CHAPTER 15

Sluggish cognitive tempo

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Introduction

There has been longstanding interest in how best to categorize the heterogeneity of children with ADHD (1, 2). In an effort to understand the variability of inattention specifically, there has recently been a resurgence of interest in sluggish cognitive tempo (SCT) (3–6), a set of behavioural symptoms characterized by daydreaming, mental fogginess/confusion, and slowed behaviour/thinking. This chapter provides a brief history of the SCT construct and summarizes the rapidly accumulating research examining SCT as distinct from ADHD and other psychopathologies and the extent to which SCT is uniquely related to functioning in various domains of major life activities. We conclude by commenting on issues of terminology and offering key directions for future research.

History of the sluggish cognitive tempo construct

The first description of attentional problems characterized by underarousal and daydreaming is believed to have appeared in a textbook by Sir Alexander Crichton in 1798 (7). As Barkley (5) observed, Crichton's description of individuals with 'low power', who are generally unsocial and insensible to external objects, may align with current descriptions of SCT. Nevertheless, the scientific study of SCT began in the 1980s when the third edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) (8) created two subtypes of attention deficit disorder (ADD): one with hyperactivity (ADD+H) and one without hyperactivity (ADD–H). In turn, researchers began to investigate differences between children with ADD+H or ADD–H. A thorough review of this research is beyond the scope of this chapter (see Barkley [5] and Becker et al. [4] for more thorough reviews). It was during this time that researchers first began to evaluate the extent to which a set of symptoms characterized by sluggishness, apathy, lethargy, and being in a world of one's own were part of, or distinct from, inattention as defined in the DSM (9–11). However, when SCT symptoms showed poor predictive power for identifying ADHD in the DSM-IV field trials (12), the study of SCT largely stalled. That is until an influential review by Milich et al. (2) appeared as well as an empirical article by McBurnett and colleagues (13), both published in 2001. These papers emphasized the importance of further study of the SCT construct. In turn, a slow but steady increase in the number of SCT studies began to enter the published literature (4). Specifically, since these two seminal papers were published in 2001, over 50 papers related to SCT have been published, most in just the past 5 years (14). As the findings from these studies have accumulated (and are reviewed next), the study of SCT has largely shifted away from efforts to identify differences between subtypes of ADHD to examine SCT in its own right, independent from and in contrast to ADHD.

Sluggish cognitive tempo is distinct from ADHD

It is now clear that SCT symptoms are empirically distinct from symptoms of ADHD. Becker et al. (14) recently conducted a meta-analysis that included factor analytical studies with over 19,000 children and adults, and found strong support for 13 SCT symptoms that loaded consistently on an SCT factor as opposed to an ADHD factor. These 13 symptoms are listed in Box 15.1. Although additional measurement work needs to be conducted now that these 13 items have been identified, it is important to note that parent, teacher, adult self-report, and child self-report ratings scales (15–20), as well as a semistructured clinical interview (21), have been developed that include at least most of these 13 items. Studies using these measures demonstrate that SCT can be reliability assessed, with excellent internal consistency and test–retest reliability, and moderate interrater reliability (14). Importantly, the internal validity of SCT has been identified across a range of sample types (clinical, community, epidemiological), age ranges (spanning ages 3–96 years), and continents (North America, South America, Europe, and Asia) (14).

Additional evidence for the distinctiveness of SCT from ADHD comes from Barkley's two nationally representative studies examining SCT in children (16) and adults (15). As in other studies, Barkley found evidence for an SCT factor that did not load with ADHD. Further, Barkley classified participants as meeting research criteria for SCT and/or ADHD and found only moderate overlap between the SCT and ADHD classifications. In both studies, approximately half of the participants with ADHD were not classified with SCT, and vice versa. These findings led Barkley (15) to conclude that the relation between SCT and ADHD 'is similar to comorbidity between two disorders, such as between anxiety and depression, than one of subtyping within a single disorder or in which subgroups share the same disorder of attention' (p. 987). In line with this conclusion, two recent studies using bifactor modelling found SCT to fall outside of a general ADHD or disruptive behaviour factor (22, 23). SCT and ADHD also appear to have different developmental trajectories, with ADHD hyperactive-impulsive symptoms declining, ADHD inattentive symptoms remaining relatively stable, and SCT symptoms showing a slight increase across childhood and adolescence (24).

Box 15.1 Sluggish cognitive tempo items

1. Apathetic/unmotivated
2. Daydreams
3. Easily confused
4. In a fog
5. Loses train of thought/cognitive set
6. Lost in thoughts
7. Sluggish
8. Sleepy/drowsy
9. Slow thinking/processing
10. Spacey
11. Stares blankly
12. Tired/lethargic
13. Underactive/slow moving

Note: These 13 items were identified in a meta-analysis as having a mean factor loading >.70 on a sluggish cognitive tempo factor; see Becker et al. (14).

Data from Becker SP, Leopold DR, Burns GL, Jarrett MA, Langberg JM, Marshall SA, et al. The internal, external, and diagnostic validity of sluggish cognitive tempo: A meta-analysis and critical review. J Am Acad Child Adolesc Psychiatry. 2015. Advance online publication. DOI: http://dx.doi.org/10.1016/j.jaac.2015.12.006

Little is known regarding the aetiology of SCT, but again, there is emerging evidence for the separateness of SCT from ADHD. The only published twin study to date found SCT to be substantially heritable, although SCT symptoms were less heritable than ADHD and more strongly influenced by shared and non-shared environmental factors (25). The one neuroimaging study of SCT found an association between SCT symptom severity and hypoactivity in the left superior parietal lobe during a cued flanker task, suggestive of deficits in reorientating or shifting of attention (26) that is different from the attention networks implicated in ADHD (27). Although these findings are intriguing, much more research examining the aetiology of SCT is clearly needed. Nevertheless, essentially all available research points to SCT as a set of attentional symptoms distinct from those captured by ADHD.

Sluggish cognitive tempo in relation to functioning and impairment

In comparison to the number of studies examining the structure of SCT, especially as related to ADHD, far fewer studies have examined SCT in relation to functioning and impairment. Nevertheless, a growing body of research indicates that SCT is associated with poorer adjustment across a range of domains of major life activities, with many associations remaining even after controlling for ADHD (for additional reviews, see [5, 14]).

