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Sluggish Cognitive Tempo and Personality: Links to BIS/BAS Sensitivity and the Five Factor Model

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Abstract

We evaluated sluggish cognitive tempo (SCT) symptoms in relation to personality as assessed via both the Reinforcement Sensitivity Theory (BIS/BAS) and Five Factor (Big 5) Model of personality. 3,172 students from five universities completed psychopathology, BIS/BAS, and Big 5 measures. Correlations and path models with SCT, attention-deficit/hyperactivity disorder (ADHD) dimensions, and anxiety/depression in relation to personality were examined. SCT evidenced a different pattern of relations to adult personality than ADHD and anxiety/depression. SCT was significantly uniquely associated with higher BIS and Neuroticism, as well as higher BAS Fun-Seeking. SCT was uniquely associated with lower Extraversion and Conscientiousness. This study provides the first evidence linking SCT to adult personality and underscores the importance of differentiating SCT from both ADHD and anxiety/depression.

Keywords

ADHD; anxiety; comorbidity; depression; internalizing; motivation; personality; psychopathology; sluggish cognitive tempo

1. Introduction

There is ongoing interest in how to best conceptualize sluggish cognitive tempo (SCT) symptoms characterized by daydreaming, mental confusion and 'fogginess,' and slowed

behavior/thinking. Initially considered to be an aspect or specifier of attention-deficit/hyperactivity disorder (ADHD), it is now clear that SCT is strongly related to but distinct from both ADHD inattention (IN) and internalizing symptoms of depression and anxiety (Becker et al., 2016). As a result, a key priority for research has been to evaluate whether SCT has a distinct pattern of external correlates that provide further support for the differentiation of SCT from ADHD and anxiety/depression. To date, studies have found SCT to be most clearly associated with increased internalizing symptoms (especially depression) and social isolation/withdrawal, and a growing number of studies also document associations between SCT symptoms and academic difficulties (Barkley, 2014; Becker & Barkley, 2018; Becker et al., 2016). In college students specifically, research has found SCT to be associated with greater overall functional impairment and increased daily life executive functioning deficits (Flannery, Luebbe, et al., 2016; Wood, Lewandowski, et al., 2017), emotion dysregulation (Flannery, Becker, et al., 2016), suicide risk (Becker, Holdaway, et al., 2018), and poorer academic-related functioning including poorer study skills, deficits in self-regulation learning strategies, self-reported difficulty on timed reading tasks, and lower self-reported grades (Becker, Langberg, et al., 2014; Flannery, Luebbe, et al., 2016; Shelton et al., 2017; Wood, Potts, et al., 2017). However, one domain that remains almost entirely unexamined is personality. This is surprising since there is long-standing interest in the links between psychopathology symptoms and personality (Bijttebier et al., 2009; Kotov et al., 2010; Malouff et al., 2005). Furthermore, personality is included as a core feature in current dimensional models of psychopathology (Kotov et al., 2017; Lahey et al., 2017). Thus, examining SCT in relation to personality may not only advance its distinction from ADHD and anxiety/depression but also inform how SCT should be conceptualized in broader models of psychopathology (Becker & Willcutt, 2018).

1.1. Reinforcement Sensitivity and Five-Factor Models of Personality

Two leading models of personality are reinforcement sensitivity theory (RST) (Gray, 1970, 1982; Gray & McNaughton, 2000) and the five-factor model (FFM) (Goldberg, 1993; John et al., 2008; McCrae & Costa, 1999). These models of personality are distinct but also have areas of correspondence.

1.1.1. Reinforcement sensitivity theory (RST).—In large part stemming from Eysenck's (Eysenck, 1967) biosocial model of personality, RST postulates that two biologically-based systems underlie individual differences in motivation and personality: the Behavioral Approach System (or Behavioral Activation System; BAS) and the Behavioral Inhibition System (BIS) (Gray, 1970, 1982). Briefly, the BAS is an approach/appetitive motivational system whereby signals of reward are activated. The BIS activates responses of inhibition and avoidance (including anxiety and arousal) in response to conditioned signals of punishment and novelty. In addition, RST has undergone revisions to subdivide BIS into BIS-anxiety and BIS-fear (Fight-Flight-Freeze System; FFFS) (Gray & McNaughton, 2000). BIS-fear motivates avoidance and escape behaviors (i.e., signals of punishment are activated), whereas BIS-anxiety resolves conflicts among competing goals when both reward and threat are activated (Gray, 1970, 1982; Gray & McNaughton, 2000). Together, BIS-anxiety and BIS-fear are conceptualized as reflecting an underlying dimension of punishment sensitivity, whereas the BAS reflects underlying reward sensitivity (Corr, 2004).

