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Journal of Psychiatric Research

journal homepage: www.elsevier.com/locate/jpsychires

Sluggish cognitive tempo and ADHD symptoms in relation to task-unrelated thought: Examining unique links with mind-wandering and rumination

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ARTICLE INFO

Keywords:

ADHD

Attention-deficit/hyperactivity disorder

Daydreaming

Mind wandering

Rumination

Sluggish cognitive tempo

ABSTRACT

Recent theoretical and empirical evidence highlights associations between attention-deficit/hyperactivity disorder (ADHD) symptoms and task-unrelated thought, including mind-wandering and rumination. However, it has been hypothesized that sluggish cognitive tempo (SCT), characterized by daydreaming and staring behaviors, may uniquely relate to task-unrelated thought. The purpose of the present study was to test whether SCT symptoms are associated with greater mind-wandering and rumination, and whether this association remains when controlling for ADHD and internalizing symptoms. Participants ($N = 4679$; 18–29 years; 69% female; 80.9% White) enrolled in six universities in the United States completed measures of SCT, ADHD symptoms, internalizing symptoms, and rumination, as well as two scales used to assess mind-wandering. Although ADHD symptoms were correlated with greater self-reported mind-wandering and rumination, relations with mind-wandering on the daydreaming frequency scale, reflective rumination, and brooding rumination were attenuated when controlling for SCT and internalizing symptoms. Above and beyond other psychopathology dimensions, SCT symptoms were uniquely associated with greater self-reported mind-wandering and both reflective and brooding rumination. Additionally, SCT symptoms were more strongly associated than other psychopathology dimensions with the mind-wandering measure of daydreaming frequency. Results provide the first empirical support for unique and robust associations between SCT symptoms and task-unrelated thought, while suggesting that the link between ADHD and mind-wandering may be less robust than previously suggested.

1. Introduction

There has been growing interest in the relation between psychopathology and task-unrelated thought, the pattern and content of thoughts that are unrelated to the task at hand (Christoff et al., 2016). Two forms of task-unrelated thought, mind-wandering (e.g., decoupling of thought from external environment) and rumination (e.g., thoughts marked by negatively-valenced content), were recently theorized as underlying symptoms of attention-deficit/hyperactivity disorder (ADHD) (Bozhilova et al., 2018). However, the extent to which specific

ADHD dimensions are related to these types of task-unrelated thought remains unclear (Lanier et al., 2019). Furthermore, no study has examined whether sluggish cognitive tempo (SCT) symptoms are associated with task-unrelated thought. This is surprising since SCT is highly correlated with ADHD symptoms and is characterized in part by behaviors such as excessive daydreaming, mental confusion, and staring into space (Becker et al., 2016). Accordingly, the present study examined both ADHD and SCT symptoms in relation to multiple types of task-unrelated thought.

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<https://doi.org/10.1016/j.jpsychires.2020.01.016>

Received 13 November 2019; Received in revised form 10 January 2020; Accepted 25 January 2020

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1.1. ADHD and task-unrelated thought

Research has recently begun to investigate ADHD and task-unrelated thought. Specifically, ADHD symptoms have been associated with greater self-reported mind-wandering (Biederman et al., 2019; Franklin et al., 2017; Seli et al., 2015a,b), excessive daydreaming (Jonkman et al., 2017), and task-unrelated thoughts during experimental tasks (Jonkman et al., 2017; Van Den Driessche et al., 2017). ADHD inattentive symptoms may be more consistently and strongly associated with mind-wandering relative to ADHD hyperactive-impulsive symptoms (Biederman et al., 2019; Jonkman et al., 2017), though other studies have found both ADHD dimensions to be independently associated with increased reports of mind-wandering (Biederman et al., 2019; Mowlem et al., 2019a,b). In sum, research supports a link between ADHD symptomatology and mind-wandering, although there is inconclusive evidence on specific links with ADHD dimensions.

Compared to mind-wandering, there has been little interest in the relation between ADHD symptomatology and rumination. Research has demonstrated significant correlations between ADHD symptoms and self-reported ruminative responses to stress (Yeguez et al., 2018), in addition to greater self-reported rumination among college students with elevated inattentive symptoms (Jonkman et al., 2017). There is thus preliminary evidence for an association between ADHD inattention and increased rumination.

Overall, although research to date has shown that ADHD symptoms (particularly inattention) are associated with task-unrelated thought, a simultaneous body of research has emerged that highlights a unique collection of attentional difficulties that may better explain ADHD's association with task-unrelated thought.