Mental health functioning

Multiple studies have documented a significant association between SCT and internalizing symptoms such as anxiety and depression (20, 28–30), although it should be noted that SCT is distinct from both anxiety and depression (18, 31, 32). In considering specific internalizing comorbidities, SCT seems to be more strongly related to depression than to anxiety (16, 31, 33, 34). However, this may be more true in children than in adults (14) and could therefore simply reflect the increased rates of depression as children transition to adolescence and adulthood. In any event, SCT is clearly more strongly related to internalizing problems than with externalizing problems such as hyperactivity-impulsivity and oppositionality (14). In fact, although SCT and ADHD inattention are themselves strongly correlated, these two attention domains evince differential associations with hyperactive-impulsive and externalizing symptoms when controlling for each other. When controlling for ADHD inattention, SCT is unassociated with, or is *negatively* associated with, externalizing behaviours, whereas ADHD inattention remains strongly positively associated with externalizing behaviours (18–20, 31, 32). Crucially, recent longitudinal studies have found the same pattern whereby SCT predicted greater internalizing behaviours and fewer hyperactive-impulsive and oppositional behaviours up to 2 years later (35–37). Further, children with ADHD who also have high levels of SCT show lower rates of externalizing behaviours such as aggression than other children with ADHD (38, 39).

These findings provide additional compelling evidence for the separation of SCT and ADHD. It would be even more so if additional research supports the hypothesis that SCT falls under the internalizing umbrella of psychopathology whereas ADHD falls under the externalizing domain (40). As Barkley has noted (41), it remains important to identify functioning domains on which SCT may have a negative impact, as well as domains that are unlikely to be impacted by SCT or for which SCT may actually play a buffering role. Future studies should therefore continue to examine SCT in relation to internalizing-salient domains while also testing the hypothesis that SCT would be unrelated to externalizing-salient domains characterized by impulsivity and risk-taking, including substance use, delinquency and antisocial behaviours, speedy and reckless driving, and accidental injuries.

Academic functioning

Somewhat discrepant findings have been reported in studies examining SCT in relation to academic functioning. Several studies did not find the presence of SCT to predict academic impairment or negatively impact academic achievement after accounting for ADHD (29, 38, 39, 42, 43). This may be due to these studies examining the relation between SCT and academics in samples of children diagnosed with ADHD, which may confound findings specific to SCT. It could also result from using very short measures of SCT comprised of just a few items. In line with this possibility, the most recent studies that have used longer, validated measures of SCT have repeatedly found SCT symptoms to be uniquely associated with poorer academic functioning, even in ADHD samples (30, 33, 44) or after controlling for ADHD symptom severity (17, 18, 32, 34, 45–47). In particular, it appears that SCT is associated with problems in organization and homework completion (16, 39, 44). In terms of academic achievement, SCT may be uniquely associated with lower achievement in mathematics, word reading, and written language (28, 32). Nevertheless, there is some indication even from these recent studies that ADHD is a stronger contributor than SCT to academic problems (16, 18, 19, 48), although more research needs to be done using real world measures of academic functioning and success. Of note, the three studies that have examined overall grade point average (GPA) each found SCT to significantly predict lower GPA after accounting for ADHD symptoms (30, 32, 44). Indeed, two of these studies found ADHD symptoms to no longer remain associated with GPA when SCT was added to the model (30, 44). In sum, additional research is needed to determine the precise relation between SCT and

academic functioning, as well as the mechanisms and developmental progression of this association.

Socioemotional functioning

Studies have repeatedly found a link between SCT and problems/impairment in social functioning (17, 18, 29, 31, 45, 47). One recent study found SCT symptoms to predict increased peer problems across the duration of a school year even after controlling for other psychopathology symptoms and initial levels of peer functioning (49). In terms of specific domains of social functioning, both Bauermeister et al. (28) and McBurnett et al. (19) found SCT to predict poorer social skills in children even after controlling for ADHD severity, though only when teacher ratings were used and not parent ratings. This is perhaps because teachers have ample opportunity to observe children's interactions with peers and the specific types of peer difficulties related to SCT. In a novel computer chat room experiment, SCT symptoms were found to be associated with a poorer perception of subtle social cues and less memory for the chat room conversation (50). Further, whereas children with ADHD are often disliked or actively rejected by peers owing to noxious and annoying behaviours (51), children with SCT are likely to be socially withdrawn and isolated (32, 38, 39, 52). Whether or not this is primarily due to shyness or social disinterest has not yet been specifically examined. It seems likely due to shyness as opposed to lack of interest, since SCT is also associated with parent reports of children's fear/shyness as part of the fight–flight–freeze motivational system (40) and children's own ratings of loneliness (17). Additional studies supporting this conclusion would have clear implications for intervention (e.g. social skills training).

Since SCT is associated with both social problems and depressive symptoms, it is not surprising that it has also been linked to problems in emotion regulation, although findings are not fully consistent across studies. In his nationally representative sample of youth, Barkley (16) found SCT to be significantly associated with children's self-regulation of emotion deficits, but SCT was a much smaller contributor than either ADHD inattention or hyperactivity-impulsivity to these deficits. Conversely, SCT was the strongest predictor of self-regulation of emotion deficits in Barkley's representative sample of adults (15). Does this mean the association between SCT and emotion regulation difficulties grows stronger across development? This is unknown, and no longitudinal studies examining the association between SCT and emotion regulation exist. However, there is some evidence that SCT is in fact associated with poorer emotion regulation in youth. Specifically, Becker et al. (17) found both child- and teacher-rated SCT symptoms to predict poorer child-rated emotion regulation coping (ability to cope with and control emotional experiences appropriately) and lower self-esteem even after controlling for ADHD, anxiety, and depressive symptoms. Likewise, Araujo Jiménez et al. (53) found SCT to be significantly associated with poorer parent-rated emotional control in a sample of children and adolescents with ADHD, even after controlling for both ADHD inattention and hyperactivity-impulsivity. These findings converge with other studies of college students that consistently document a link between SCT and emotion dysregulation (54–56). Interestingly, Willcutt et al. (32) hypothesized that regulation difficulties may account for the association between SCT and social isolation, whereby 'individuals with SCT may become overwhelmed by the rapid flow of complex information that must be processed continuously to successfully navigate social interactions, which may then lead to avoidance of social situations and subsequent isolation' (pp. 32–3). In line with this possibility, Flannery et al. (54) directly tested and found support for emotion dysregulation mediating the association between SCT and social problems, albeit with a cross-sectional design making longitudinal studies that are better suited for testing indirect and developmental pathways a clear research priority. Also important to distinguish in future research is whether such dysregulation actually reflects greater emotional distress, more emotional lability, or poor self-regulation of elicited emotions.