Thus, in the present study we focus on the overarching domains of BAS and BIS (encapsulating both BIS-anxiety and BIS-fear).

1.1.2. The five-factor model (FFM).—The FFM of personality emerged from a lexical hypothesis positing that the most salient and meaningful personality characteristics are embedded in the trait descriptors used in natural language (Allport, 1937; Cattell, 1943; John et al., 2008). Studies have consistently identified five high-order factors (the “Big 5”) that represent the broad domains of personality: extraversion (sociable, energetic, assertive), agreeableness (trusting, cooperative, altruistic), conscientiousness (responsible, orderly, dependable), neuroticism (easily upset, tendency to experience negative emotion, emotional lability), and openness to experience (imaginative, intellectual, creative). Support for the FFM structure has been established across measures, ages, and cultures (Allik, 2005; Digman, 1997; John et al., 2008; McCrae & Costa, 1997; Schmitt et al., 2007; Soto et al., 2008).¹

1.1.3. Connections between RST and the FFM.—Although RST and the FFM emerged from somewhat different historical traditions and have different emphases, they are both models of personality and thus can be expected to relate to each other in meaningful ways. Perhaps most clearly, RST emerged from Eysenck’s personality theory whereby extraversion was recast (via rotation of 30 degrees) as BAS and neuroticism was recast as BIS (Corr, 2004; Gray, 1970). Thus, the Big 5 trait of neuroticism is positively associated with BIS and negatively associated with BAS, whereas the Big 5 trait of extraversion is positively associated with BAS and negatively associated with BIS (Corr, 2004; Smits & Boeck, 2006). There is also evidence that higher agreeableness is associated with higher BIS and lower BAS (Keiser & Ross, 2011; Mitchell et al., 2007; Segarra et al., 2014; Slobodskaya, 2007; Smits & Boeck, 2006). Studies have found that conscientiousness is positively associated with BIS (Keiser & Ross, 2011; Mitchell et al., 2007; Segarra et al., 2014) and/or negatively associated with BAS (Mitchell et al., 2007; Slobodskaya, 2007; Smits & Boeck, 2006). Finally, mixed findings have been reported for openness, with studies reporting no association with either BIS or BAS (Keiser & Ross, 2011), a negative association with BIS (Mitchell et al., 2007; Slobodskaya, 2007), or a positive association with BAS (Segarra et al., 2014; Smits & Boeck, 2006). Although the direct link between RST and the Big 5 was not the focus of the present study, we expected psychopathology dimensions to relate in meaningful ways to both of these personality models given their conceptual and empirical linkages.

1.2. SCT Symptoms and Personality

In the current study, it was hypothesized that SCT symptoms would be associated with increased BIS and neuroticism, as well as decreased BAS, extraversion, and conscientiousness. There are several reasons for this hypothesis. In particular, there is

¹It is important to note that there are some differences in the dimensions of the English language lexical Big Five and the Five Factor Model (FFM). For instance, agreeableness has been more broadly defined in the FFM compared to the lexical Big Five. It has been suggested that the FFM conceptualization of agreeableness combines elements of the lexical Big Five with other elements such as *straightforwardness* and *modesty* (Ashton & Lee, 2005). The Big Five Inventory (BFI) used in this study was developed directly from the lexical Big Five and, as such, does not include some aspects of agreeableness such as honesty/straightforwardness and modesty/humility that are included in other personality measures assessing the same five personality dimensions (Miller et al., 2011).