1.2. SCT and task-unrelated thought

Sluggish cognitive tempo (SCT) is characterized by excessive daydreaming, inconsistent alertness, and underactive behavior. Although initially viewed as a specifier of, or even redundant with, ADHD inattentive symptoms, a meta-analysis found strong support for SCT symptoms being separable from ADHD inattentive symptoms across child, adolescent, and adult populations (Becker et al., 2016). It is important to investigate the association between SCT and task-unrelated thought given its potential to advance theory and identify mechanisms underlying the SCT phenotype. SCT includes both slow/sluggish behaviors in addition to daydreaming/inconsistent alertness behaviors (Becker et al., 2016; Fenollar Cortés et al., 2017; Kamradt et al., 2018), with the latter characteristics potentially representing excessive task-unrelated thought. Indeed, it has been noted that “both sluggish cognitive tempo and mind wandering have been described in terms of weak attentional control, marking a propensity for individuals to drift from thought to thought rather than maintaining focus on a given task” (Adams et al., 2010, p. 5). This is an especially intriguing possibility given that SCT symptoms are at least in part defined by internal distractibility (e.g., daydreaming) while ADHD symptoms are in part defined by external distractibility (e.g., extraneous stimuli) (Becker et al., 2018b). Moreover, poor internal attentional control, including an inability to disengage from thoughts, has been linked to greater rumination (Whitmer and Gotlib, 2013). In fact, a recent study found that adolescent-reported SCT symptoms, but not ADHD inattentive symptoms, were uniquely associated with greater reflective and brooding rumination (Becker et al., 2019). It is thus surprising that more studies have yet to directly examine SCT in relation to task-unrelated thought, particularly given the growing interest in whether mind wandering is a core feature or correlate of ADHD symptoms.

1.3. Distinguishing between types of task-unrelated thought

Before testing relations between ADHD and SCT symptoms and task-

unrelated thought, it is important to distinguish between different types of thought. In this study, we focus on mind-wandering and rumination given that they are both task-unrelated thoughts but also differ in their constraints and content. As described within a dynamic framework of mind-wandering, “both mind-wandering and rumination tend to be stimulus independent and unrelated to the current task ... However, although thoughts during mind-wandering are free to ‘move hither and thither’, thoughts during rumination tend to remain fixed on a single theme or topic” (Christoff et al., 2016). Thus, mind-wandering is a type of spontaneous thought, whereas rumination is a type of thought with strong automatic constraints (Christoff et al., 2016). In addition, mind-wandering has been conceptualized as containing a variety of broad content (e.g., thoughts/ideas unrelated to a current task), while rumination unique focuses on negative-valenced content (e.g., thinking about past and current difficulties) (Christoff et al., 2016).

Specifically, mind-wandering is a universal experience pertaining to the decoupling of thought from the external environment toward task-unrelated thoughts (Jonkman et al., 2017). Though mind-wandering is characterized by both deliberate and spontaneous thought, most research has focused on the latter (Seli et al., 2015a,b). Daydreaming, conceptualized as a marker of mind-wandering with a focus on internal, often imaginative, stimuli (McMillan et al., 2013), has been correlated with higher self-reported mind-wandering (Chiorri and Vannucci, 2019; Forster and Lavie, 2014), less self-reported present moment awareness (Marchetti et al., 2014), and higher task-unrelated thoughts assessed during sustained attention tasks (Mrazek et al., 2012; Stawarczyk et al., 2012). Although mind-wandering and daydreaming have been linked to adaptive outcomes (e.g., creativity, problem-solving), research has also documented associations with increased internalizing symptoms (Marchetti et al., 2016) and reduced performance during cognitively challenging tasks (Lanier et al., 2019).

In contrast to mind-wandering, rumination is characterized by perseveration on negative affective states and is often subdivided into reflective rumination (e.g., effectively thinking about solutions) and brooding rumination (e.g., passively focusing on distress) (Nolen-Hoeksema et al., 2008; Treynor et al., 2003). Although originally viewed as adaptive (Treynor et al., 2003), emerging research indicates that reflective rumination may be linked to maladaptive outcomes such as heightened suicide risk (Surrence et al., 2009). Conversely, brooding rumination has been consistently associated with depressive and anxiety symptoms (McLaughlin and Nolen-Hoeksema, 2011). Considered together, mind-wandering and rumination are both types of task-unrelated thought that are related to a variety of maladaptive outcomes.