Neuropsychological and executive functioning

Only a handful of studies have examined neuropsychological deficits associated with SCT, and most of these studies have used samples (and, thus, neuropsychological test batteries) specific to, or oversampled for, ADHD (28, 32, 43, 57, 58). In general, these studies demonstrate that SCT is unassociated with pervasive neuropsychological deficits, whereas a large literature links ADHD to wideranging neuropsychological impairments (59, 60). In particular, ADHD is clearly associated with deficits in response inhibition, working memory, and response variability. In contrast, SCT does not seem to be associated with any of these deficits when accounting for the contribution of ADHD symptoms (28, 32, 43). However, there is some indication that SCT may be uniquely related to problems with early information processing or selective attention (58). Furthermore, two of the larger studies examining SCT in relation to neuropsychological test performance both found SCT to be related to poorer sustained attention after controlling for ADHD inattention (32, 43). There is mixed evidence in terms of whether or not SCT remains associated with slower motor or processing speed after controlling for ADHD (28, 32, 61). One study found SCT to be associated with variability of spatial memory performance specifically (57). Replication will be needed to draw conclusions regarding any of these findings. It will be especially important for future studies examining SCT in relation to neuropsychological functioning to do so in non-ADHD samples, as well as to use neuropsychological and cognitive tests more specific to the nature of SCT that may not be frequently used in studies of ADHD. In addition, only one study has examined SCT in relation to neuropsychological test performance in adults. This study found neither SCT nor ADHD to predict test performance, which is likely due to this study's use of a college student sample (55). In sum, although more studies are needed, it seems clear that SCT is not associated with substantial or pervasive executive functioning (EF) deficits. This is yet one more indication that SCT is best conceptualized as distinct from ADHD.

When ratings of EF in daily life are used, as opposed to neuropsychological tests of EF, there appear to be different conclusions between studies of youth or adults. This can be seen most clearly in Barkley's national studies (15, 16), which did not suffer from possible ascertainment bias by using previously ADHD defined samples. In the study of children and adolescents, SCT accounted for very little variance across all EF dimensions when controlling for ADHD symptoms in youth, though SCT did contribute somewhat to deficits in self-organization and problem-solving. ADHD inattention was far and away the strongest predictor of EF deficits across all EF dimensions (16). In contrast, in the national study of adults, ADHD inattention remained the strongest predictor of self-management to time and self-motivation EF dimensions, but SCT accounted for the most variance in the self-organization

and problem-solving, self-restraint, and self-regulation of emotion dimensions (15). In line with these studies, Araujo Jiménez (53) found ADHD symptoms to be a stronger predictor than SCT symptoms of most EF dimensions in a sample of youth aged 6–17 years, though SCT did contribute meaningful variance in predicting emotional control, working memory, and planning/organization. Similarly, Becker and Langberg (62) found SCT to be significantly associated with metacognitive EF deficits in a sample of young adolescents diagnosed with ADHD. However, this was only true when parent ratings of SCT were used and not teacher ratings. As hypothesized, SCT was not significantly associated with behavioural regulation EF deficits that are more strongly linked to poor inhibition (62). In line with findings from Barkley's nationally representative study of adults (15), two studies conducted with college students suggest SCT to be more clearly related to EF ratings in adults, with the strongest associations apparent for the organization and problem-solving, self-motivation, and self-regulation of emotion dimensions, with significant, albeit weaker, associations also found for the time management and self-restraint dimensions (55, 56). Once again, longitudinal and developmentally informed studies are needed to evaluate the developmental pathways and mechanisms of the linkage between SCT and daily life EF deficits.

Functional impairment

In addition to studies examining SCT in relation to aspects of adjustment, several studies have examined SCT in relation to global and specific domains of functional impairment. SCT is related to global impairment (14), though likely to a lesser degree and less pervasively so than ADHD (15, 16). Nevertheless, it is clear that SCT is associated with functional impairment not explained by any overlap with ADHD (15, 16, 19, 32, 56). It is thus not surprising that SCT is also linked to increased stress (63) and a poorer quality of life (64), as well as lower educational attainment and socioeconomic status (14–16). As such, SCT is clearly not benign and so is deserving of both research inquiry and clinical attention.

Key directions for future research

Throughout this chapter we have pointed out key directions for future research, but it is important to mention a few additional areas (see also 3, 14). First, there is a clear need for additional longitudinal research. Such studies would allow for a better understanding of the developmental course of SCT, longitudinal correlates, and pathways by which SCT is associated with developmental outcomes and functional impairments. Second, and relatedly, the vast majority of extant SCT studies have focused on school-aged children and college students, making research in other developmental periods, as well as in other samples of young adults, a necessity. Third, very little is known regarding the aetiology of SCT, including either biological and/or environmental contributions to the SCT phenotype. In particular, social adversities may be more relevant for the aetiology of SCT than for ADHD (3, 14). Pathological mind wandering is another intriguing possibility for the aetiology of SCT (3, 65). As we have discussed elsewhere (5, 6, 17), it is also possible that different attentional networks are implicated in SCT versus ADHD. Moreover, SCT is only modestly associated with nighttime sleep problems (66–68), but is moderately related to both sleep quality and daytime sleepiness (66, 69). It would be fruitful for studies to evaluate whether similar mechanisms contribute to SCT and hypersomnia, including use of methodologies such as the multiple sleep latency test and default mode network connectivity.