tentative evidence suggesting that SCT may be best conceptualized within the internalizing domain of psychopathology (see Becker & Willcutt, 2018), though it should be noted that no study has directly tested this possibility. For instance, it has been shown that SCT is not best included as part of a general disruptive behavior factor (Lee et al., 2016). Rather, SCT is more strongly associated with internalizing symptoms than with externalizing behaviors (Becker et al., 2016), and SCT symptoms are associated with increased anxiety/depressive symptoms in adults (Becker, Burns, et al., 2018; Becker, Langberg, et al., 2014; Kamradt et al., 2017; Leikauf & Solanto, 2017; Wood, Lewandowski, et al., 2017). Studies of adults, primarily conducted in college students, have also found SCT symptoms to be associated with increased social withdrawal/isolation and loneliness, lower self-esteem, greater emotion dysregulation, suicide risk, and poorer sleep quality (Barkley, 2012; Becker, Burns, et al., 2018; Becker, Holdaway, et al., 2018; Becker, Luebke, et al., 2014; Flannery, Becker, et al., 2016; Jarrett et al., 2017). These domains of functioning are themselves clearly linked to internalizing symptoms (Aldao et al., 2010; Eisenberg et al., 2001; Gross & Muñoz, 1995; Hawkey & Cacioppo, 2010; Sowislo & Orth, 2013) as well as to increased neuroticism and BIS sensitivity (Asendorpf & Van Aken, 2003; Brezo et al., 2006; Hintsanen et al., 2014; Kim et al., 2015; Kokkonen & Pulkkinen, 2001; Markarian et al., 2013; O'Connor & Forgan, 2007; Robins et al., 2001; Schmitz et al., 2003; Tull et al., 2010). If SCT does fall under the internalizing umbrella of psychopathology, SCT can be expected to evidence similar associations as internalizing symptoms with personality. Specifically, internalizing symptoms are most clearly associated with increased BIS sensitivity and Big 5 neuroticism, as well as lower conscientiousness (Bijttebier et al., 2009; Johnson et al., 2003; Kotov et al., 2010; Malouff et al., 2005). Although findings are somewhat less consistent, internalizing symptoms may also be associated with lower BAS sensitivity and Big 5 extraversion, and either unassociated or negatively associated with agreeableness (Bijttebier et al., 2009; Johnson et al., 2003; Kotov et al., 2010; Malouff et al., 2005).

In addition to the conceptual and empirical links between internalizing symptoms and SCT, one study has directly examined SCT in relation to BIS/BAS. In a community sample of 89 school-aged children (ages 9–12 years), Becker and colleagues (Becker et al., 2013) found SCT symptoms (and internalizing symptoms broadly) to be significantly associated with increased BIS whereas ADHD symptoms (and externalizing symptoms broadly) were significantly associated with increased BAS. However, the study had a small sample size, limited measures of both SCT and ADHD, did not consider separate ADHD-IN and ADHD-HI dimensions, and did not consider personality from both the RST and FFM frameworks (Becker et al., 2013). Further, findings regarding the differential links between SCT and ADHD in relation to personality in childhood cannot be assumed to generalize to young adults, particularly as a recent study shows SCT to increase slightly across the transition from childhood to adolescence (Leopold et al., 2016) and young adults have higher rates of SCT than both children and the general adult population (Flannery, Becker, et al., 2016; Jarrett et al., 2017; Wood, Lewandowski, et al., 2017).

1.3. The Present Study

The present study is the most comprehensive examination to date of SCT in relation to personality, and it is the first study to examine SCT and personality in adults. Using

measures of both BIS/BAS and the Big 5 in a large sample of university students, we first evaluated whether SCT symptoms evidenced different patterns of correlations with personality than ADHD-IN, ADHD-HI, and anxiety/depression symptoms. As detailed above, we hypothesized that SCT symptoms would be most strongly correlated with increased BIS and neuroticism, as well as decreased BAS, extraversion, and conscientiousness.

Next, in path models, we controlled for ADHD-IN, ADHD-HI, and anxiety/depression dimensions to evaluate whether SCT remained uniquely associated with personality and whether SCT and internalizing symptoms had similar associations with personality. Since sex is clearly related to personality (Schmitt et al., 2008; Weisberg et al., 2011), we controlled for sex in all analyses. Based on the existing literature, the following hypotheses were made for the unique associations of each of the psychopathology dimensions with personality:

1. After controlling for sex, ADHD-IN, ADHD-HI, and anxiety/depression, we expected SCT symptoms to be uniquely associated with higher BIS and neuroticism (Becker et al., 2013) as well as lower BAS, extraversion, and conscientiousness. No specific hypothesis was made regarding agreeableness or openness.
2. ADHD-IN symptoms would be uniquely associated with higher BIS and neuroticism, as well as lower conscientiousness. We expected ADHD-IN to be unassociated or negatively associated with BAS, extraversion, agreeableness, and openness (Hundt et al., 2008; Knouse et al., 2013; Nigg et al., 2002; Parker et al., 2004; Rabiner et al., 2008; Stanton & Watson, 2016).
3. ADHD-HI symptoms would be uniquely associated with higher BAS, extraversion, and neuroticism, as well as lower agreeableness. We expected ADHD-HI to be unassociated or negatively associated with BIS, as well as unassociated with openness. No specific hypothesis was made regarding conscientiousness (Hundt et al., 2008; Knouse et al., 2013; Mitchell, 2010; Mitchell & Nelson-Gray, 2006; Nigg et al., 2002; Parker et al., 2004; Rabiner et al., 2008; Stanton & Watson, 2016).
4. Anxiety/depression symptoms would be uniquely associated with higher BIS and neuroticism, as well as lower BAS, extraversion, and conscientiousness. We expected internalizing symptoms to be unassociated or negatively associated with agreeableness and unassociated with openness (Bijttebier et al., 2009; Johnson et al., 2003; Kotov et al., 2010; Malouff et al., 2005).