1.4. Present study

The present study used a large, multi-site sample of college students to examine ADHD and SCT symptoms in relation to mind-wandering and rumination. The study had two objectives:

1. The first objective was to evaluate ADHD and SCT symptoms in relation to multiple self-report measures of task-unrelated thought. Specifically, correlations were conducted to examine SCT, inattention, hyperactivity, and impulsivity in relation to mind-wandering, reflective rumination, and brooding rumination. We separated hyperactive and impulsive dimensions following inconsistent research on whether these dimensions are associated with mind-wandering (Lanier et al., 2019) and research supporting a three-factor structure of ADHD in adults (Barkley, 2011; Becker et al., 2014; Martel et al., 2016). We expected all four psychopathology dimensions to be significantly correlated with greater mind-wandering, reflective rumination, and brooding rumination. We hypothesized SCT and inattention to have significantly stronger correlations than hyperactivity and impulsivity with task-unrelated thought. There was not an a priori hypothesis for hyperactive and impulsive symptoms given mixed findings from past research.

2. The second objective was to examine whether SCT and ADHD symptoms were uniquely associated with task-unrelated thought. For this objective, the task-unrelated thought measures were regressed on the SCT, ADHD inattention, ADHD hyperactivity, and ADHD impulsivity dimensions. Both anxiety and depressive symptoms were also included in these models given their established associations with task-unrelated thought (McLaughlin and Nolen-Hoeksema, 2011). We hypothesized that SCT, ADHD inattention, depression, and anxiety would each be uniquely associated with task-unrelated thought. We did not make an a priori hypothesis regarding the ADHD hyperactive and impulsive dimensions.

2. Methods

2.1. Participants

Participants were 4679 undergraduates enrolled in six universities across regions of the United States. Participants' ages ranged from 18 to 29 years ($M = 19.08$, $SD = 1.36$) and 69.8% identified as female, 30% as male, and 0.2% as other. There were 80.9% of participants who identified as White, while the remaining identified as Black/African American (7.1%), Asian, (6.2%), Biracial/Multiracial (4.8%), American Indian/Alaska Native (0.5%), or Native Hawaiian/Other Pacific Islander (0.2%); 10% identified as Hispanic or Latino. Most of the participants reported as being in their first year of college (58.3%), while the others reported being in their second year (21.8%), third year (12.5%), or fourth year or later (7.1%) year. Thirteen percent of the participants reported clinically significant symptoms of ADHD (≥ 5 symptoms rated as 'often' or 'very often'; 5.6% reported elevated inattentive symptoms, 4.7% reported elevated hyperactive-impulsive symptoms, and 2.7% reported elevated inattentive and hyperactive-impulsive symptoms). See Dvorsky et al. (2019) and Swope et al. (2020) for additional details.

2.2. Procedures

This study was approved at each of each institution's local Institutional Review Board (IRB). Data were conducted during the 2016–2017 academic year. Participants at five of the universities provided consent and completed the survey anonymously using a Qualtrics platform. The sixth university instructed participants to select individual timeslots to complete in-person consent, followed by the online survey. Participants across all universities received course credit for following completing the study, which lasted an hour on average.

2.3. Measures

SCT symptoms. The Adult Concentration Inventory (ACI; Becker et al., 2018a) is an adult self-report measure of SCT symptoms developed following a meta-analysis that identified optimal items distinguishing SCT from ADHD-IN and internalizing symptoms (Becker et al., 2016). Factor analyses resulted in 10 SCT items that demonstrated convergent and discriminative validity from both ADHD-IN and internalizing symptomatology (Becker et al., 2018a). Participants rated on a four-point scale (0 = *not at all*, 3 = *very often*) how often each symptom (e.g., "I stare off into space") occurred in the past six months. To eliminate potential contamination of the SCT scale with the Imaginal Process Inventory daydreaming measure of mind-wandering described below, one item ("I daydream") was removed from the SCT scale in the present study. In the present study, the nine-item SCT scale demonstrated acceptable internal consistency ($\alpha = 0.87$).

ADHD symptoms. The Barkley Adult ADHD Rating Scale-IV (BAARS-IV; Barkley, 2011) was used to measure adult self-reported ADHD symptoms. The 18 items assess the inattentive and hyperactive-impulsive symptoms of ADHD in the DSM-5. Participants complete each item using a four-point scale (0 = *not at all*, 3 = *very often*). Factor

analyses from Barkley's (2011) nationally representative sample and a large sample of college students (Becker et al., 2014) found support for separate inattention (9 items), hyperactivity (5 items), and impulsivity (4 items) dimensions. In the present study, $\alpha_s = 0.88, 0.72$ and 0.79 for inattention, hyperactivity, and impulsivity, respectively.