Finally, it is important to examine whether the presence of SCT symptoms predicts or moderates treatment response to currently established evidence-based interventions for ADHD as well as other psychiatric disorders (e.g. anxiety, mood, sleep disorders). It is likewise important to evaluate interventions that might be efficacious for treating SCT, including both pharmacological and psychosocial interventions. Initial evidence indicates that atomoxetine may effectively reduce SCT symptoms (70), and selective serotonin reuptake inhibitors may also be effective given the strong association between SCT and internalizing problems such as anxiety and depression (5). In terms of psychosocial interventions, Pfiffner and colleagues (71) found evidence-based parent- and teacher-mediated behavioural interventions to reduce SCT symptoms in children with ADHD predominantly inattentive type. Given SCT's associations with internalizing problems (especially depression) and social withdrawal, we have also hypothesized that cognitive–behavioural treatment (CBT), social skills training, and behavioural activation may be effective for treating SCT (3, 5, 14, 72). However, each of these possibilities has yet to be examined empirically. Of course, it will be important to do so in samples that are not restricted to individuals diagnosed with ADHD but instead use a broader sampling strategy (e.g. including individuals with anxiety, depression, and/or sleep disorders) or are selected based on SCT specifically.

A comment on terminology

Before concluding, we believe one additional point regarding terminology is warranted. In coauthoring this chapter, we hope it is clear that we (SPB and RAB) agree on the vast majority of conclusions that can be drawn regarding the current state of SCT, as well as the very clear need for additional research that can ultimately shed light on the aetiology, course, and clinical implications of SCT. Nevertheless, we also acknowledge one area of professional disagreement; namely, the best term to be used to describe this constellation of symptoms.

Barkley has advocated moving away from the SCT terminology and suggests the term concentration deficit disorder (CDD) (3, 5, 41, 73) for various reasons, 'not the least of which is that SCT can be viewed by the public as pejorative, derogatory, or frankly offensive' (5) (p. 435). It is important to note that Becker agrees that the SCT term is far from optimal and 'shares with Barkley the overarching concerns he has for the SCT label' (17) (p. 1038). In fact, this is why Becker avoided the SCT term when naming his youth self-report scale, calling it the Child Concentration Inventory (17). However, Becker has also expressed concerns that it may be 'premature to use terminology suggesting that the SCT construct is a diagnostic entity (e.g. Concentration Deficit Disorder)' (14). Just as the SCT label may be perceived as pejorative and offensive, premature use of the term 'disorder' may create confusion for families and professionals while also drawing unfavourable media attention that detracts from the important value of SCT research (74, 75). Further, terminology suggestive of a 'disorder' casts SCT in a dichotomous light, and Becker believes it is important to consider other options, especially the possibility that SCT is best viewed as a transdiagnostic construct as opposed to a categorical diagnosis (4, 76). This latter possibility aligns with the broader shift in psychiatry as outlined

by the United States National Institute of Mental Health research domain criteria (RDoC) initiative (77, 78). Thus, Becker would currently favour a term that focuses more on 'symptoms' as opposed to 'diagnosis' and is actively considering possible alternatives as research continues to emerge, even though he has so far continued to use the SCT terminology.

However, as Barkley has appropriately noted, 'the mere fact that SCT has existed for 35 years and so should continue to be used out of mere historical tradition is not a convincing reason to retain a term that research participants and other consumers likely will find offensive' (41). Becker agrees fully with this point, but for him the issue is one of timing: a new term is needed but much more remains to be learned before we can settle on an ideal term. There is no easy solution to this dilemma, as the introduction of a new term earlier may likely spur the very research needed to determine an even better term. Barkley has clearly acknowledged that he is not wedded to his proposed CDD terminology (41). He suggests here that perhaps the term 'syndrome' might be a better modifier of 'concentration deficit' so as not to convey official sanctioning of it as a recognized clinical disorder. Where does this leave us? We both agree that we need a new term that: 1) accurately describes the constellation of symptoms and state of the science; and 2) is not off-putting to either the scientific community or general population. We hope we can find consensus around such a term in the near future. In the meantime, we are certainly in agreement that there is a crucial need for much more research on SCT/CDD, and we hope our colleagues will join us in pursuing this theoretically and clinically important area of study.

