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# The Internal, External, and Diagnostic Validity of Sluggish Cognitive Tempo: A Meta-Analysis and Critical Review

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**Objective:** To conduct the first meta-analysis evaluating the internal and external validity of the sluggish cognitive tempo (SCT) construct as related to or distinct from attention-deficit/hyperactivity disorder (ADHD) and as associated with functional impairment and neuropsychological functioning.

**Method:** Electronic databases were searched through September 2015 for studies examining the factor structure and/or correlates of SCT in children or adults. The search procedures identified 73 papers. The core SCT behaviors included across studies, as well as factor loadings and reliability estimates, were reviewed to evaluate internal validity. Pooled correlation effect sizes using random effects models were used to evaluate SCT in relation to external validity domains (i.e., demographics, other psychopathologies, functional impairment, and neuropsychological functioning).

**Results:** Strong support was found for the internal validity of the SCT construct. Specifically, across factor analytic studies including more than 19,000 individuals, 13 SCT items loaded consistently on an SCT factor as opposed to an ADHD factor. Findings also support the reliability (i.e., internal consistency, test-retest reliability, interrater reliability) of SCT. In terms of external validity, there is some indication that SCT may increase with age ( $r = 0.11$ ) and be associated with lower socioeconomic status ( $r = 0.10$ ). Modest (potentially negligible) support

was found for SCT symptoms being higher in males than females in children ( $r = 0.05$ ) but not in adults. SCT is more strongly associated with ADHD inattention ( $r = 0.63$  in children,  $r = 0.72$  in adults) than with ADHD hyperactivity-impulsivity ( $r = 0.32$  in children,  $r = 0.46$  in adults), and it likewise appears that SCT is more strongly associated with internalizing symptoms than with externalizing symptoms. SCT is associated with significant global, social, and academic impairment ( $r = 0.38$ – $0.44$ ). Effects for neuropsychological functioning are mixed, although there is initial support for SCT being associated with processing speed, sustained attention, and meta-cognitive deficits.

**Conclusion:** This meta-analytic review provides strong support for the internal validity of SCT and preliminary support for the external validity of SCT. In terms of diagnostic validity, there is currently not enough evidence to describe SCT in diagnostic terms. Key directions for future research are discussed, including evaluating the conceptualization of SCT as a transdiagnostic construct and the need for longitudinal research.

**Key words:** attention-deficit/hyperactivity disorder, diagnosis, nosology, sluggish cognitive tempo, systematic review

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Although sluggish cognitive tempo (SCT) has been studied in child and adolescent psychiatry and psychology since the mid-1980s, the last 15 years have witnessed a marked increase in interest in examining and understanding the SCT construct.<sup>1</sup> Although SCT was initially evaluated as a possible way to identify children with a “pure” attention-deficit/hyperactivity disorder (ADHD) predominantly inattentive type (ADHD-I),<sup>2</sup> research has not convincingly supported this possibility and has increasingly turned to examining SCT in its own right.<sup>1</sup> This growing

body of research has primarily focused on evaluating the internal and external validity of SCT. That is, research on SCT has so far been primarily concerned with 2 questions: whether SCT symptoms are empirically distinct from other psychopathology symptoms and reliable (i.e., internal validity); and whether SCT symptoms are associated with demographic characteristics, other psychopathology symptoms, functional impairments, and/or cognitive or neuropsychological functioning (i.e., external validity).

As the body of research examining the internal and external validity of SCT has grown, it has been argued that SCT may be its own psychiatric disorder.<sup>3,4</sup> However, the proposal for a new psychiatric disorder comes with important responsibilities and should be approached with caution given the far-reaching implications for diagnostic nosology, public perceptions of psychiatry and psychology, public health, and potential to pathologize nonpsychopathological behaviors. With these considerations in mind, the goals of



This article is discussed in an editorial by Dr. Russell A. Barkley on page 157.



Supplemental material cited in this article is available online.

this meta-analytic and critical review are 3-fold. First, a meta-analysis of the internal validity of SCT was undertaken to empirically evaluate the specific set of items/behaviors that best measures the SCT construct, the distinctiveness of SCT from ADHD and other psychopathologies (e.g., depression, anxiety), and the reliability (i.e., internal consistency, test-retest, and interrater reliability) of SCT. Second, a meta-analysis of the external validity of SCT was conducted to evaluate whether SCT is uniquely associated with demographics, other psychopathologies, functional impairments, and/or cognitive/neuropsychological functioning. Third, the meta-analytic findings are discussed in light of the 8 domains outlined by Cantwell<sup>5</sup> (modified from Robins and Guze<sup>6</sup>) that together provide a framework for determining the diagnostic validity of a construct. Finally, we offer important directions for future research tied directly to these 8 diagnostic validity criteria, with specific attention to those domains for which extant studies offer mixed results or for which empirical data are as yet unavailable. Taken together, this study synthesizes and integrates the literature regarding the internal, external, and diagnostic validity of the SCT construct while also highlighting important directions for future research.

## METHOD

### Literature Search

A comprehensive search of the relevant literature was completed to identify all studies published in English that included data relevant to the internal or external validity of SCT. Because the SCT construct was first introduced in the mid-1980s,<sup>7</sup> computer searches were performed for the dates January 1985 through September 2015 in the PubMed, PsycINFO, and Web of Science databases (see Supplement 1, including Figure S1, available online, for additional detail regarding the search procedures). Only peer-reviewed publications were included, since it was determined that some typical indices of study quality do not readily apply to the current state of SCT research (see Supplement 1, available online, for additional information). The search procedures identified 73 papers, including 61 papers based on 54 independent samples of children and adolescents, and 12 papers based on 10 independent samples of adults. To facilitate the evaluation of the validity of SCT across the developmental spectrum, studies of children and adolescents (defined as 17 years of age or younger) and studies of adults (18 years of age and older) were examined separately.

### Meta-Analysis

To provide a comprehensive summary of the literature, meta-analyses were completed for each criterion measure if at least 2 studies used designs and measures that addressed the internal and/or external validity of SCT (e.g., psychometric characteristics of SCT measures and analyses of the relation between SCT and functional impairment, other psychopathology symptoms, and neuropsychological functioning). In addition to summarizing the meta-analytic results, we also provide a brief qualitative summary of relevant issues that were unable to be examined meta-analytically (e.g., the relation between SCT and impairment after controlling for ADHD).

*Summary Statistics.* Pooled effect sizes were calculated using the Comprehensive Meta-Analysis statistical package.<sup>8</sup> Because most studies reported results of correlational analyses of continuous measures of SCT, all other effect sizes were converted to

Pearson correlations ( $r$ ). If a study reported more than 1 effect size that was relevant for a particular analysis (for example, 2 different measures of anxiety), a single effect size was computed using the procedure described by Gleser and Olkin.<sup>9</sup> To minimize the impact of any heterogeneity among effect sizes due to systematic differences in study populations, experimental design, measures, or other study procedures, effect sizes were estimated using a random effects model<sup>10</sup> (see Supplement 1, available online, for additional details).

Summary statistics from the meta-analyses are described in the text and tables included in the main article. Parallel tables in the supplemental materials (available online) list the individual effect sizes that were included in the meta-analysis that yielded each pooled effect size. The supplemental tables (available online) also provide a summary of analyses conducted to test for evidence of publication bias or significant heterogeneity among the effects.

### Measurement of SCT: The Universe of SCT Items

In contrast to reviews of the internal validity of clearly defined diagnostic constructs such as the *DSM-IV* symptom dimensions of ADHD,<sup>11</sup> a systematic evaluation of the measurement of SCT is complicated by the fact that there is currently no consensus regarding the core constructs that should be included in a comprehensive definition of SCT. Furthermore, even when there is general agreement regarding an overarching construct that should be included, the operational definition of the constructs has often varied dramatically across studies. Therefore, to set the stage for this comprehensive review of the validity of SCT as a construct, we first systematically examined the specific items that have been used to measure SCT in previous studies.