Depressive and anxiety symptoms. The depression and anxiety subscales of the Depression Anxiety Stress Scale-21 (DASS; Antony et al., 1998; Lovibond and Lovibond, 1995) were used to assess adult self-reported depressive and anxiety symptoms. The DASS-21 has demonstrated strong reliability estimates in clinical and nonclinical populations (Antony et al., 1998). Participants responded to each item on the seven-item depression (e.g., "I was unable to become enthusiastic about anything") and seven-item anxiety subscale (e.g., "I felt scared without any good reason") in reference to the past week using a four-point scale (0 = *did not apply to me at all*, 3 = *applied to me very much or most of the time*). None of the DASS-21 items overlap with items on the rumination scale described below. In the present study, $\alpha_s = .90$ and $.79$ for depression and anxiety, respectively.

Mind-wandering. Different scales have been used to assess mind-wandering, and two measures were included in this study to include as comprehensive a measurement of mind-wandering as possible and to allow for a comparison of findings across scales with different item content. Specifically, the newly-developed Mind Excessively Wandering Scale (MEWS; Mowlem et al., 2019a,b) and the historical Imaginal Process Inventory (IPI; Singer and Antrobus, 1966) were both used as separate measures of self-reported mind-wandering.

The MEWS was originally developed to identify the mental phenomena of mind-wandering that is present among individuals with ADHD (Mowlem et al., 2019a,b). The MEWS has demonstrated acceptable internal consistency, acceptable factor loadings, and convergent validity with other measures of mind-wandering and ADHD symptoms in clinical and non-clinical adult populations (Mowlem et al., 2019a,b). Participants respond to each of the 12 items (e.g., "I have difficulty controlling my thoughts") on a four-point scale (0 = *not at all or rarely*, 3 = *nearly all of the time or constantly*). Internal consistency in the present study was good ($\alpha = 0.93$).

The IPI daydreaming frequency subscale is frequently used as a measure of mind-wandering (Forster and Lavie, 2014; Mrazek et al., 2012). Scores on the IPI daydreaming subscale are correlated with task-unrelated thought during sustained attention tasks (Mrazek et al., 2012; Stawarczyk et al., 2012). Additionally, the daydreaming frequency subscale has demonstrated strong internal consistency and test-retest reliability (Chiorri and Vannucci, 2019; Marchetti et al., 2014). Participants responded to each of the 12 items (e.g., "In the past five days, I lost myself in active daydreaming") on a five-point scale. In the present study, internal consistency was good ($\alpha = 0.95$).

Rumination. The Ruminative Response Scale (RRS; Treynor et al., 2003) was used to measure adult self-reported ruminative responses. The RRS includes three factors to assess for rumination (brooding, reflection, and depression-related). The five-item brooding scale (e.g., "When you feel down, sad, or depressed, how often do you think, why do I always react this way?") and the five-item reflection subscale (e.g., "When you feel down, sad, or depressed, how often do you go someplace alone to think about your feelings?") were used in the present study. Internal consistency for reflection ($\alpha = 0.84$) and brooding ($\alpha = 0.87$) was satisfactory.

2.4. Analytic approach

Data quality check. In order to ensure quality responses, an instructional manipulation check (IMC; Oppenheimer et al., 2009), trap questions (e.g., "Please click on the response 'sometimes'"), and questions assessing for participants' reported effort were used. Participants were only able to proceed with the survey if they answered the IMC correctly, which asked the participant to select a specific answer for the question. Successful completion of trap questions were designated with

a 50% accuracy or higher and effort ratings of 5 or higher on a 10 point scale (0 = *not much effort*, 10 = *my best effort*). 4679 (94%) of the total 4955 participants met the designated criteria. See [Dvorsky et al. \(2019\)](#) and [Swope et al. \(2020\)](#) for additional details.

Primary Analyses. All analyses were conducted in Mplus v8.2 ([Muthén and Muthén, 1998–2018](#)). Latent variables were used for all constructs with each item specified to load on its respective factor. Item ratings were treated as ordered-categories. Analyses used the robust weighted least squares means and variance (WLSMV) estimator. There was little missing information (covariance coverage was approximately 99%; the WLSMV uses a pairwise approach to missing information). First, correlations were conducted to examine the psychopathology dimensions (i.e., SCT, inattention, hyperactivity, impulsivity, depression, anxiety) in relation to the task-unrelated thought domains (i.e., reflection rumination, brooding rumination, IPI mind-wandering, MEWS mind-wandering). In addition, the Mplus model constraint procedure was used to test for significant differences among factor correlations for significant differences. Second, structural regression analyses were conducted to examine the unique relations between psychopathology dimensions and task-unrelated thought. Statistical significance was set at $p < .001$ for all analyses given the sample size; we also focused on effect magnitude.