References

1. Diamond A. Attention-deficit disorder (attention-deficit/hyperactivity disorder without hyperactivity): a neurobiologically and behaviorally distinct disorder from attention-deficit/hyperactivity disorder (with hyperactivity). *Development and Psychopathology*. 2005;17(3):807–25.
2. Milich R, Balentine AC, Lynam DR. ADHD combined type and ADHD predominantly inattentive type are distinct and unrelated disorders. *Clinical Psychology: Science and Practice*. 2001;8(4):463–88.
3. Barkley RA. Sluggish cognitive tempo (concentration deficit disorder?): current status, future directions, and a plea to change the name. *Journal of Abnormal Child Psychology*. 2014;42(1):117–25.
4. Becker SP, Marshall SA, McBurnett K. Sluggish cognitive tempo in abnormal child psychology: an historical overview and introduction to the special section. *Journal of Abnormal Child Psychology*. 2014;42(1):1–6.
5. Barkley RA. Concentration deficit disorder (sluggish cognitive tempo). In: Barkley RA, editor. *Attention-deficit/hyperactivity disorder: A handbook for diagnosis and treatment*. 4th edn. New York: Guilford, 2015. pp. 435–52.
6. Becker SP. Topical review: sluggish cognitive tempo: research findings and relevance for pediatric psychology. *Journal of Pediatric Psychology*. 2013;38(10):1051–7.
7. Crichton A. *An inquiry into the nature and origin of mental derangement: comprehending a concise system of the physiology and pathology of the human mind and a history of the passions and their effects*. London: Cadell & Davies, reprinted by AMS Press, New York, 1976; 1798.
8. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*, 3rd edn. Washington, D.C.: American Psychiatric Association, 1980. 494 pp.
9. Carlson CL, Lahey BB, Neeper R. Direct assessment of the cognitive correlates of attention-deficit disorders with and without hyperactivity. *Journal of Psychopathology and Behavioral Assessment*. 1986;8(1):69–86.
10. Lahey BB, Schaughency EA, Frame CL, Strauss CC. Teacher ratings of attention problems in children experimentally classified as exhibiting attention deficit disorder with and without hyperactivity. *Journal of the American Academy of Child Psychiatry*. 1985;24(5):613–16.
11. Neeper R, Lahey BB. The Children's Behavior Rating Scale: a factor analytic developmental study. *School Psychology Review*. 1986;15(2):277–88.
12. Frick PJ, Lahey BB, Applegate B, Kerdyck L, Ollendick T, Hynd GW, et al. DSM-IV field trials for the disruptive behavior disorders: symptom utility estimates. *Journal of the American Academy of Child and Adolescent Psychiatry.* 1994;33(4):529–39.
13. McBurnett K, Pfiffner LJ, Frick PJ. Symptom properties as a function of ADHD type: an argument for continued study of sluggish cognitive tempo. *Journal of Abnormal Child Psychology.* 2001;29(3):207–13.
14. Becker SP, Leopold DR, Burns GL, Jarrett MA, Langberg JM, Marshall SA, et al. The internal, external, and diagnostic validity of sluggish cognitive tempo: a meta-analysis and critical review. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2016;55(3):163–78.
15. Barkley RA. Distinguishing sluggish cognitive tempo from attention-deficit/hyperactivity disorder in adults. *Journal of Abnormal Psychology.* 2012;121(4):978–90.
16. Barkley RA. Distinguishing sluggish cognitive tempo from ADHD in children and adolescents: executive functioning, impairment, and comorbidity. *Journal of Clinical Child & Adolescent Psychology.* 2013;42(2):161–73.
17. Becker SP, Luebbe AM, Joyce AM. The Child Concentration Inventory (CCI): initial validation of a child self-report measure of sluggish cognitive tempo. *Psychological Assessment.* 2015;27(3):1037–52.
18. Lee S, Burns GL, Snell J, McBurnett K. Validity of the sluggish cognitive tempo symptom dimension in children: sluggish cognitive tempo and ADHD-inattention as distinct symptom dimensions. *Journal of Abnormal Child Psychology*. 2014;42(1):7–19.
19. McBurnett K, Villodas M, Burns GL, Hinshaw SP, Beaulieu A, Pfiffner LJ. Structure and validity of sluggish cognitive tempo using an expanded item pool in children with attention-deficit/hyperactivity disorder. *Journal of Abnormal Child Psychology*. 2014;42(1):37–48.
20. Penny AM, Waschbusch DA, Klein RM, Corkum P, Eskes G. Developing a measure of sluggish cognitive tempo for children: content validity, factor structure, and reliability. *Psychological Assessment.* 2009;21(3):380–9.
21. McBurnett K. *Kiddie-Sluggish Cognitive Tempo Diagnostic Interview Module for Children and Adolescents*. San Francisco: McBurnett, 2010.
22. Garner AA, Peugh J, Becker SP, Kingery KM, Tamm L, Vaughn AJ, et al. Does sluggish cognitive tempo fit within a bi-factor model of ADHD? *Journal of Attention Disorders*. 2017;21(8):642–54.
23. Lee S, Burns GL, Beauchaine TP, Becker SP. Bifactor latent structure of attention-deficit/hyperactivity disorder (ADHD)/oppositional defiant disorder (ODD) symptoms and first-order latent structure of sluggish cognitive tempo symptoms. *Psychological Assessment.* 2016;28(8):917–28.
24. Leopold DR, Christopher ME, Burns GL, Becker SP, Olson RK, Willcutt EG. Attention-deficit/hyperactivity disorder and sluggish cognitive tempo throughout childhood: temporal invariance and stability from preschool through ninth grade. *Journal of Child Psychology and Psychiatry*. 2016;57(9):1066–74.
25. Moruzzi S, Rijsdijk F, Battaglia M. A twin study of the relationships among inattention, hyperactivity/impulsivity and sluggish cognitive tempo problems. *Journal of Abnormal Child Psychology.* 2014;42(1):63–75.
26. Fassbender C, Krafft CE, Schweitzer JB. Differentiating SCT and inattentive symptoms in ADHD using fMRI measures of cognitive control. *Neuroimage Clinic*. 2015;8:390–7.
27. Posner MI, Rothbart MK. Research on attention networks as a model for the integration of psychological science. *Annual Review of Psychology*. 2007;58:1–23.
28. Bauermeister JJ, Barkley RA, Bauermeister JA, Martinez JV, McBurnett K. Validity of the sluggish cognitive tempo, inattention,

