symptoms. In addition, given that there is currently no standardized diagnostic interview for adult SCT, our analyses utilized a self-report SCT rating scale. Future studies validating clinical interviews of SCT will be helpful to assess SCT as a construct across measures, and cross-informant and predictive validity should also be established. Furthermore, this study did not have a clinical sample of participants, such as those recruited based on clinically elevated SCT symptoms, which may limit our results. As well, a relatively small proportion of our sample had diagnoses of ADHD and our sample was predominantly composed of university students. It is unclear whether results, such as on test–retest reliability, may differ with a more impaired sample. Further research should include a higher proportion of clinical and non-student populations. Future studies are also recommended to examine how SCT is related to impairment above and beyond ADHD symptoms. Prevalence studies of SCT symptoms that include a measure of impairment will be helpful in determining the proportion of those with clinically significant SCT symptoms. Participants in this study were in the adult age range. Future SCT studies with children, young adolescents, and older adults would ensure a more representative sample across the lifespan and help to better understand SCT symptoms across developmental periods. The relationship between SCT symptoms in childhood and adulthood should also be investigated. In addition, further studies of SCT items in adults are necessary as the original SCT items have more research support with child samples (and parent and teacher ratings) than adult samples. This study did not examine the relations between SCT and other factors that may be related to SCT symptoms, such as personality and sleep, and future studies examining these associations are recommended. Additional research into potential biomarkers for SCT would yield further insight. Furthermore, although study findings support the transcultural validity of SCT, future studies that examine SCT items within the same study across cultures are necessary to determine exactly how cultural differences between Japanese and Western countries may have affected these results.

Conclusions

This study examined the factor structure and psychometric properties of a Japanese translation of Barkley's (2011) scale for assessing SCT in adults. A two-factor model of SCT and ADHD-IN symptoms was validated, demonstrating adequate convergent and discriminant validity for five of the nine SCT items. This measure also demonstrated adequate internal consistency and test–retest reliability. A four-factor model of SCT, ADHD-IN, ADHD-HI, and internalizing symptoms showed acceptable fit indices and reliability. This study also replicated the "double dissociation" effect between SCT and ADHD-IN. Further, adults with ADHD were found to have higher SCT scores than adults without ADHD. Overall, these findings provide preliminary support for using the five-item measure for assessing SCT in Japanese adults and also provide support for the transcultural validity of SCT. It will be important to continue to investigate the nature of SCT symptoms and their associations particularly with impairment, as research increasingly suggests that clinical consideration of SCT symptoms, beyond ADHD, may be important (e.g., Barkley 2012; Servera et al. 2018).

Compliance with ethical standards

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