3. Results

3.1. Correlation analyses

Descriptive statistics of the study variables are provided in [Table 1](#). Participant characteristics (i.e., age, sex, race, year in school) were not significantly associated or were only negligibly associated with the mind-wandering or rumination variables (all $r_s < 0.10$) and were not considered further. The task-unrelated thought variables were significantly correlated with each other (all $p_s < .001$). IPI mind-wandering and MEWS mind-wandering were strongly associated ($r = 0.57$). Brooding was strongly associated with reflection rumination ($r = 0.83$). Reflective and brooding rumination were strongly associated with MEWS mind-wandering ($r_s = 0.50$ and 0.61 , respectively) and moderately associated with IPI mind-wandering ($r_s = 0.37$ and 0.34 , respectively). As shown in [Table 2](#), the psychopathology dimensions were all significantly correlated with each other (all $p_s < .001$), with most correlations large in magnitude.

[Table 3](#) shows the correlations of the psychopathology dimensions with task-unrelated thought variables (all $p_s < .001$), with superscripts used to indicate significant differences between the magnitude of the bivariate correlations within each task-unrelated thought dimension. Regarding the MEWS mind-wandering scale, all six psychopathology dimensions were strongly associated with greater mind-wandering (all $r_s > 0.40$), with SCT ($r = 0.65$) and inattention ($r = 0.67$) having the strongest associations with MEWS mind-wandering scores. For the IPI mind-wandering scale, SCT symptoms were most strongly associated with greater IPI mind-wandering ($r = 0.64$), followed next by inattention ($r = 0.52$), which was in turn more strongly associated with greater IPI mind-wandering than the remaining psychopathology dimensions. Finally, for both rumination dimensions, a stepwise pattern in correlation magnitude differences was found. Specifically, depressive symptoms were most strongly correlated with greater rumination ($r_s = 0.60$ and 0.67 for reflection and brooding rumination, respectively), followed in order by anxiety, SCT and inattention (which did not differ from each other), hyperactivity, and impulsivity.

3.2. Structural regression analyses

[Table 4](#) shows the unique effects (standardized partial regression coefficients) of the psychopathology dimensions in relation to the task-unrelated thought dimensions. Regarding MEWS mind-wandering, five of

Table 1

Descriptive statistics of manifest study variables.

Variable	Mean	SD	Range	Skew	Kurtosis
SCT	1.19	0.59	0–3	0.65	0.34
ADHD Inattention	1.68	0.54	1–4	1.07	1.23
ADHD Hyperactivity	1.75	0.55	1–4	0.88	0.62
ADHD Impulsivity	1.62	0.6	1–4	1.22	1.34
Depression	0.54	0.61	0–3	1.53	2.05
Anxiety	0.48	0.51	0–3	1.46	2.18
RRS Reflection	9.69	3.69	4–20	0.56	−0.42
RRS Brooding	10.51	3.91	4–20	0.49	−0.54
IPI Mind-wandering	2.76	0.91	1–5	0.21	−0.60
MEWS Mind-wandering	1.01	0.65	0–3	0.53	−0.003

Note. $N = 4679$. ADHD = attention-deficit/hyperactivity disorder. IPI = Imaginal Process Inventory. MEWS = Mind Excessively Wandering Scale. RRS = Ruminative Response Scale. SCT = sluggish cognitive tempo. SD = standard deviation.

Table 2

Intercorrelations among latent psychopathology dimensions.

	1	2	3	4	5	6
1. SCT	–					
2. ADHD inattention	.80	–				
3. ADHD hyperactivity	.55	.63	–			
4. ADHD impulsivity	.43	.54	.63	–		
5. Depression	.59	.63	.43	.28	–	
6. Anxiety	.60	.62	.60	.41	.76	–

Note. $N = 4679$. ADHD = attention-deficit/hyperactivity disorder. SCT = sluggish cognitive tempo. All correlations significant at $p < .001$.

the six psychopathology dimensions were uniquely associated with higher mind-wandering scores, with impulsivity the only dimension not uniquely associated with mind-wandering ($\beta = 0.03$; see [Table 4](#)). The unique relative associations with MEWS mind-wandering were similar for the five significant psychopathology dimensions ($\beta_s = 0.15–0.22$). On the other hand, SCT was the only psychopathology dimension to be uniquely and significantly associated with greater IPI mind-wandering. Whereas higher SCT symptoms were strongly associated with greater IPI mind-wandering ($\beta = 0.59$), the other psychopathology dimensions were negligibly, non-significantly associated with IPI mind-wandering ($\beta_s = -0.03 - 0.04$).