To synthesize these complex data, all items included in measures of SCT in previous studies were coded to indicate the core domain/construct that was assessed by the item. If a single item assessed multiple domains/constructs that could potentially be independent indicators of SCT (e.g., a widely used item asked whether the individual is “underactive, slow moving, or lacks energy”), the item was included in the list for each of the domains/constructs (see Supplement 1, available online, for more detail). Despite the variability in the specific wording of items across studies, this initial examination of item content suggested that the overall pool of 150 items was intended to measure a smaller set of 18 core features that may potentially characterize SCT. Table 1 lists each of these core behaviors and the number of studies that included at least 1 item that assessed each domain/construct; Table S1, available online, provides a comprehensive list of the coding decisions for all potential SCT items used in previous studies. No study included in the current review measured all 18 SCT domains/constructs, but nearly all studies included at least 1 item that measured the tendency to daydream (65 of 73 studies), and several other items were included in more than half of the studies (Table 1). In contrast, items assessing apathetic behavior, low motivation, and the tendency to become easily bored were included only in a minority of studies.

## RESULTS

### Internal Validity

As a first step to assess the validity of SCT as a construct, SCT must be shown to have adequate internal validity. In this section, we review studies that included SCT items in factor analytic studies and then summarize results of studies that examined the internal consistency, interrater reliability, and short-term and long-term stability of SCT.

**TABLE 1** Core Behaviors of the Sluggish Cognitive Tempo (SCT) Construct and Frequency of Inclusion Across Studies

SCT Construct	Studies Including at Least 1 Item From the SCT Construct, n
Daydreams	64
Sleepy/drowsy	49
Underactive/slow moving	49
Easily confused	47
Stares blankly	45
Lost in thoughts	43
In a fog	38
Tired/lethargic	35
Sluggish	33
Spacey/alertness changes from moment to moment	29
Slow thinking and responding	26
Apathetic/unmotivated	20
Low initiative and persistence	17
Absentminded	15
Easily bored	14
Slow work/task completion	18
Loses train of thought/loses cognitive set	12
Poor listening/difficulty with directions	5

Note: A total of 73 studies were identified by the literature search. See Table S1, available online, for a full list of all items that were included as measures of each construct.

### Factor Analyses

As summarized in Table 2,<sup>12-35</sup> factor analyses of SCT items have been conducted in 23 independent samples that included a total of more than 19,000 participants. These studies include 12 community/school-based samples, 8 clinical samples (primarily ADHD-specific samples), 3 population-based samples, and 2 college student samples. Although the majority of the studies were conducted with children and adolescents (20 samples), factor analyses were also reported in 2 studies of college students and 1 sample of adults across the lifespan. Parent ratings were obtained in 18 samples of children and adolescents and 1 sample of young adults. Teacher ratings were available for 13 samples, and the 3 studies of adults obtained self-report ratings. The number of putative SCT symptoms included in these studies varied widely. Several studies included only 2 potential SCT items that were included in the *DSM-IV* field trials,<sup>26,31</sup> whereas 1 of the most recent studies conducted exploratory factor analyses of an initial pool of 44 potential SCT items.<sup>27</sup>

Table 3 summarizes the overall results of factor analytic studies of SCT, with 3 particularly noteworthy findings:

1. Despite differences in raters, age of the sample, sampling procedures, specific factor analytic procedures, and the number of SCT items included in the analysis, all but 2 studies<sup>24,31</sup> suggested that at least a subset of SCT items loaded on a factor or factors separate from *DSM-IV* inattention and hyperactivity-impulsivity.<sup>12-23,25-35</sup>
2. An analysis of individual items indicated that 13 of the 18 potential SCT items loaded consistently on an SCT factor (mean loading of at least 0.70 across all samples). These items are marked with a double-dagger in Table 3. In contrast, items measuring 5 specific constructs consistently loaded more weakly on SCT factors (all <0.60) and tended to cross-load with *DSM-IV* inattention. These included items that assessed absentmindedness, difficulty initiating and sustaining effort to complete tasks efficiently, tendency to quickly become bored, slow work completion, and difficulty listening and acting upon instructions.
3. Several SCT items are similar to symptoms of other disorders such as depression or anxiety (e.g., psychomotor retardation, fatigue or loss of energy, mind going blank). Further, as summarized in detail later in this review, SCT ratings are moderately correlated with both ratings and diagnoses of a range of internalizing and externalizing disorders. Therefore, in addition to symptoms of ADHD, several factor analytic studies also included symptoms of internalizing and externalizing disorders to evaluate the extent to which SCT items could be differentiated from symptoms of other correlated disorders.<sup>14,25,32</sup> Similarly, 1 study examined the factor structure of ratings of SCT and daytime sleepiness.<sup>36</sup> A separate SCT factor emerged in each of these analyses, providing important additional support for the internal validity of SCT.

In summary, factor analytic studies clearly suggest that SCT is a distinct symptom dimension that is separable from ADHD<sup>12-35</sup> and other dimensions of psychopathology,<sup>14,25,32,37</sup> and there is initial evidence that SCT is also distinct from daytime sleepiness.<sup>36</sup> Further research is needed to clarify the following: whether the 13 SCT items identified in this review as consistently loading on an SCT factor are the optimal symptom set for assessing SCT; whether SCT is invariant across different raters; and whether SCT is best conceptualized as unidimensional or multidimensional in nature.

### Reliability

Based on initial support for the internal validity of the SCT construct from factor analytic studies, a number of studies tested the reliability of SCT summary scores. Table 4 summarizes meta-analytic results of all available studies that examined the reliability of measures of SCT (Table S2, available online, lists all studies included in these summary statistics). For studies that reported results separately for different SCT factors,<sup>19,27</sup> the mean of these results was included as the single effect from the study. All analyses were repeated both with and without these studies included in the analysis, and the overall pattern of results did not change.

*Internal Consistency.* Cronbach's  $\alpha$  is a measure of the extent to which the individual SCT items on a scale correlate with one another. Values above 0.60 provide moderate support and values above 0.80 provide strong support for the internal consistency of a measure.<sup>38</sup> Consistent with the results of the factor analyses, studies of children, adolescents, and adults suggest that SCT scales that include at least

**TABLE 2** Characteristics of Factor Analytic Studies of Sluggish Cognitive Tempo (SCT)

Studies	Sample <sup>a</sup>	N	Age (y)	SCT Measure <sup>b</sup>	Scale	Raters <sup>c</sup>	Factor Analysis <sup>d</sup>	Other Symptoms Included <sup>e</sup>	No. of SCT Items Evaluated	Final No. of SCT Items	Summary of Factor Analytic Findings
Studies in Children and Adolescents											
Barkley 2013 <sup>12</sup>	Pop	1,800	6–17	Barkley	0–3	P	EFA	I, H	14	12	2 SCT factors labeled “sluggish” and “daydreaming”; other items loaded with <i>DSM-IV</i> inattention.
Bauermeister 2012 <sup>13,f</sup>	Clinic	140	6–11	CBCL/TRF	0–2	P, T	CFA	I, H	4	4	1 SCT factor
Becker 2014 <sup>14</sup>	Clinic	680	6–12	CBCL	0–2	P	CFA	I, H, A, O, D	4	3	1 SCT factor
Becker 2015 <sup>15</sup>	Comm	124	6–13	CCI (Penny)	0–3	S	ESEM/CFA	I, H, A, D	14	14	Although 3 SCT factors were initially identified (“slow,” “sleepy,” and “daydreamer”), bifactor modeling supported use of a unidimensional SCT scale
Belmar 2015 <sup>16</sup>	Comm	652	6–14	CADBI	0–5	P, T	EFA	I	8	8	1 SCT factor
Bernad 2014 <sup>17,g</sup>	Comm	574–743	First Grade (age 7)	CADBI	0–5	T, Aid	EFA/CFA	I	8	3	1 SCT factor; other items cross-loaded with <i>DSM-IV</i> inattention
Burns 2013 <sup>18,g</sup>	Comm	802	6–7	CADBI	0–5	P	EFA	I, H, O, D	10	5	1 SCT factor; other items had primary or cross-loadings with <i>DSM-IV</i> inattention
Fenollar Cortés 2014 <sup>19</sup>	Clinic	131	6–16	CADBI	0–5	P	CFA	None	7	7	2 SCT factors labeled “inconsistent alertness” and “slowness”
Garner 2010 <sup>20</sup>	Clinic	276 (P) 258 (T)	5–17	CBCL/TRF	0–2	P, T	CFA	I, H	4 (P) 5 (T)	3 (P) 4 (T)	1 SCT factor
Garner 2014 <sup>21</sup>	Clinic	146	6–12	CBCL/TRF	0–2	P, T	CFA	I, H	3 (P) 4 (T)	3 (P) 4 (T)	1 SCT factor
Hartman 2004 <sup>22</sup>	Comm	286 (P) 229 (T)	8–18	DBRS	0–3	P, T	CFA	I, H	5	5	1 SCT factor
Jacobson 2012 <sup>23</sup>	Clinic	143	3–18	Penny	0–3	T	EFA	I, H	14	14	1 SCT factor labeled “sleepy/sluggish”; SCT items on the “slow/daydreamy” and “low initiation/persistence” factors cross-loaded with <i>DSM-IV</i> inattention
Lahey 2004 <sup>24</sup>	Comm	1,358	4–17	CAPS	1–4	P	EFA	I, H, A, O, C, D	5	0	No SCT factor emerged
Lee 2014 <sup>25</sup>	Comm	703 <sup>i</sup>	5–13	CADBI	0–5	P, T	EFA/CFA	I, H	10	8	1 SCT factor
McBurnett 2001 <sup>26</sup>	Clinic	692	3–18	SNAP	0–3	P, T	EFA	I	2	2	1 SCT factor
McBurnett 2014 <sup>27</sup>	Clinic	165	7–11	K-SCT	0–3	P, T	EFA/CFA	I, H	44	15	3 SCT factors labeled “daydreams,” “sleepy/tired,” and “working memory problems”