2. Method

2.1. Participants

Participants were 3,172 undergraduate students enrolled in five universities in the United States (see Becker et al., 2018). Four of the five universities are public universities, and the universities are located in the Midwest, Southeast, and Northwest regions of the United States. A multi-university approach was used to increase sample size and diversity

(geographic, racial, and socioeconomic), and to bolster confidence that findings were not attributable to university-specific factors. Participants ranged in age from 18 to 29 years ($M = 19.24$, $SD = 1.52$) and approximately two thirds were female (69.8%, $n = 2,214$). The majority (80.4%) of participants self-identified as White; the remaining participants self-identified either as Asian/Asian American (6.4%), Black/African American (6.3%), Native Hawaiian/Other Pacific Islander (0.7%), American Indian/Alaska Native (0.6), or Biracial/Multiracial (5.6%). 6.7% of participants self-identified as Hispanic or Latino. Most participants (59.5%) were in their first year of college; the remaining participants were in their second (20.4%), third (12.1%), fourth (7.5%), or other (0.4%) year of college.

2.2. Procedures

This study was approved by the local Institutional Review Board (IRB) at each university, with the individual study protocols specifying that data would be merged across sites for analysis and dissemination. Procedures varied slightly based on normative practices at each institution. At four of the sites, this study was an anonymous online survey. Specifically, after signing up for the study in Sona, participants were directed to the survey in Qualtrics where they first read an information sheet describing the study and providing contact information of the local investigator, IRB, and student counseling center. If the participant chose to continue, they were then directed to the survey, and after completing the survey, automatically received course credit in Sona for their participation. At the fifth university, participants were given an individual timeslot for coming to the investigator's laboratory, and after providing informed consent in-person, completed the same Qualtrics survey as participants at the other four universities on their own time. They were similarly granted course credit for participation.

2.3. Measures

2.3.1. ADHD symptoms.—The *Barkley Adult ADHD Rating Scale-IV* (BAARS-IV) (Barkley, 2011) was used to assess ADHD symptoms. The BAARS-IV includes 18 items that are consistent with the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*) (American Psychiatric Association, 1994) symptoms of ADHD that have been updated in their wording to also reflect modifications made in *DSM-5* (American Psychiatric Association, 2013). Using a four-point scale (in this study, 0 = *not at all*, 3 = *very often*), participants respond to each item with reference to how often each statement best describes their behavior over the past six months. The ADHD-IN (e.g., “difficulty sustaining my attention in tasks or fun activities”) and ADHD-HI (e.g., “fidget with hands and feet or squirm in seat”) subscales of the BAARS-IV are empirically distinct (though strongly correlated, $r \sim .5$ to $.6$) and have demonstrated satisfactory internal consistency and test-retest reliability over a 2- to 3-week time period (Barkley, 2011; Becker, Langberg, et al., 2014). In the present study, Cronbach's α s were .89 and .83 for the ADHD-IN and ADHD-HI dimensions, respectively.

2.3.2. SCT symptoms.—The *Adult Concentration Inventory* (ACI) (Becker et al., 2015) was used to assess SCT. A previous study using the same sample as the current study provided initial psychometric evidence for the 10-item ACI (Becker, Burns, et al., 2018). Each item is rated on a four-point scale (0 = *not at all*, 1 = *sometimes*, 2 = *often*, 3 = *very*

often) in reference to the past six months (e.g., “I daydream”, “I get lost in my thoughts”). In the initial validation study, SCT was uniquely associated with poorer socio-emotional adjustment, daily life executive functioning (EF) deficits, and functional impairment (Becker, Burns, et al., 2018). In the present study, Cronbach’s $\alpha = .89$.