In examining rumination dimensions, depression, anxiety, and SCT symptoms were each significantly ($p < .001$) associated with increased reflective and brooding rumination, with depression being most strongly associated with both types of rumination ($\beta_s = 0.49$ and 0.47 for reflection and brooding rumination, respectively). Conversely, in the regression analyses, inattentive symptoms were no longer significantly related to brooding rumination and were significantly associated with *lower* reflective rumination. Finally, ADHD hyperactivity and impulsivity symptoms were no longer significantly associated with either type of rumination.¹

4. Discussion

Recent theoretical ([Bozhilova et al., 2018](#)) and empirical ([Lanier et al., 2019](#)) research has generated an interest in ADHD and task-

¹ Analyses were re-run using a combined hyperactivity-impulsivity factor as opposed to separate hyperactivity and impulsivity factors. The overall pattern of findings was unchanged from those reported in [Table 4](#). The only exception is that when a combined hyperactivity-impulsivity factor was used, ADHD inattention was significantly negatively associated with brooding rumination ($\beta = -0.07$, $SE = 0.02$, $p = .02$). The combined hyperactivity-impulsivity factor was not significantly associated with IPI mind-wandering, reflection rumination, or brooding rumination ($p_s > .05$) but was significantly associated with higher MEWS mind-wandering scores ($\beta = 0.15$, $SE = 0.02$, $p < .001$).

Table 3
Correlation analyses examining sluggish cognitive tempo, ADHD, and internalizing dimensions in relation to task-unrelated thought.

	MEWS Mind-Wandering		IPI Mind-Wandering (Daydreaming)		RRS Reflection		RRS Brooding	
	Correlation	SE	Correlation	SE	Correlation	SE	Correlation	SE
SCT	0.65 ^a	0.01	0.64 ^a	0.01	0.41 ^a	0.01	0.49 ^a	0.01
ADHD inattention	0.67 ^a	0.01	0.52 ^b	0.01	0.38 ^a	0.02	0.48 ^a	0.01
ADHD hyperactivity	0.57 ^{d,e}	0.01	0.38 ^c	0.02	0.31 ^b	0.02	0.38 ^b	0.02
ADHD impulsivity	0.43 ^e	0.02	0.27 ^d	0.02	0.18 ^c	0.02	0.26 ^c	0.02
Depression	0.59 ^{c,d}	0.01	0.39 ^c	0.01	0.60 ^d	0.01	0.67 ^d	0.01
Anxiety	0.62 ^{b,c}	0.01	0.41 ^c	0.01	0.52 ^c	0.01	0.62 ^c	0.01

Note. N = 4679. Within each task-unrelated thought variable (column), latent correlation coefficients with different superscripts differ significantly in relation to the outcome variable at $p < .001$. ADHD = attention-deficit/hyperactivity disorder. MEWS = Mind Excessively Wandering Scale. IPI = Imaginal Process Inventory. RRS = Ruminative Response Scale. SCT = sluggish cognitive tempo. SE = standard error. All correlations significant at $p < .001$.

Table 4
Structural regression analyses examining sluggish cognitive tempo, ADHD, and internalizing dimensions in relation to task-unrelated thought.

	MEWS Mind-Wandering		IPI Mind-Wandering (Daydreaming)		RRS Reflection		RRS Brooding	
	β	SE	β	SE	β	SE	β	SE
SCT	0.22*	0.02	0.59*	0.02	0.12*	0.03	0.14*	0.03
ADHD inattention	0.21*	0.03	0.02	0.03	-0.12*	0.03	-0.07	0.03
ADHD hyperactivity	0.15*	0.02	0.03	0.03	0.05	0.03	0.02	0.03
ADHD impulsivity	0.03	0.02	-0.03	0.02	-0.03	0.02	0.01	0.02
Depression	0.15*	0.02	-0.01	0.03	0.49*	0.03	0.47*	0.03
Anxiety	0.15*	0.03	0.04	0.03	0.13*	0.03	0.20*	0.03

Note. N = 4679. ADHD = attention-deficit/hyperactivity disorder. MEWS = Mind Excessively Wandering Scale. IPI = Imaginal Process Inventory. RRS = Ruminative Response Scale. SCT = sluggish cognitive tempo. SE = standard error.

* $p < .001$.

unrelated thought. However, no study has incorporated SCT symptoms when testing these relations, despite previous suggestions that task-unrelated thought may be a hallmark feature of SCT (Adams et al., 2010; Barkley, 2014). To add to the existing literature, the current study used a large, multi-site sample of college students and two domains of task-unrelated thought: mind-wandering (i.e., shift in thoughts away from an ongoing task) and rumination (i.e., pattern of thoughts fixed on negatively-valenced content). Results of the present study provide the first empirical support for unique and robust associations between SCT symptoms and task-unrelated thought, while suggesting that the link between ADHD and task-unrelated thought may be less robust than previously suggested.