TABLE 2 Continued

Studies	Sample <sup>a</sup>	N	Age (y)	SCT Measure <sup>b</sup>	Scale	Raters <sup>c</sup>	Factor Analysis <sup>d</sup>	Other Symptoms Included <sup>e</sup>	No. of SCT Items Evaluated	Final No. of SCT Items	Summary of Factor Analytic Findings
Neeper 1986 <sup>28</sup>	Comm	678	5–15	CBRS	1–5	T	EFA	I, H, A	5	5	1 SCT factor
Penny 2009 <sup>29</sup>	Comm	335	4–13	Penny	0–3	P	EFA	I, H	25	14	2 SCT factors labeled “sleepy” and “daydreamer.” SCT items on the “slow” factor cross-loaded with DSM-IV inattention
Penny 2009 <sup>29</sup>	Comm	335	4–13	Penny	0–3	T	EFA	I, H	25	14	1 SCT factor labeled “sleepy/daydreamer”; SCT items on the “slow” factor cross-loaded with DSM-IV inattention
Servera 2015 <sup>30,g</sup>	Comm	756	6–7	CADBI	0–5	P	EFA	I	8	8 (F) 5 (M)	1 SCT factor
Todd 2004 <sup>31, males</sup>	Pop	1,414	7–19	DICA-IV	0–1	P	EFA	I, H	2	2	1 SCT factor identified in males
Todd 2004 <sup>31, females</sup>	Pop	1,424	7–19	DICA-IV	0–1	P	EFA	I, H	2	0	No SCT factor identified in females
Willcutt 2014 <sup>32</sup>	Comm	721	8–15	DBRS	0–3	P, T	EFA	I, H, A, O, C, D	9	6	1 SCT factor
Studies in Adults											
Barkley 2012 <sup>33,h</sup>	Pop	1,249	18–93	BAARS-IV	1–4	S	EFA/CFA	I, H	9	9	1 SCT factor
Becker 2014 <sup>34</sup>	College	768	17–34	BAARS-IV	1–4	S	CFA	I, H	9	9	1 SCT factor
Leopold 2015 <sup>35</sup>	College	3,925 <sup>i</sup>	18–42	None	0–3	S, P	EFA/CFA <sup>k</sup>	I, H	10 (P) 8 (S)	10 (P) 8 (S)	1 SCT factor

Note: A = anxiety; BAARS = Barkley Adult ADHD Rating Scale; C = conduct disorder; CADBI = Child and Adolescent Disruptive Behavior Inventory; CBCL = Child Behavior Checklist; CBRS = Child Behavior Rating Scale; CCI = Child Concentration Inventory; CFA = confirmatory factor analysis; D = depression; DBRS = Disruptive Behavior Rating Scale; DICA-IV = Diagnostic Interview for Children and Adolescents-IV; EFA = exploratory factor analysis; ESEM = exploratory structural equation modeling; F = fathers; H = hyperactivity/impulsivity; I = inattention; K-SCT = Kiddie Sluggish Cognitive Tempo Scale; M = mothers; O = oppositional defiant disorder; TRF = Teacher’s Report Form.

<sup>a</sup>Sample consists of Comm (community sample), Clinic (clinic sample [in most cases, samples with attention-deficit/hyperactivity disorder; ADHD] specifically), College (college undergraduates), and Pop (population-based sample [nationally representative]).

<sup>b</sup>SCT measures derived from BAARS, CADBI, CBCL, CBRS, CCI, DICA-IV (2 SCT items from the DSM-IV field trials added to the DSM-IV DICA-IV), K-SCT, Penny (SCT scale developed by Penny et al. [2009]), TRF.

<sup>c</sup>Raters include parent (P), self (S), and teacher (T).

<sup>d</sup>Factor analysis includes CFA, EFA, and ESEM.

<sup>e</sup>Other symptoms include I, H, A, D, C, and O.

<sup>f</sup>Bauermeister et al. (2012) reported results from expanded analysis of Bauermeister et al. (2005) sample.

<sup>g</sup>These studies examined different raters (parent, teacher) and different time points in the same sample of children.

<sup>h</sup>Barkley (2012) is a subset of results from Barkley (2011).

<sup>i</sup>N = 703 for analyses using parent ratings, N = 366 for analyses using teacher ratings.

<sup>j</sup>N = 3,925 for analyses using self ratings, N = 2,242 for analyses using parent ratings.

<sup>k</sup>CFA results were reported in the published manuscript, but EFA was conducted on the same dataset for this review.