2.3.3. Anxiety/depression symptoms.—The depression and anxiety subscales of the *Depression Anxiety Stress Scales-21* (DASS-21) (Antony et al., 1998; Lovibond & Lovibond, 1995) were used to assess internalizing symptoms. Participants respond to each item 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*). The DASS-21 demonstrates high reliability and is widely accepted as being valid for use with college-aged participants (Antony et al., 1998; Sinclair et al., 2012). Previous analyses in this sample provided support for a 9-item internalizing scale as opposed to separate anxiety and depression subscales (Becker, Burns, et al., 2018). This 9-item internalizing scale (comprised of 6 depression items and 3 anxiety items) was used in the current study ($\alpha = .89$).

2.3.4. BIS/BAS sensitivity.—The BIS/BAS Scales (Carver & White, 1994) is an adult self-report measure of RST that has been used extensively, including in college student samples. It is comprised of 24 items (four are filler items) rated on a four-point scale (1 = *very true for me*, 4 = *very false for me*), and all but two of the items are reverse-keyed. The BIS/BAS Scales were empirically derived to consist of a single BIS scale (7 items; e.g., “Criticism or scolding hurts me quite a bit,” “If I think something unpleasant is going to happen I usually get pretty ‘worked up’”) and three BAS subscales: drive (4 items; e.g., “I go out of my way to get things I want”), reward responsiveness (5 items; e.g., “When I’m doing well at something I love to keep at it”), and fun seeking (4 items; “I’m always willing to try something new if I think it will be fun”). The BIS/BAS Scales have demonstrated adequate internal consistency (Carver & White, 1994; Johnson et al., 2003). In the present study, Cronbach’s α s were as follows: BIS $\alpha = .75$, BAS drive $\alpha = .79$, BAS reward responsiveness $\alpha = .73$, and BAS fun seeking $\alpha = .70$.

2.3.5. Big 5 personality traits.—The Big Five Inventory (BFI) (John et al., 1991; John et al., 2008) is a 44-item measure which uses short phrases to reflect the Big Five traits of the FFM. Participants are directed to respond to each item based on how they generally are, using a five-point scale (1 = *disagree strongly*, 5 = *agree strongly*). After reverse-scoring 16 items, subscale scores are calculated for extraversion (8 items; e.g., “is outgoing, sociable”), agreeableness (9 items; e.g., “has a forgiving nature”), conscientiousness (9 items; “makes a plan and follows through with them”), neuroticism (8 items; “can be tense”), and openness (10 items; “likes to reflect, plays with ideas”). The BFI is widely used in personality studies and demonstrates convergent validity with other FFM measures, as well as peer ratings of personality (John et al., 2008; John & Srivastava, 1994). In the present study, Cronbach’s α s were as follows: extraversion $\alpha = .86$, agreeableness $\alpha = .78$, conscientiousness $\alpha = .78$, neuroticism $\alpha = .82$, and openness $\alpha = .76$.

2.4. Analytic Strategy

2.4.1. Survey validity checks.—Prior to running primary analyses, data were screened for invalid responses. In order to improve the quality of participant responses, we utilized an instructional manipulation check (IMC) (Oppenheimer et al., 2009). The IMC is a question given at the start of a survey that measures whether a participant is reading the instructions carefully. The IMC consists of a set of instructions and a question that is similar to other survey questions in length and response format. In contrast to other questions, though, the instructions indicate that the respondent should ignore the question and click on a specific answer. The use of such questions has been shown to improve subsequent responses, since respondents are primed to focus on the importance of reading the instructions (see Oppenheimer et al., 2009). It should be noted that such a manipulation has been shown to be effective even when participants respond incorrectly to the initial IMC (i.e., they did not read the instructions carefully). In turn, we chose to use the IMC as a prompt for respondents to recognize the importance of attending to instructions but did not exclude participants with an initially incorrect IMC response. Respondents were required to answer this question correctly, though, to be able to proceed with the survey. We modeled our question after the example used in Oppenheimer et al. (2009). Please see Figure 1 in that article for details.

In addition to the IMC, we also utilized “trap” questions that were designed to detect individuals who were quickly responding to survey questions without sufficient attention to item content. Within each measure of our battery, we included a question that stated something like “If you are paying attention, please click on the response ‘sometimes’.” In addition to these questions, we had one question at the end of the full survey that asked participants the following: “How much effort did you put into this study from 0 to 10 (0 = *not much effort at all*, 5 = *moderate effort*, 10 = *my best effort*)?” To ensure the validity of responding, we set a threshold of 50% accuracy or higher for the “trap questions” and a self-reported effort rating of 5 or higher. We chose this threshold since we wanted to ensure that participants were putting forth sufficient effort while also not excluding participants who might have responded inaccurately due to attention lapses or impulsive responding (e.g., those with elevated ADHD or SCT symptoms). This threshold was met by the 3,172 of the 3,307 participants (96%) who completed the survey; these 3,172 participants were used in analyses².