4.1. SCT and other psychopathology dimensions in relation to mind-wandering

When controlling for other psychopathology domains, SCT symptoms remained uniquely associated with both measures of mind-wandering. However, a differential pattern of findings emerged when comparing the strength of these effects with other psychopathologies. Similar to the bivariate results, when examining mind-wandering as assessed with the MEWS, the magnitude of associations was similar for SCT and other psychopathology dimensions, with the exception of impulsivity. Conversely, SCT symptoms were strongly associated with greater self-reported mind-wandering on the IPI whereas the other psychopathology domains were not uniquely associated with IPI-assessed mind-wandering. Although researchers have proposed mind-wandering as a key feature of SCT (Adams et al., 2010; Barkley, 2014; Becker et al., 2018b), no study to date has tested these relations. Our findings are the first to provide empirical support for this possibility and demonstrate that SCT symptoms, even when controlling for ADHD and internalizing symptoms domains, are uniquely associated with self-reported mind-wandering.

Findings of the present study also suggest that previous reports regarding ADHD's association with mind-wandering may be less robust or

more nuanced than previously thought. Though ADHD symptom domains were correlated with greater mind-wandering, these relations became non-significant or attenuated when controlling for SCT and internalizing symptoms. Specifically, inattentive and hyperactive symptoms remained uniquely associated with greater MEWS-assessed mind-wandering, albeit effects were smaller in magnitude, and these dimensions were not significantly associated with IPI-assessed mind-wandering in the regression analyses. The findings for inattentive and hyperactive symptoms are consistent with a previous study finding both symptom domains, but not impulsivity, to be linked with mind-wandering (Biederman et al., 2019). However, our findings also demonstrate that studies examining the association between ADHD and mind-wandering should in tandem consider SCT symptoms and incorporate multiple measures of mind-wandering.

Of note, recent studies have found SCT symptoms to be uniquely associated with greater openness to experience (Becker et al., 2018c) and greater anticipation of upcoming rewarding experiences (Swope et al., 2020). Interestingly, the personality trait of openness to experience has been linked to greater positive-constructive daydreaming (e.g., elaboration on positive experiences; Blouin-Hudon and Zelenski, 2016). Thus, individuals with SCT symptoms may have a tendency to be more imaginative and insightful. This possibility also parallels evidence from the mind-wandering literature that points to both maladaptive and adaptive correlates of mind-wandering (Mooneyham and Schooler, 2013; Smallwood and Andrews-Hanna, 2013).

It is important to acknowledge the diverging pattern of findings for the two different mind-wandering measures. SCT symptoms were more strongly associated than all other psychopathology dimensions with scores on the IPI measure of mind-wandering. The IPI scale focused on daydreaming frequency and, importantly, the “daydreaming” item was removed from the SCT scale before conducting analyses, suggesting this finding is not due to item overlap. In contrast, using the MEWS, the magnitude of associations between SCT and mind-wandering was similar to the associations of most other psychopathology dimensions with mind-wandering. Whereas the IPI mind-wandering scale is specific

to daydreaming frequency, the MEWS includes more wide-ranging content, including difficulties with focus (e.g., “I can only focus my thoughts on one thing at a time with considerable effort”), mental organization (e.g., “My thoughts are disorganized and ‘all over the place’”), and attentional control (e.g., “I have difficulty slowing my thoughts down and focusing on one thing at a time”). Thus, the MEWS item content may be a non-specific measure of mind-wandering in relation to psychopathology domains. Importantly, whereas IPI mind-wandering scale scores are significantly correlated with laboratory-measured mind-wandering using the sustained attention to response task (SART; Stawarczyk et al., 2012), we are unaware of any studies examining the MEWS in relation to SART-assessed mind-wandering. Thus, there is less evidence for the validity of the MEWS as a measure of mind-wandering, and this is an especially important area for research given the increasing interest in the intersection between mind-wandering and psychopathology. It will be important for future research to further examine these two measures of mind-wandering, for example by examining these scales in relation to deliberate or spontaneous mind-wandering (Seli et al., 2015a) or using person centered analyses (e.g., latent profile analysis) to identify patterns of mind-wandering within individuals.