**TABLE 3** Summary of Results of Factor Analytic Studies of Sluggish Cognitive Tempo (SCT)

Item Content	Total Factor Analytic Studies That Included the Item			Percentage of EFA That Reported a Primary Loading on an SCT factor <sup>a</sup> (%)			Mean (Range) of Loadings of the Item on an SCT Factor			
	Parent Ratings	Teacher Ratings	Self-Report	Parent Ratings	Teacher Ratings	Self-Report	Parent Ratings	Teacher Ratings	Self-Report	All Raters
Sluggish <sup>‡</sup>	9	7	1	75	83	100	0.75 (0.55–1.0)	0.86 (0.77–0.93)	0.80	<b>0.80</b>
Tired/lethargic <sup>‡</sup>	6	6	2	100	100	100	0.78 (0.64–0.95)	0.84 (0.75–0.94)	0.73 (0.60–0.86)	<b>0.80</b>
Slow thinking/processing <sup>‡</sup>	4	4	2	100	100	0	0.84 (0.81–0.86)	0.85 (0.67–0.97)	0.65 (0.60–0.70)	<b>0.80</b>
Loses train of thought/cognitive set <sup>‡</sup>	4	4	—	100	100	—	0.79 (0.74–0.87)	0.79 (0.72–0.88)	—	<b>0.79</b>
Sleepy/drowsy <sup>‡</sup>	11	9	3	90	100	67	0.79 (0.64–1.0)	0.83 (0.65–0.91)	0.72 (0.67–0.81)	<b>0.79</b>
Spacey <sup>‡</sup>	5	4	2	80	100	50	0.77 (0.41–0.93)	0.82 (0.66–0.94)	0.72 (0.70–0.74)	<b>0.78</b>
In a fog <sup>‡</sup>	7	4	3	100	100	67	0.79 (0.66–0.87)	0.79 (0.71–0.88)	0.71 (0.70–0.74)	<b>0.77</b>
Underactive/slow moving <sup>‡</sup>	9	8	3	100	100	100	0.76 (0.60–0.92)	0.83 (0.73–0.84)	0.68 (0.55–0.84)	<b>0.77</b>
Daydreams <sup>‡</sup>	14	12	3	80	86	100	0.74 (0.45–0.98)	0.79 (0.56–0.92)	0.68 (0.61–0.83)	<b>0.75</b>
Lost in thoughts <sup>‡</sup>	10	5	—	71	83	—	0.72 (0.45–0.87)	0.79 (0.56–0.92)	—	<b>0.75</b>
Stares blankly <sup>‡</sup>	13	7	—	69	75	—	0.71 (0.45–0.98)	0.78 (0.56–0.93)	—	<b>0.74</b>
Easily confused <sup>‡</sup>	11	8	3	71	75	100	0.72 (0.40–0.95)	0.78 (0.65–0.96)	0.70 (0.66–0.78)	<b>0.74</b>
Apathetic/unmotivated <sup>‡</sup>	2	5	1	50	100	100	N/A	0.73 (0.57–0.80)	0.71	<b>0.72</b>
Absentminded	6	5	1	33	50	—	0.59 (0.35–0.90)	0.61 (0.41–0.82)	0.72	0.61
Slow work/task completion	3	2	—	0	67	—	—	0.59	—	0.59
Low initiative and persistence	5	4	—	0	25	—	0.38 (0.26–0.50)	0.63 (0.41–0.84)	—	0.50
Poor listening/difficulty with directions	3	3	1	0	0	0	<0.50 <sup>b</sup>	N/A	0.51	<0.50
Easily bored	2	2	2	0	0	0	0.23 (0.16–0.29)	0.17	0.63	0.38

Note: The 13 items with a mean factor loading >0.70 are marked with a superscript dagger (†) and have their factor loading in boldface type. EFA = exploratory factor analysis.

<sup>a</sup>Primary loading on SCT factor in EFA that included symptoms of attention-deficit/hyperactivity disorder (ADHD), and sometimes additional disorders. Primary loading defined as a loading of 0.60 or higher on an SCT factor that was at least 0.20 higher than the next highest loading on any other factor.

<sup>b</sup>Poor listening note: all items were dropped from all final factor analytic models due to low loadings on an SCT factor or cross-loadings with DSM-IV inattention.

**TABLE 4** Summary of Meta-Analytic Findings of the Reliability of Sluggish Cognitive Tempo (SCT)

Reliability Criterion	Number of Studies	Total N	Pooled Estimate
Cronbach $\alpha$ in samples of children and adolescents			Mean $\alpha^a$
≤3 SCT items	8	2,968	0.64
4–6 SCT items	7	2,699	0.80
≥7 SCT items	11	4,561	0.91
Cronbach $\alpha$ in samples of adults			
≤3 SCT items	1	983	0.73
≥7 SCT items	7	6,960	0.86
			$r_w$ (95% CI) <sup>b</sup>
Test–retest reliability			
Children and adolescents, 6- to 12-week interval	6	1,892	0.80 (0.77, 0.83)
Children and adolescents, 1-year interval	2	1,464	0.74 (0.71, 0.76)
Self-report ratings by adults	1	62	0.88 (0.85, 0.91)
Interrater reliability			
Parent and teacher ratings of children and adolescents	4	2,134	0.54 (0.29, 0.72)
Mother and father ratings of children and adolescents	1	802	0.71 (0.67, 0.74)
Parent and self-report ratings of young adults	1	2,135	0.48 (0.46, 0.50)
Teacher and child self-report ratings	1	124	0.53 (0.40, 0.66)

Note: SCT = sluggish cognitive tempo. See Table S2, available online, for a full list of effect sizes included in these summary statistics.

<sup>a</sup>Mean  $\alpha$  weighted by sample size.

<sup>b</sup>Pooled estimate of test–retest and interrater reliability correlations weighted by sample size.

4 items have adequate-to-high internal consistency, with optimal reliability obtained for scales with 7 or more items. In contrast, this specific aspect of reliability was clearly weaker for scales with 3 or fewer SCT items (Table 4).

**Test–Retest Reliability.** Although fewer studies have reported test–retest reliability of SCT ratings, the studies that have been completed to date suggest that SCT ratings are highly reliable over periods ranging from a few weeks to 1 year when ratings are completed by the same individual at both points in time (Table 4). Although additional research is needed to more thoroughly examine the stability of SCT over longer developmental periods, these initial data provide important support for the stability of SCT.

**Interrater Reliability.** Only a handful of studies have examined the interrater reliability of SCT. Analyses of 1 sample of children found a high correlation between ratings by mothers and fathers<sup>18</sup> and ratings by teachers and teachers' aides,<sup>17</sup> and another study reported a high correlation between children's self-ratings of SCT and teacher ratings.<sup>15</sup> In contrast, correlations were more modest between parent and teacher ratings of children and between young adults' self-report ratings and ratings completed by their parents (Table 4). It is important to note, however, that the interrater reliability estimates for SCT are similar to the moderate interrater reliability observed for measures of ADHD<sup>11</sup> and measures of internalizing and externalizing psychopathology.<sup>39,40</sup>

In summary, studies of the reliability of SCT provide strong support for the reliability of SCT. Similar to other dimensions of psychopathology, additional research is needed to examine the implications of the modest agreement between raters in different settings.

## External Validity

After adequate internal validity has been demonstrated, a construct's external validity can be evaluated by examining associations with demographic characteristics and key external criteria. For a mental disorder, the most decisive external criterion is evidence that the disorder is associated with distress or functional impairment that is sufficiently severe to warrant intervention. In this section, we first summarize the zero-order correlations of SCT in relation to demographic characteristics, other psychopathology symptoms, and measures of functional and neuropsychological impairment in both children and adults. Next, for functional and neuropsychological impairments, we examine whether associations remain significant when symptoms of other correlated disorders are controlled.

## SCT in Relation to Demographic Characteristics

Modest support was found for SCT symptoms being higher in males than in females in children but not adults (weighted correlations are summarized in Table 5, with individual studies and effects listed in Table S3, available online). In terms of group differences in the proportion of males and females, mixed findings have been reported. Several studies find no group differences in sex<sup>33,41–43</sup>; 2 studies found a higher prevalence of girls in the high SCT groups than in the ADHD-only groups<sup>12,44</sup>; and 1 study reported a higher percentage of boys in a high SCT group than a low SCT group.<sup>45</sup> However, it should be noted that this latter study did not divide the high SCT group into those with and without ADHD, leaving it possible that the high proportion of boys in the high SCT group was due to a subset who also displayed elevated ADHD symptoms.



**TABLE 5** Summary of Meta-Analytic Findings Examining the Bivariate Association Between Sluggish Cognitive Tempo (SCT) and Demographic Characteristics, Other Psychopathologies, Functional Impairment, and Neuropsychological Impairment