and hyperactivity symptom dimensions: neuropsychological and psychosocial correlates. *Journal of Abnormal Child Psychology*. 2012;40(5):683–97.
29. Becker SP, Langberg JM. Sluggish cognitive tempo among young adolescents with ADHD: relations to mental health, academic, and social functioning. *Journal of Attention Disorders.* 2013;17(8):681–9.
30. Becker SP, Langberg JM, Luebbe AM, Dvorsky MR, Flannery AJ. Sluggish cognitive tempo is associated with academic functioning and internalizing symptoms in college students with and without attention-deficit/hyperactivity disorder. *Journal of Clinical Psychology*. 2014;70(4):388–403.
31. Becker SP, Luebbe AM, Fite PJ, Stoppelbein L, Greening L. Sluggish cognitive tempo in psychiatrically hospitalized children: factor structure and relations to internalizing symptoms, social problems, and observed behavioral dysregulation. *Journal of Abnormal Child Psychology.* 2014;42(1):49–62.
32. Willcutt EG, Chhabildas N, Kinnear M, DeFries JC, Olson RK, Leopold DR, et al. The internal and external validity of sluggish cognitive tempo and its relation with DSM-IV ADHD. *Journal of Abnormal Child Psychology.* 2014;42(1):21–35.
33. Fenollar Cortés J, Servera M, Becker SP, Burns GL. External validity of ADHD inattention and sluggish cognitive tempo dimensions in Spanish children with ADHD. *Journal of Attention Disorders.* 2017;21(8):656–66.
34. Jacobson LA, Murphy-Bowman SC, Pritchard AE, Tart-Zelvin A, Zabel TA, Mahone EM. Factor structure of a sluggish cognitive tempo scale in clinically-referred children. *Journal of Abnormal Child Psychology.* 2012;40(8):1327–37.
35. Bernad MD, Servera M, Becker SP, Burns GL. Sluggish cognitive tempo and ADHD inattention as predictors of externalizing, internalizing, and impairment domains: a 2-year longitudinal study. *Journal of Abnormal Child Psychology*. 2016;44(4):771–85.
36. Bernad MD, Servera M, Grases G, Collado S, Burns GL. A cross-sectional and longitudinal investigation of the external correlates of sluggish cognitive tempo and ADHD-inattention symptom dimensions. *Journal of Abnormal Child Psychology*. 2014;42(7):1225–36.
37. Servera M, Bernad MD, Carrillo JM, Collado S, Burns GL. Longitudinal correlates of sluggish cognitive tempo and ADHD-inattention symptom dimensions with Spanish children. *Journal of Clinical Child & Adolescent Psychology.* 2016;45(5):632–41.
38. Carlson CL, Mann M. Sluggish cognitive tempo predicts a different pattern of impairment in the attention deficit hyperactivity disorder, predominantly inattentive type. *Journal of Clinical Child & Adolescent Psychology.* 2002;31(1):123–9.
39. Marshall SA, Evans SW, Eiraldi RB, Becker SP, Power TJ. Social and academic impairment in youth with ADHD, predominately inattentive type and sluggish cognitive tempo. *Journal of Abnormal Child Psychology.* 2014;42(1):77–90.
40. Becker SP, Fite PJ, Garner AA, Greening L, Stoppelbein L, Luebbe AM. Reward and punishment sensitivity are differentially associated with ADHD and sluggish cognitive tempo symptoms in children. *Journal of Research in Personality*. 2013;47(6):719–27.
41. Barkley RA. Commentary on the internal, external, and diagnostic validity of sluggish cognitive tempo: a meta-analysis and critical review. *Journal of the American Academy of Child and Adolescent Psychiatry.* 2016;55(3):157–8.
42. Watabe Y, Owens JS, Evans SW, Brandt NE. The relationship between sluggish cognitive tempo and impairment in children with and without ADHD. *Journal of Abnormal Child Psychology.* 2014;42(1):105–15.
43. Wåhlstedt C, Bohlin G. DSM-IV-defined inattention and sluggish cognitive tempo: independent and interactive relations to neuropsychological factors and comorbidity. *Child Neuropsychology.* 2010;16(4):350–65.
44. Langberg JM, Becker SP, Dvorsky MR. The association between sluggish cognitive tempo and academic functioning in youth with attention-deficit/hyperactivity disorder (ADHD). *Journal of Abnormal Child Psychology.* 2014;42(1):91–103.
45. Burns GL, Servera M, Carrillo JM, Cardo E. Distinctions between sluggish cognitive tempo, ADHD-IN, and depression symptom dimensions in Spanish first-grade children. *Journal of Clinical Child & Adolescent Psychology.* 2013;42(6):796–808.
46. Khadka G, Burns GL, Becker SP. Internal and external validity of sluggish cognitive tempo and ADHD inattention dimensions with teacher ratings of Nepali children. *Journal of Psychopathology and Behavioral Assessment.* 2016;38(3):433–42.
47. Lee S, Burns GL, Becker SP. Towards establishing the transcultural validity of sluggish cognitive tempo: evidence from a sample of South Korean children. *Journal of Clinical Child & Adolescent Psychology*. Advance online publication. doi: 10.1080/15374416.2016.1144192.
48. Belmar M, Servera M, Becker SP, Burns GL. Validity of sluggish cognitive tempo in South America: an initial examination using mother and teacher ratings of Chilean children. *Journal of Attention Disorders.* 2017;21(8):667–72.
49. Becker SP. Sluggish cognitive tempo and peer functioning in school-aged children: a six-month longitudinal study. *Psychiatry Research.* 2014;217(1–2):72–8.
50. Mikami AY, Huang-Pollock CL, Pfiffner LJ, McBurnett K, Hangai D. Social skills differences among attention-deficit/hyperactivity disorder types in a chat room assessment task. *Journal of Abnormal Child Psychology.* 2007;35(4):509–21.
51. Gardner DM, Gerdes AC. A review of peer relationships and friendships in youth with ADHD. *Journal of Attention Disorders*. 2015;19(10):844–55.
52. Capdevila-Brophy C, Artigas-Pallarés J, Navarro-Pastor JB, García-Nonell K, Rigau-Ratera E, Obiols JE. ADHD predominantly inattentive subtype with high sluggish cognitive tempo: a new clinical entity? *Journal of Attention Disorders*. 2014;18(7):607–16.
53. Araujo Jiménez EA, Jané Ballabriga MC, Bonillo Martin A, Arrufat FJ, Serra Giacobo R. Executive functioning in children and adolescents with symptoms of sluggish cognitive tempo and ADHD. *Journal of Attention Disorders*. 2015;19(6):507–14.
54. Flannery AJ, Becker SP, Luebbe AM. Does emotion dysregulation mediate the association between sluggish cognitive tempo and college students' social impairment? *Journal of Attention Disorders*. 2016;20(9):802–12.
55. Jarrett MA, Rapport HF, Rondon AT, Becker SP. ADHD dimensions and sluggish cognitive tempo symptoms in relation to self-report and laboratory measures of neuropsychological functioning in college students. *Journal of Attention Disorders*. 2017;21(8):673–83.
56. Wood WL, Lewandowski LJ, Lovett BJ, Antshel KM. Executive dysfunction and functional impairment associated with sluggish cognitive tempo in emerging adulthood. *Journal of Attention Disorders.* 2017;21(8):691–700.
57. Skirbekk B, Hansen BH, Oerbeck B, Kristensen H. The relationship between sluggish cognitive tempo, subtypes of attention-deficit/hyperactivity disorder, and anxiety disorders. *Journal of Abnormal Child Psychology*. 2011;39(4):513–25.
58. Huang-Pollock CL, Nigg JT, Carr TH. Deficient attention is hard to find: applying the perceptual load model of selective attention to attention deficit hyperactivity disorder subtypes. *Journal of Child Psychology and Psychiatry, and Allied Disciplines.* 2005;46(11):1211–18.
59. Willcutt EG, Doyle AE, Nigg JT, Faraone SV, Pennington BF. Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. *Biological Psychiatry.* 2005;57(11):1336–46.
60. Hervey AS, Epstein JN, Curry JF. Neuropsychology of adults with attention-deficit/hyperactivity disorder: a meta-analytic review. *Neuropsychology*. 2004;18(3):485–503.
61. Hinshaw SP, Carte ET, Sami N, Treuting JJ, Zupan BA. Preadolescent girls with attention-deficit/hyperactivity disorder: II. Neuropsychological performance in relation to subtypes and