4.2. SCT and other psychopathology dimensions in relation to rumination

Only one previous study (Becker et al., 2019) has documented significant correlations between SCT symptoms and ruminative responses. In the present study, SCT symptoms were uniquely associated with higher reflective and brooding rumination as hypothesized, though smaller in magnitude compared to depressive symptoms. In contrast, ADHD inattentive, hyperactive, and impulsive symptoms were negligibly or even negatively associated with rumination in the structural regression analyses. Although inattentive symptoms have been previously linked with ruminative responses (Jonkman et al., 2017), findings from the present study replicate the Becker et al. (2019) study in suggesting that this may be due in large part to the co-occurrence of inattention with internalizing and SCT symptoms, given the change in results from bivariate to multivariate analyses.

An interesting finding was that inattentive symptoms became associated with less reflective rumination and were unrelated to brooding rumination in the regression analyses, whereas SCT symptoms remained uniquely positively associated with both types of rumination. These findings provide some evidence of recent proposals that excessive internal distractibility may be a feature that distinguishes SCT from ADHD inattentive symptoms (Becker et al., 2018b). Rumination has been theorized to be one mechanism explaining the relation between SCT and internalizing psychopathology (Becker and Willcutt, 2019). Given that brooding, and to a lesser extent reflective rumination, has been identified as a key feature of internalizing psychopathology and suicidal behavior (Hsu et al., 2015; Surrence et al., 2009), rumination may be the mechanism linking SCT with these outcomes. An important area of future research will be to investigate whether rumination mediates the association between SCT symptoms and internalizing psychopathology and other negative outcomes (e.g., social withdrawal, suicidal behavior).

4.3. Limitations and future directions

Strengths of the current study include a large sample size recruited from six universities and examination of both reflective and brooding rumination as well as multiple self-report measures of mind-wandering. Despite these strengths, several limitations are worth noting. The cross-sectional nature of the study precludes drawing causal inferences. Future research should use experimental and longitudinal designs to investigate the relation between SCT symptoms and task-unrelated thought over time. Longitudinal studies would also be well-positioned to examine whether task-unrelated thought explains the relations

between SCT and internalizing psychopathologies and functional impairment. Moreover, future research could then test whether the frequency of mind-wandering exacerbates relations between psychopathology symptoms and areas of impairment. In addition, although we included two self-report measures of mind-wandering, laboratory-assessed mind-wandering during the SART or similar paradigms was not possible given the constraints of the study and will be important to include in future research (Christoff et al., 2016). It will also be important to examine whether SCT symptoms are associated with default mode network activity, a set of brain regions including the medial temporal lobe, that are consistently active during rest and are implicated in mind-wandering (Christoff et al., 2016). Additionally, the relatively homogenous sample prevents generalizing findings to varying age groups and clinical populations. For instance, it is possible that relations between ADHD and task-unrelated thought would be stronger in a clinical sample of adults with ADHD. Similar to the broader research on mind-wandering (Lanier et al., 2019), research would benefit from testing relations of SCT with task-unrelated thought in younger samples as SCT symptoms tend to increase following childhood (Leopold et al., 2016). Finally, recent research has identified a differential pattern of outcomes among distinct valences of rumination (e.g., sadness, anger; Harmon et al., 2019). Future research should consider testing whether these unique valences of rumination are differentially associated with SCT and other psychopathologies.

5. Conclusion

Findings from the present study are the first to demonstrate that SCT symptoms are uniquely associated with measures of task-unrelated thought while controlling for ADHD and internalizing symptom domains. Specifically, SCT symptoms were uniquely associated with greater mind-wandering, reflective rumination, and brooding rumination. Additionally, SCT symptoms were more strongly associated than other psychopathology dimensions with mind-wandering as assessed by a measure of daydreaming frequency. These findings suggest that task-unrelated thought may be a key feature of the SCT construct, or potentially even a causal contributor to SCT, and point to the importance of additional studies examining SCT in relation to mind-wandering and rumination.

CRediT authorship contribution statement

Joseph W. Fredrick: Conceptualization, Writing - original draft. **Michael J. Kofler:** Data curation, Writing - review & editing. **Matthew A. Jarrett:** Data curation, Writing - review & editing. **G. Leonard Burns:** Data curation, Writing - review & editing. **Aaron M. Luebke:** Data curation, Writing - review & editing. **Annie A. Garner:** Data curation, Writing - review & editing. **Sherelle L. Harmon:** Data curation, Writing - review & editing. **Stephen P. Becker:** Conceptualization, Data curation, Formal analysis, Writing - original draft.

Declaration of competing interest

None.

Acknowledgement

Stephen Becker is currently supported by award K23MH108603 from the National Institute of Mental Health (NIMH). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health (NIH).

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpsychires.2020.01.016>.

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