Construct	Studies of Children and Adolescents		Studies of Adults	
	Studies (Total N)	Weighted <i>r</i> (95% CI)	Studies (Total N)	Weighted <i>r</i> (95% CI)
Demographic variables				
Age	10 (4,240)	0.11 (0.01, 0.22)	6 (3,528)	0.00 (−0.09, 0.09)
Sex	11 (4,899)	0.05 (0.01, 0.09)	6 (2,830)	0.01 (−0.06, 0.07)
Socioeconomic status	3 (2,185)	−0.10 (−0.03, −0.17)	3 (2,304)	−0.09 (−0.15, −0.02)
ADHD				
Inattention	27 (12,972)	0.63 (0.56, 0.69)	8 (7,911)	0.72 (0.67, 0.76)
Hyperactivity-impulsivity	26 (12,623)	0.32 (0.24, 0.40)	8 (7,911)	0.46 (0.39, 0.52)
Internalizing psychopathology				
Anxiety	10 (3,521)	0.30 (0.18, 0.31)	5 (2,439)	0.46 (0.39, 0.54)
Depression	10 (3,797)	0.49 (0.34, 0.61)	6 (2,737)	0.50 (0.43, 0.57)
Shy/withdrawn	3 (1,096)	0.41 (0.18, 0.59)	—	—
Anxious/depressed	4 (1,572)	0.53 (0.35, 0.67)	—	—
Overall internalizing	7 (1,659)	0.40 (0.31, 0.49)	—	—
Externalizing psychopathology				
ODD	11 (4,724)	0.32 (0.22, 0.40)	—	—
CD	7 (2,113)	0.31 (0.22, 0.40)	—	—
Aggressive behavior	2 (997)	0.27 (0.16, 0.37)	—	—
Delinquent behavior	2 (997)	0.21 (0.09, 0.34)	—	—
Overall externalizing	5 (1,274)	0.36 (0.31, 0.41)	—	—
Functional impairment				
Global	4 (3,392)	0.44 (0.36, 0.51)	3 (1,499)	0.52 (0.33, 0.67)
Academic	15 (6,623)	0.44 (0.35, 0.52)	3 (2,089)	0.45 (0.19, 0.72)
Social	18 (7,954)	0.38 (0.33, 0.43)	3 (2,390)	0.37 (0.12, 0.56)
Neuropsychological functioning				
Intelligence	7 (1,560)	0.24 (0.14, 0.33)	—	—
Response inhibition	2 (930)	0.24 (0.14, 0.33)	1 (298)	0.13 (0.01, 0.25)
Working memory	4 (1,211)	0.19 (0.08, 0.29)	1 (298)	−0.03 (−0.14, 0.09)
Reaction time variability	3 (1,071)	0.23 (0.12, 0.33)	1 (298)	0.11 (0.00, 0.22)
Processing speed	2 (861)	0.29 (0.05, 0.53)	—	—
Vigilance	2 (930)	0.29 (0.09, 0.49)	1 (298)	0.01 (−0.11, 0.14)

Note: See Table S3, available online, for a full list of studies examining SCT in relation to demographic characteristics; Table S4, available online, for studies examining SCT in relation to attention-deficit/hyperactivity disorder (ADHD) and other psychopathologies; Table S5, available online, for studies examining SCT in relation to functional impairment; and Table S6, available online, for studies examining SCT in relation to individually administered neuropsychological measures. Studies using ratings of neuropsychological functioning are summarized in the text. All effects are scaled so that positive correlations indicate that higher levels of SCT are associated with greater impairment on the cognitive task. Dash (—) indicates no studies. CD = conduct disorder; ODD = oppositional defiant disorder.

There is a small but significant positive association between SCT and age (see Tables 5 and S3, available online). Other studies have examined whether children with high levels of SCT symptoms differ from other children on demographic characteristics. Although several studies did not find individuals with high SCT to differ in age from individuals without high SCT,<sup>41-45</sup> Barkley found age differences in his nationally representative studies of children<sup>12</sup> and adults.<sup>33</sup> In both studies, individuals with elevated SCT symptoms were older than individuals with elevated ADHD symptoms or co-occurring SCT and ADHD symptoms.<sup>12,33</sup>

Although few studies have examined SCT in relation to socioeconomic status (SES),<sup>12,33,34,42,45,46</sup> meta-analytic results of extant studies suggest that SCT may be related to less family income and parent education in children

(see Table S3A, available online) and adults (see Table S3B, available online).

Finally, most studies conducted to date indicate that individuals with elevated SCT symptoms do not differ in race/ethnicity from individuals without elevated SCT symptoms.<sup>12,14,20,33,41,42,44,45</sup> In contrast, 1 study found nonwhite children to have higher rates of SCT than white children.<sup>47</sup>

In summary, dimensional SCT symptoms are only modestly associated with male sex, and individuals with high levels of SCT symptoms may be more likely to be female. There is a modest positive association between SCT and age. More research is needed to investigate SCT in relation to demographic characteristics as well as the emerging evidence that SCT is associated with lower socioeconomic status.

### SCT in Relation to Other Psychopathologies

Results of factor analyses provide critical support for the distinction between SCT and other common symptoms of psychopathology. In addition, it is essential to understand how SCT relates to these other symptom dimensions to determine how SCT may fit within a broader developmental psychopathology framework. Therefore, a meta-analysis was completed to summarize results from all studies that reported correlations between SCT and any other dimension of psychopathology (weighted correlations are summarized in Table 5, with individual studies and effects listed in Table S4, available online).

*Univariate Associations Between SCT and Other Psychopathologies.* Significant correlations with small to medium effect sizes were reported between SCT and all other dimensions of psychopathology that have been measured in existing studies. Effects were larger for inattention and internalizing symptoms in comparison to hyperactivity-impulsivity and symptoms of other externalizing psychopathologies. However, consistent with the results of the factor analyses, correlations between SCT ratings and all other dimensions of psychopathology, including ADHD inattention, were well below what would be considered redundant (i.e.,  $<0.85$ )<sup>48,49</sup> in studies of children, adolescents, and adults. These results provide key support for the distinction between SCT and *DSM-IV* inattention, as well as the overall construct validity of SCT.

*Multivariate Analyses to Test Whether SCT Is Independently Associated With Other Psychopathologies.* Although studies show SCT symptoms to remain positively associated with internalizing symptoms when controlling for ADHD inattention symptoms, several studies found SCT to be unassociated or negatively associated with hyperactive-impulsive and externalizing symptoms when controlling for ADHD inattention.<sup>14,18,19,25,27,29,30,35</sup> In contrast, ADHD inattention remains associated with hyperactive-impulsive and externalizing symptoms when controlling for SCT symptoms, pointing to an important double dissociation of SCT and ADHD inattention symptoms that provides further support for the distinctiveness of SCT from ADHD.

In summary, studies examining SCT in relation to other psychopathology symptoms find that SCT symptoms are more strongly associated with ADHD inattention and internalizing behaviors than with ADHD hyperactivity-impulsivity and externalizing behaviors (although additional studies are needed in samples of adults in particular). The association between SCT and internalizing is robust and generally holds even after controlling for ADHD symptoms, whereas the association between SCT and hyperactivity-impulsivity or externalizing is often nonsignificant or negative when controlling for ADHD inattention. Nonetheless, the etiology of each of these associations with SCT is unknown and represents an important area for future research.

### SCT in Relation to Functional Impairment

*Univariate Associations Between SCT and Functional Impairment.* As summarized in Table 5 and Table S5, available online, meta-analytic results of studies of children and

adolescents suggests that SCT is associated with significant global, social, and academic impairment, with moderate effect sizes in each of these domains (weighted  $r = 0.38$ – $0.44$ ). Furthermore, extant longitudinal studies have found SCT to be associated with increased social impairment across a school year<sup>45</sup> and both academic and social impairment up to 2 years later.<sup>17,30,50</sup> In addition, the most comprehensive study of impairment and SCT found that SCT is associated with significant impairment in a range of additional domains, including self-care, sports performance, and completion of chores.<sup>12</sup>

A similar pattern was reported by a smaller number of studies that examined the relation between SCT and impairment in adults.<sup>33,34,43,46,51,52</sup> These studies found significant correlations between SCT and global impairment ( $r = 0.52$ ), academic impairment ( $r = 0.45$ ), and social impairment ( $r = 0.37$ ), with correlations that were similar in magnitude to the results obtained in studies of children and adolescents. In addition, Barkley<sup>33</sup> reported that SCT was associated with a wide range of aspects of functional impairment that are more relevant in adulthood, including friendships and romantic relationships, home life and parenting, occupational functioning, management of finances, and health maintenance.