individual classification. *Journal of Consulting and Clinical Psychology.* 2002;70(5):1099–111.
62. Becker SP, Langberg JM. Attention-deficit/hyperactivity disorder and sluggish cognitive tempo dimensions in relation to executive functioning in adolescents with ADHD. *Child Psychiatry and Human Development.* 2014;45(1):1–11.
63. Combs MA, Canu WH, Broman-Fulks JJ, Rocheleau CA, Nieman DC. Perceived stress and ADHD symptoms in adults. *Journal of Attention Disorders*. 2015;19(5):425–34.
64. Combs MA, Canu WH, Broman-Fulks JJ, Nieman DC. Impact of sluggish cognitive tempo and attention-deficit/hyperactivity disorder symptoms on adults' quality of life. *Applied Research in Quality of Life.* 2014;9(4):981–95.
65. Adams ZW, Milich R, Fillmore MT. A case for the return of attention-deficit disorder in DSM-5. *The ADHD Report.* 2010;18(3):1–6.
66. Becker SP, Luebbe AM, Langberg JM. Attention-deficit/hyperactivity disorder dimensions and sluggish cognitive tempo symptoms in relation to college students' sleep functioning. *Child Psychiatry and Human Development*. 2014;45(6):675–85.
67. Koriakin TA, Mahone EM, Jacobson LA. Sleep difficulties are associated with parent report of sluggish cognitive tempo. *Journal of Developmental & Behavioral Pediatrics.* 2015;36(9):717–23.
68. Becker SP, Pfiffner L, Stein MA, Burns GL, McBurnett K. Sleep habits in children with attention-deficit/hyperactivity disorder predominantly inattentive type and associations with comorbid psychopathology symptoms. *Sleep Medicine*. 2016;21:151–9.
69. Langberg JM, Becker SP, Dvorsky MR, Luebbe AM. Are sluggish cognitive tempo and daytime sleepiness distinct constructs? *Psychological Assessment.* 2014;26(2):586–97.
70. Wietecha L, Williams D, Shaywitz S, Shaywitz B, Hooper SR, Wigal SB, et al. Atomoxetine improved attention in children and adolescents with attention-deficit/hyperactivity disorder and dyslexia in a 16 week, acute, randomized, double-blind trial. *Journal of Child and Adolescent Psychopharmacology.* 2013;23(9):605–13.
71. Pfiffner LJ, Yee Mikami A, Huang-Pollock C, Easterlin B, Zalecki C, McBurnett K. A randomized, controlled trial of integrated home-school behavioral treatment for ADHD, predominantly inattentive type. *Journal of the American Academy of Child and Adolescent Psychiatry.* 2007;46(8):1041–50.
72. Becker SP, Ciesielski HA, Rood JE, Froehlich TE, Garner AA, Tamm L, et al. Uncovering a clinical portrait of sluggish cognitive tempo within an evaluation for attention-deficit/hyperactivity disorder: a case study. *Clinical Child Psychology and Psychiatry*. 2016;21(1):81–94.
73. Saxbe C, Barkley RA. The second attention disorder? Sluggish cognitive tempo vs. attention-deficit/hyperactivity disorder: update for clinicians. *Journal of Psychiatric Practice* . 2014;20(1):38–49.
74. Schwarz A. Idea of new attention disorder spurs research, and debate. *The New York Times*. April 11, 2014.
75. Aldhous P. The daydream disorder: is sluggish cognitive tempo a disease or disease mongering? *Slate.* September 29, 2014.
76. Becker SP, Willcutt EG. Advancing the study of sluggish cognitive tempo via DSM, RDoC, and hierarchical models of psychopathology. (Under review).
77. Cuthbert BN, Insel TR. Toward the future of psychiatric diagnosis: the seven pillars of RDoC. *BioMed Central Medicine*. 2013;11:126.
78. Insel T, Cuthbert B, Garvey M, Heinssen R, Pine DS, Quinn K, et al. Research domain criteria (RDoC): toward a new classification framework for research on mental disorders. *American Journal of Psychiatry*. 2010;167(7):748–51.