*Multivariate Analyses to Test Whether SCT Is Independently Associated With Impairment.* To clarify whether SCT is independently associated with impairment or whether these difficulties are better explained by the symptoms of ADHD and other disorders that often co-occur with SCT, a number of studies conducted multiple regression analyses in which ratings of SCT and other symptoms were entered simultaneously as independent variables predicting each measure of impairment. One study found that SCT ratings were associated with global impairment in children even after symptoms of ADHD, depression, and anxiety were controlled.<sup>32</sup> Another study similarly found SCT to remain associated with poorer quality of life in adults after controlling for ADHD symptoms.<sup>46</sup>

Several studies have found SCT symptoms to be associated with significant social impairment even when symptoms of ADHD, oppositional defiant disorder, conduct disorder, and depression were controlled.<sup>14,15,25,30,32,45,51,53,54</sup> SCT is also uniquely associated with lower self-reported self-esteem and emotion regulation difficulties when controlling for ADHD.<sup>15,33,43,51,52</sup> Although no study has examined SCT and sleep functioning in children, SCT symptoms remain associated with adults' daytime sleepiness, poorer sleep quality, and nighttime sleep disturbance when controlling for ADHD symptoms.<sup>36,55,56</sup>

Results for measures of academic functioning are somewhat less consistent. Several studies reported that SCT was associated with multiple aspects of academic impairment after ADHD symptoms were controlled,<sup>17,23,25,27,30,32,34,57</sup> whereas a smaller subset of studies (typically using shorter measures of SCT) found that any academic impairment associated with SCT was explained by comorbid inattention.<sup>13,22,53,58,59</sup>

In summary, SCT is associated with significant functional impairment in a wide range of important domains, and most

studies suggest that SCT is associated with impairment even after symptoms of ADHD and other psychopathology are controlled. Overall, these results provide key support for the external and discriminant validity of the SCT construct. Future studies should increase the specificity used in examining various domains of impairment and sleep functioning. More studies with young children, adolescents, and adults are also needed to understand how SCT affects functioning across development. In addition, the 4 longitudinal studies conducted to date<sup>17,30,45,50</sup> support the predictive validity of SCT as related to social and academic impairment, but there is a clear need for more longitudinal studies that examine the effects of SCT across domains of impairment and across longer developmental periods in individuals with and without ADHD.

### SCT in Relation to Neuropsychological and Executive Functioning

*Univariate Associations Between SCT and Neuropsychological/Executive Functioning.* A smaller number of studies have examined the neurocognitive correlates of SCT (Table 5 and Table S6, available online). In studies of children and adolescents, elevations of SCT symptoms are significantly associated with lower scores on tests of general intelligence, response inhibition, working memory, processing speed, and sustained attention, although these effect sizes are relatively small in magnitude (weighted  $r = 0.19-0.29$ ).<sup>22,32,53,54,58,60-62</sup> Other studies have generally found SCT to be significantly correlated with poorer executive functioning in daily life as assessed by parent rating scales.<sup>12,63,64</sup>

The single study that examined the relation between SCT and performance on individually administered neuropsychological tests in young adults found no significant associations between SCT and neuropsychological performance.<sup>43</sup> In contrast, 3 studies with adults have shown SCT to be significantly correlated with executive functioning in daily life as assessed with self-report rating scales.<sup>33,43,52</sup>

*Multivariate Analyses to Test Whether SCT Is Independently Associated With Neuropsychological/Executive Functioning.* In contrast to the results of most studies of functional impairment, results of neuropsychological and executive functioning studies were more mixed when symptoms of inattention were controlled. One study suggests that SCT may be related to slower motor speed in youth with ADHD.<sup>65</sup> Converging results from 2 studies that administered extensive neuropsychological batteries suggest that SCT may be independently associated with weaknesses in sustained attention and processing speed, whereas phenotypic correlations between SCT and response inhibition, working memory, and reaction time variability may be due to comorbid ADHD inattention symptoms.<sup>32,58</sup> In studies examining children's daily life executive functioning using parent-report rating scales, SCT is often no longer associated with behavioral regulation domains but remains associated with metacognitive domains, such as planning, organization, and self-motivation above and beyond ADHD.<sup>12,63,64</sup>

The 1 study that examined SCT and neuropsychological test performance in adults found SCT to be not associated with performance after controlling for ADHD, although it is important to note that ADHD was also unassociated with performance after controlling for SCT in this college student sample.<sup>43</sup> Studies using self-report rating scales of daily life executive functioning have generally found SCT symptoms to remain significantly associated with poorer executive functioning, with effects strongest for the self-regulation of emotion and self-organization domains.<sup>33,43,52</sup>

In summary, initial neuropsychological and executive functioning studies provide important support for the external validity of SCT. However, mixed results when symptoms of ADHD inattention were controlled suggest that much more work is needed to clarify the neuropsychological and executive functioning correlates of SCT. In addition, it should be noted that most studies examining SCT and neuropsychological functioning have done so in ADHD-defined samples (and with tests typically included in ADHD studies), which may cloud any neuropsychological impairments unique to SCT.

## DISCUSSION

The results of this meta-analytic review provide compelling support for the internal validity of SCT in addition to promising support for the external validity of SCT. This review demonstrates that at least a subset of SCT symptoms is statistically distinct from the ADHD symptom dimensions and inattention specifically. The separability of SCT from ADHD has now been replicated in 20 studies using a wide range of raters, age ranges, sampling procedures, and factor analytic methods. Although notably fewer in number, the studies examining the factor structure of SCT in relation to other psychopathologies including internalizing symptoms and daytime sleepiness have also found a distinct SCT factor. Results also converge in supporting the internal consistency, test-retest reliability, and interrater reliability of the SCT construct, although more studies are clearly needed to evaluate the stability of SCT across development and agreement between raters (and reasons for modest agreement) in different settings. In comparison to internal validity, fewer studies have examined the external validity of SCT. For instance, whereas the relation between SCT and ADHD symptoms has been examined in more than 20,000 children and adults, SCT in relation to other psychopathologies, functional impairment, or demographic characteristics has been examined in less than half this many, and the relation between SCT and neuropsychological functioning has been examined in fewer than 2,000 individuals (Table 5). Nonetheless, although this is clearly an important area for additional research, results from this review generally support the internal and external validity of SCT.

### What Is the Diagnostic Validity of SCT?

This meta-analytic review has focused on the internal validity and external validity of the SCT construct. We now discuss key findings stemming from this review in the

context of the 8 domains outlined by Cantwell<sup>5</sup> for evaluating whether a construct demonstrates diagnostic validity.

1. *Clinical Phenomenology.* As described by Cantwell,<sup>5</sup> “the clinical phenomenology of a disorder includes its essential core features and its associated features; it also entails subtyping the disorder and determining the existence of comorbid conditions” (p. 2151). Results from our review clearly indicate that SCT is distinct from ADHD and other psychopathology symptom dimensions. In particular, studies using both exploratory and confirmatory factor analytic techniques have found a set of SCT symptoms to be distinct from ADHD inattentive symptoms, and recent bifactor modeling further demonstrates that ADHD or a general disruptive behavior factor does not underlie SCT symptoms.<sup>21,37</sup> However, in contrast to the established symptom set for the ADHD dimensions, an agreed-upon symptom set for SCT does not exist. Results from this review point to 13 specific SCT items that can serve as a good starting point for establishing an SCT symptom set (see items marked with a double-dagger in Table 3). These 13 SCT items all have strong (>0.70) loadings on an SCT factor in exploratory factor analyses and include both the cognitive (e.g., daydreams, easily confused) and behavioral (e.g., sluggish, underactive) aspects that have historically been used to define SCT. As a starting place for establishing an SCT symptom set that can be used consistently across studies, we recommend that future studies examining SCT use measures that capture most if not all of these 13 SCT item constructs/domains. Although existing SCT measures capture most of these constructs/domains,<sup>12,15,25,29,42</sup> each existing measure does not include certain SCT constructs/domains and/or has items that simultaneously assess multiple domains (e.g., “mentally foggy or easily confused”). It is thus likely that these measures will need to be modified and/or new measures developed.

Although distinct, findings from this review also indicate that SCT is related to other psychopathologies, such as ADHD inattention and depression. Importantly, when controlling for ADHD inattention, a growing number of studies find that associations between SCT and internalizing symptoms (e.g., anxiety, depression) remain significant, whereas its association with externalizing behavior (e.g., hyperactivity-impulsivity, oppositionality) becomes nonsignificant or even negative. Extant studies also show a significant relation between SCT and sleep problems (and daytime sleepiness in particular),<sup>36,55,66</sup> although no study has evaluated the relation between SCT and objective measures of sleep using actigraphy, polysomnography, or the Multiple Sleep Latency Test (MSLT). In addition, most studies to date have used community samples or samples of individuals with ADHD, with all but a few recent studies<sup>16,67,68</sup> conducted in North American or European samples. Studies evaluating the presence, structure, and impact of SCT in other clinical populations (e.g., anxiety, mood, sleep disorders), as well as other cultural contexts, are needed to further understand the clinical phenomenology of SCT.

Finally, SCT is less clearly associated with laboratory-based tasks of neuropsychological functioning or rating

scales of daily life executive functioning, particularly when controlling for ADHD symptoms. Exceptions include laboratory-based tasks assessing processing speed and sustained attention or rating scale measures assessing organization, planning, self-motivation, and emotion regulation. It is important to note, however, that most studies examining SCT in relation to neuropsychological functioning have lacked a comprehensive neuropsychological test battery and/or have included samples of children diagnosed with ADHD, possibly obscuring neuropsychological impairments unique to SCT.

2. *Demographic Factors.* Surprisingly few studies have examined SCT in relation to demographic factors. All but 1 study have found SCT to be unassociated with race/ethnicity. Although a consistent pattern has not emerged across the available studies, there is some indication that individuals with high levels of SCT symptomatology are more likely to be older or female. Of note, these findings are specific to the few studies that have selected individuals based on high SCT; SCT may be modestly associated with age or sex in the population, and a recent study found a slight increase in SCT symptoms over a 10-year period spanning preschool to adolescence.<sup>69</sup> However, more studies are needed before conclusions can be drawn. It would be interesting to know whether the developmental progression of SCT parallels the progression of depressive symptoms, whereby rates of depression increase in adolescence and for females in particular. No study has directly examined the age of onset of SCT symptoms, and only 1 longitudinal study has crossed developmental periods (and depression was not evaluated).<sup>69</sup> In addition, findings from this review suggest that SCT may be related to lower socioeconomic status, including less parent education and lower family income.<sup>12,45</sup> This finding is discussed in more detail below. At a minimum, it would be helpful if future studies report correlations of SCT with demographic factors, even if this is not the primary focus of the study.

3. *Psychosocial Factors.* As noted above, several studies suggest that SCT may be related to psychosocial stress (e.g., lower family income).<sup>12,45</sup> There are several areas of psychosocial adjustment (e.g., attachment, family functioning, trauma exposure) that have yet to receive empirical attention in relation to SCT. Further investigation of the extent to which psychosocial stress or adversity contributes to the development, presence, or exacerbation of SCT symptoms is needed.

4. *Biological Factors.* The lack of studies examining biological factors in relation to SCT is a notable gap in the available research. The 1 study that has examined SCT in relation to brain functioning found SCT symptoms to be associated with hypoactivity in the left superior parietal lobe during a cued Flanker task, suggesting an association between SCT and impaired reorienting or shifting of attention.<sup>70</sup> This is an important preliminary finding suggesting that SCT and ADHD inattention may be meaningfully distinguished across attention networks.<sup>15,71</sup> Furthermore, as SCT is characterized by underarousal,<sup>1,3,72</sup> studies are needed to evaluate whether SCT is associated with a deficit in

the release of catecholamines (e.g., dopamine, norepinephrine),<sup>72</sup> as well as genetic polymorphisms and other brain regions/networks (e.g., default mode network, thalamus)<sup>73,74</sup> linked to underarousal and vigilance. Findings from such studies may also help to explain associations between SCT and certain comorbidities such as sleep problems and daytime sleepiness. Moreover, as underarousal has also been investigated in relation to ADHD,<sup>75-77</sup> research in this area may further our understanding of the distinction between (and the frequent co-occurrence of) ADHD and SCT.

5. *Family Genetic Factors.* Two twin studies have examined the genetic and environmental influences on SCT symptoms in children (Willcutt *et al.*, unpublished material, 2015).<sup>78</sup> Both studies found SCT to be significantly heritable, with between approximately one- to two-thirds of the total variance in SCT accounted for by genetic influences. Both studies also found SCT symptoms to be less heritable than ADHD symptoms. Additional twin studies are needed, as well as adoption, family aggregation, and gene mapping studies that have not yet been used in studies of SCT.

6. *Family Environmental Factors.* The 2 twin studies that demonstrated significant heritability of SCT also found that shared and nonshared environmental factors influence the presence of SCT (Willcutt *et al.*, unpublished material, 2015)<sup>78</sup> Although this finding will need to be replicated, it points to an important direction for future research. Identification of potential environmental factors that contribute to SCT, such as socioeconomic status and psychosocial stress, as well as parenting styles and behaviors, parent-child interactions, and parent psychopathology may provide potential avenues for intervention or prevention.

7. *Natural History.* As specified by Cantwell, 1 aspect of natural history is understanding the “untreated outcome of various types of child and adolescent psychopathology” (p. 2152).<sup>5</sup> Results of this review converge in finding SCT to be moderately associated with global, social, and academic impairment. Crucially, in many instances, SCT remains associated with psychosocial functioning when controlling for a range of other important variables. Of note, many studies conducted to date have used broad rating scale measures of adjustment, so multi-method investigations of the nuanced impairments associated with SCT are needed. For example, an association between SCT and social impairment has been documented in multiple studies, but many of these studies have relied on global indices of social problems or peer impairment. There is some indication that SCT is linked to social withdrawal specifically,<sup>32,41,42</sup> but this needs to be further evaluated using a range of methods (e.g., ratings, direct observation, peer sociometric nominations). Further exploration of the precise academic impairments associated with SCT is also warranted.

Few longitudinal studies have examined the longitudinal stability of SCT across developmental stages<sup>69</sup> or its predictive validity.<sup>17,30,45,50</sup> No retrospective studies of SCT exist. Moreover, 3 of the 4 studies examining the longitudinal correlates of SCT have done so using different raters and different time points across a 2-year period in the same sample, underscoring the need for longitudinal studies across longer developmental periods and in a variety of

samples. Future studies should examine not only the longitudinal course and correlates of SCT but also predictors of continuity/discontinuity and moderators of SCT in relation to subsequent impairment.

8. *Intervention Response.* No interventions have been designed or evaluated for targeting SCT specifically. Of note, a home-school behavioral intervention has been developed for children with ADHD-I that included conceptualizations of SCT in its development.<sup>79</sup> An evaluation of this intervention did show a reduction in SCT symptoms among children diagnosed with ADHD-I.<sup>79</sup> The only study evaluating the effects of medication on SCT symptoms found atomoxetine to reduce SCT symptoms in youth with ADHD,<sup>80</sup> which aligns with other studies showing atomoxetine to be effective for youth with ADHD who have co-occurring internalizing problems (although findings are stronger for comorbid anxiety than for comorbid depression).<sup>81-83</sup> The sole study evaluating SCT as a predictor of treatment response did not find SCT to affect response to methylphenidate,<sup>44</sup> although it should be acknowledged that this study used a limited measure of SCT and did not use a randomized design. Intervention is clearly an important area for future research, both in terms of evaluating whether existing treatments affect SCT symptoms in a range of samples (e.g., those with ADHD, depression, sleep disorders), but also the development and evaluation of interventions specifically targeting SCT. In particular, since initial evidence suggests that SCT aligns with the internalizing rather than externalizing spectrum of psychopathology,<sup>47</sup> approaches grounded in a cognitive-behavioral therapy approach may be effective.<sup>3,84</sup> Given the strong association between SCT and depression, behavioral activation and physical activity may be other worthwhile directions for intervention.

In summary, the available studies included in this review generally support these 8 diagnostic validity domains. However, there are some domains that remain unexamined, and in none of these domains is there overwhelmingly convincing evidence to support the diagnostic validity of SCT. In most cases, it is simply too early to draw conclusions, as the recurring theme across domains is the promise and possibility that must be tempered by the need for more research. Given the current rate at which SCT-related research is accumulating, it is likely that a much clearer picture will emerge within the next decade.