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Foreword

TO COME

Contents

SECTION 5
Comorbidity

SECTION 6
Clinical assessment *295*

SECTION 7
Interventions

SECTION 8
Clinical management

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Abbreviations

ACC	anterior cingulate cortex
ACG	anterior cingulate gyrus
ADD	attention deficit disorder
ADHD-RS	ADHD rating scale
AERS	Adverse Event Reporting System
AHI	apnea–hypopnea index
AIM	ADHD plus impairments in mood
AMHS	adult mental health services
APA	American Psychiatric Association
ARI	affective reactivity index
ASD	autism spectrum disorder
ATX	atomoxetine
BADDS	Brown Attention Deficit Disorder Scale
BDNF	brain-derived neurotropic factor
BMI	body mass index
BOLD	blood oxygen level-dependent
BPD	borderline personality disorder
BPT	behavioural parent training
CAADID	Conners Adult ADHD Diagnostic Interview
CAARS	Conners Adult ADHD Rating Scale
CAI	computer-assisted instruction
CAMHS	child and adolescent mental health services
CAPA	Child and Adolescent Psychiatric Assessment
CBCL	childhood behaviour checklist
CBT	cognitive–behavioural therapy/treatment
CD	conduct disorder
CDD	concentration deficit disorder
CDI	child-directed intervention
CELF	Clinical Evaluation of Language Fundamentals
CEN	central executive network
CGAS	Child Global Assessment Scale
CGH	comparative genome hybridization
CGI	Clinical Global Impressions
CHMP	Committee for Medicinal Products for Human Use
CHP	Challenging Horizons Programme
CI	confidence interval
CLAS	Child Life and Attention Skills
CNV	contingent negative variation
CNV	copy number variant
CoT	children-of-twins
CSD	current source density
CWPT	classwide peer tutoring
CXR	clonidine extended-release
DA	dopamine
DAMP	deficits in attention, motor control + perception
DAWBA	development and wellbeing assessment
DCD	developmental coordination disorder
DESR	deficient emotional self-regulation
DIVA 2.0	Diagnostic Interview for ADHD for adults
DLMO	dim light melatonin onset
DMDD	disruptive mood dysregulation disorder
DMN	default mode network
DN	default network
DPFC	dorsolateral prefrontal cortex
DSM	*Diagnostic and Statistical Manual of Mental Disorders*
DTI	diffusion tensor imaging
DZ	dizygotic
EAGG	European ADHD Guidelines Group
EC	effortful control
EDS	excessive daytime sleepiness
EEG	electroencephalogram/electroencephalography
EF	executive functioning
EIS	emotional impulsiveness scale
EMA	European Medicines Agency
EMG	electromyogram/electromyography
EMR	electronic medical record
EPSC	excitatory postsynaptic current
ERA	English and Romanian Adoptees study
ERN	error-related negativity
ERP	event-related potential
ES	effect size
ESM	experience sampling method
ESSENCE	early symptomatic syndromes eliciting neurodevelopmental clinical examinations
FAS	fetal alcohol syndrome
FDA	Food and Drug Administration
fMRI	functional magnetic resonance imaging
FR	familial risk index
GABA	gamma-aminobutyric acid
GCTA	genome-wide complex trait analysis
GREML	genomic-relationship-matrix restricted maximum likelihood
GWAS	genome-wide association studies
GXR	guanfacine extended-release
HKD	hyperkinetic disorder
HRQoL	health-related quality of life
ICA	independent component analysis
ICD	*International Classification of Diseases*

ID	intellectual disability
IFC	inferior prefrontal cortex
IFG	inferior frontal gyrus
IPC	inferior parietal cortex
iPSC	induced pluripotent stem cells
ITT	intention to treat
K-SADS	Kiddie-Schedule of Affective Disorders
LDX	lisdexamphetamine
LI	language impairment
LMIC	lower- and middle-income countries
LNCG	local normative comparison group
MAP	mindful awareness practice
MAS	mixed amfetamine salts
MBCT	mindfulness-based cognitive therapy
MBD	minimal brain dysfunction
MDD	major depressive disorder
MEG	magnetoencephalography
MEP	motor-evoked potential
MET	motivational enhancement therapy
MI	motivational interviewing
MMN	mismatch negativity
MND	minor neurological dysfunction
MPFC	medial prefrontal cortex
MPH	methylphenidate
MRI	magnetic resonance imaging
MRR	mortality rate ratio
MSLT	multiple sleep latency test
MTA	Multimodal Treatment sudy of children with ADHD
MZ	monozygotic
NCLB	No Child Left Behind
NE	negative emotionality
NE	norepinephrine
NIDA	National Institute of Drug Abuse
NIMH	National Institute of Mental Health
NIRS	near-infrared spectroscopy
NMDA	N-methyl-D-aspartate
NREM	non-rapid eye movement
NSCH	National Survey for Children's Health
OCB	obsessive-compulsive behaviour
OCD	obsessive-compulsive disorder
ODD	oppositional defiant disorder
OEST	other early standard therapy
OFC	orbitofrontal cortex
OR	odds ratio
OSA	obstructive sleep apnea
PAS-ADD	Psychiatric Assessment Schedule for Adults with Developmental Disabilities
PCC	posterior cingulate cortex
PCIT	parent–child interaction therapy
PD	pharmacodynamic
PDD	pervasive development disorder
PDI	parent-directed intervention
PET	positron emission tomography
PFC	prefrontal cortex
PK	pharmacokinetic
PLMD	periodic limb movement disorder
PSG	polysomnography
PUFA	polyunsaturated fatty acids
QoL	quality of life
RAI	resource allocation index
RCT	randomized controlled trial
RD	reading disorder
RDoC	research domain criteria
REM	rapid eye movement
rGE	gene–environment interaction
RLS	restless leg syndrome
ROI	region of interest
RR	relative risk ratio
RTV	response time variability
SCID-5	Structured Clinical Interview for DSM-5
SCN	suprachiasmatic nucleus
SCP	shared care protocol
SCP	slow cortical potential
SCT	sluggish cognitive tempo
SD	standard deviation
SDB	sleep-disordered breathing
SDQ	Strengths and Difficulties Questionnaire
SES	socioeconomic status
SFC	superior frontal cortex
SFT	solution-focused treatment
SICI	short-interval intracortical inhibition
SMA	supplementary motor area
SMD	severe mood dysregulation
SMD	standardized mean difference
SMR	sensorimotor rhythm
SNAP	Swanson, Nolan, and Pelham rating scale
SNP	single nucleotide polymorphism
SNRI	serotonin-norepinephrine reuptake inhibitors
SPCD	social pragmatic communication disorder
SPECT	single-photon emission computed tomography
SSD	speech sound disorder
SSRI	selective serotonin reuptake inhibitor
SSRT	stop signal reaction time
SST	social skills training
SUD	substance use disorder
SWA	slow-wave activity
tACS	transcranial alternating current stimulation
TAU	treatment as usual
TBR	theta to beta power ratio
TCA	tricyclic antidepressant
TD	tic disorders
TDC	typically developing control
tDCS	transcranial direct current stimulation
TMS	transcranial magnetic stimulation
ToM	theory of mind
VAN	ventral attention network
VBM	voxel-based morphometry
VNTR	variable number of tandem repeats
WCC	weak central coherence
WHO	World Health Organization