**What Is the Current State (and Future Possibility) of SCT?** This meta-analytic review provides compelling support for the internal validity of the SCT construct, as well as initial support for its external validity. However, as noted in the preceding section, research on SCT is still largely in its infancy, rendering the diagnostic validity of SCT unclear. Thus, a lingering question that remains is how SCT should be conceptualized. We turn our attention to this issue, including key voids in research necessary for answering this question.

*Five Important Directions for SCT Research.* Although we will not reiterate all of the future research directions

discussed above, 5 crucial areas for research attention are important to highlight:

1. There is a clear need for longitudinal research examining the SCT construct. Longitudinal research can not only advance our understanding of the stability and predictive validity of SCT (which are themselves important domains for evaluation), but can also examine the developmental progression, moderators, mediators, and underlying mechanisms that link SCT to demographic, mental health, or impairment domains. For instance, this review makes clear that SCT is associated with ADHD inattention and depression, as well as other psychopathology dimensions. What is unknown is the directionality or progression of these associations. Does SCT contribute to the development of depression or vice versa? The answer to this question is entirely unknown.
2. The time has come to truly “extend SCT research beyond the domain of ADHD” (p. 1055).<sup>85</sup> To date, almost all studies of SCT have been conducted in community/school-based samples or samples of children with ADHD. Given what we know thus far about SCT, there is a need to examine SCT in other clinical samples such as youth with depression, learning disabilities, and sleep disorders. Does SCT remain distinct from these domains in these samples? Does SCT predict impairment in these samples? Answers to these questions also remain unknown.
3. The vast majority of SCT studies have relied solely on rating scales of behavior and impairment. Studies using these measures are important and should continue to be conducted and disseminated. Nonetheless, if SCT research is to truly advance, it must become multi-methodological and must consider both etiology and impairment. Both subjective and objective measures of functioning should be used, as should studies examining the biological bases of SCT with genetic<sup>77</sup> and neuro-imaging methodologies.
4. Although this review points to 13 core constructs/domains of SCT that can be differentiated from ADHD (Table 3), more psychometric research is needed to more clearly identify the best symptom set for defining and assessing SCT. In particular, it will be critical for future research using these 13 SCT constructs/domains to determine whether SCT is best characterized as unidimensional or multidimensional. Given the wide variability in the SCT item sets used across studies to date, we were unable to address this issue in the current meta-analysis (see Table 2 for descriptive summary). Several recent studies have found that SCT may be multidimensional,<sup>12,19,23,25,27,29</sup> although a large study of youth with and without ADHD<sup>32</sup> and a population-based study of adults<sup>33</sup> both found SCT symptoms to load on a single factor. Also, although initial findings evaluating a child self-report version of Penny’s measure found support for a 3-factor structure, bi-factor modeling and omega hierarchical reliability statistics indicated that the measure is best considered as unidimensional rather than multidimensional.<sup>15</sup> Relatedly,

the association of SCT with working memory/loss of cognitive set<sup>27</sup> must remain preliminary until tested by future studies that include similar items. In addition, although there is preliminary evidence that teachers have an advantage in detecting SCT,<sup>20,26</sup> the comparison of informants is understudied, and it is commendable that parent, teacher, and self-report measures of SCT have been developed in the past few years.<sup>12,15,25,27,29,33</sup> Identifying the optimal reporter(s) of SCT is important, given some findings that SCT may operate differently in the home versus school contexts.<sup>59</sup> This is particularly important, as SCT seems to be more closely related to internalizing than externalizing psychopathology,<sup>47</sup> and child self-report may thus be especially important to consider, which stands in contrast to current practice for assessing ADHD in children.

5. Finally, although it is increasingly clear that SCT is statistically distinct from other psychopathologies, it remains to be seen whether SCT can also be identified as clinically distinct. That is, can individuals with SCT be identified and distinguished from individuals who meet diagnostic criteria for ADHD, depression, anxiety, and sleep disorders? If these individuals can be identified, the unique nature of SCT can be articulated from a clinical viewpoint that is currently absent. If these individuals cannot be identified, it raises questions as to the distinctiveness of SCT. Studies using a clinical interview to assess SCT<sup>86</sup> would be highly valuable in addressing this issue.

*Should SCT Be Conceptualized as a Distinct Psychiatric Disorder?* It has been argued that SCT may be its own psychiatric disorder.<sup>3,4</sup> Do results of our review support this possibility? In short, it is simply too early to tell. There are many issues related to this possibility that have yet to receive any empirical scrutiny at all, and several other issues have been examined in only a handful of studies. Most of these studies have been conducted by a small group of investigators, making replication from other research groups an important consideration. In addition, although cut-points on parent rating scales have been used to identify individuals with elevated SCT symptoms,<sup>12,33</sup> no study has directly recruited individuals based on the presence or absence of SCT using other methods (e.g., clinical interviews) and evaluated whether these groups of individuals meaningfully differ across units of analysis. If SCT cannot be identified separately from comorbidities such as ADHD, depression, or sleep disorders, it raises the question of whether SCT should be conceptualized as a distinct disorder or instead a specifier of existing disorders that is important for understanding developmental trajectories, functioning, and treatment decision making.

Given these considerations, we believe that the ongoing study of SCT is clearly important but do not recommend describing SCT in diagnostic terms at this time. To do so prematurely could create confusion for researchers, clinicians, and families, as well as the public more broadly. As such, it also seems premature to use terminology suggesting that the SCT construct is a diagnostic entity

(e.g., concentration deficit disorder).<sup>3,4</sup> Although the term “sluggish cognitive tempo” is not ideal, it has the historical advantage of being the research term used to describe these symptoms over the past 3 decades and seems appropriate to use until a term more closely grounded in empirical research emerges. We appreciate that this approach may lead to some individuals “falling through the cracks” in terms of identification and intervention. This possibility should not be dismissed and underscores the importance of ongoing SCT research to evaluate not only diagnostic validity but also approaches for prevention and intervention.

As research findings continue to accumulate, it may become clearer that SCT should be thought of in diagnostic terms. Nevertheless, other possibilities should also be considered, including the possibility that SCT has transdiagnostic utility: that is, it is possible that SCT is a meaningful construct that predicts the developmental course, associated impairments, and treatment response across a range of other psychopathologies, “much like emotion regulation is not itself a disorder but is nonetheless critically important for understanding psychopathology across the life span” (p. 4).<sup>1</sup> In sum, a pluralistic approach is needed to understand the current state and future possibilities of SCT.

Several limitations should be noted when interpreting the results of this review. First, there were limited numbers of relevant studies for many of the internal and external validity domains examined, which necessarily tempers confidence in the conclusions that can be drawn. Each domain would benefit from additional studies, particularly in evaluating the unique aspects of impairment related to SCT as opposed to more global measures of functioning. In addition, most research to date has used a cross-sectional design with school-aged children, leaving longitudinal research and studies with young children, adolescents, and adults a research priority. Studies not published in English were excluded, which limited our ability to conduct a fully systematic review of the literature. Statistical tests for publication or other selection biases indicate that the exclusion of unpublished studies did not have a substantive impact on the overall pattern of findings (see failsafe *N*, Egger’s regression, and trim and fill statistics in Supplement 1, available online). Finally, there was a high degree of heterogeneity in most of the meta-analytic effect sizes (see Cochrane’s *Q* and *I*<sup>2</sup> statistics in Supplement 1, available online), and we were unable to consider potential moderators of associations such as ADHD diagnostic status or rater. These too are important areas for future research.

In conclusion, this is the first meta-analysis evaluating the internal and external validity of SCT. Overall, findings provide support for the internal and external validity of the SCT construct, although it is important to note that

research on SCT is in its infancy, particularly as compared to disorders such as ADHD. Studies incorporating multiple levels of analysis (e.g., genetics, neuroimaging, behavior, impairment) are particularly lacking, as are longitudinal studies that span development and evaluate treatment response. It is thus premature to conceptualize SCT in diagnostic terms, but this and other possibilities, such as the transdiagnostic value of SCT, are important areas for further investigation. &

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