2.4.2. Primary analyses.—All primary analyses were conducted in Mplus v8 (Muthén & Muthén, 1998–2014). Manifest variables were used for all constructs. Analyses used the robust maximum likelihood (MLR) estimator which uses all the available information for the analyses and also accounts for any nonnormality. There was little missing information (covariance coverage was approximately 99%). First, correlations were conducted to examine SCT, ADHD-IN, ADHD-HI, and internalizing dimensions in relation to BIS/BAS and Big 5 dimensions. Given the sample size, statistical significance was set at $p < .01$, though we also focused on size of effects. A correlation of 0.10 is considered a small effect, a correlation of 0.30 is considered a medium effect, and a correlation of 0.50 is considered a large effect (Cohen et al., 2003). The Mplus model constraint procedure was also used to test

²The overall pattern of findings was unchanged when analyses were re-run with the full sample of 3,307 participants.

for statistically significant differences in the magnitude of the bivariate correlations of the psychopathology dimensions in relation to personality. Second, path analyses were conducted to determine the ability of SCT, ADHD-IN, ADHD-HI, and anxiety/depression dimensions to uniquely predict BIS/BAS and Big 5 dimensions. Separate path models were conducted for BIS/BAS and Big 5 dimensions as the dependent variables (because the path models were fully saturated (i.e., 0 degrees of freedom), they demonstrated perfect fit to the data and model fit statistics are, therefore, not used or reported). Participant sex was included as a covariate in the path analyses³.

3. Results

3.1. Correlation Analyses

Table S1 shows the descriptive statistics and intercorrelations among the study variables. The psychopathology dimensions were all significantly correlated with each other (all p s < .01). SCT symptoms were strongly correlated with ADHD-IN symptoms ($r = .65$), internalizing symptoms ($r = .50$), and ADHD-HI symptoms ($r = .49$). ADHD-IN symptoms were likewise strongly correlated with internalizing symptoms ($r = .53$) and ADHD-HI symptoms ($r = .61$). ADHD-HI symptoms were moderately correlated with internalizing symptoms ($r = .39$). Most RST and Big 5 dimensions were also intercorrelated, though there were exceptions and significant correlations ranged from small to large in magnitude. As expected, neuroticism was strongly positively associated with BIS ($r = .59$) and negatively, though weakly, associated with BAS (r s = $-.07$ to $-.14$). Extraversion was positively correlated with BAS dimensions (r s = $.29$ to $.38$) and negatively associated with BIS ($r = -.20$). In contrast to expectations, both agreeableness and conscientiousness were most clearly correlated, positively so, with BAS reward responsiveness (r s = $.26$ and $.24$, respectively). Finally, openness was significantly positively associated with BAS dimensions (r s = $.16$ to $.21$) and unassociated with BIS ($r = -.04$) (see Table S1).

Table 1 shows the correlations of the psychopathology domains with the personality dimensions, with superscripts used to indicate significant differences between the magnitude of the bivariate correlations within each personality dimension. All four of the psychopathology domains were correlated with significantly higher BIS (small to medium effects) and neuroticism (large effects for SCT and internalizing; medium effects for ADHD-IN and ADHD-HI). All four psychopathology dimensions were also significantly correlated with lower agreeableness (small to medium effects), and conscientiousness (large effects for SCT and ADHD-IN; medium effects for ADHD-IN and internalizing). SCT, ADHD-IN, and internalizing were each associated with lower BAS reward responsiveness, though effect sizes were small. SCT, ADHD-IN, and internalizing domains were each associated with significantly lower BAS drive and extraversion (generally small effects), whereas ADHD-HI was associated with significantly higher BAS drive and extraversion (small effects). SCT and ADHD-HI were both significantly correlated with significantly higher BAS fun seeking

³As noted by other investigators examining ADHD in relation to personality (Martel & Nigg, 2006), some ADHD symptoms are highly similar to personality items which may contribute to predictor-criterion overlap. In our study, this issue was most clearly evident in two conscientiousness items (“tends to be disorganized”, “is easily distracted”). In addition, our internalizing measure had similar content to two neuroticism items (“is depressed, blue”, “worries a lot”). When these personality items were removed from their respective scales and analyses re-run, findings were unchanged.

and openness, whereas internalizing symptoms were associated with significantly lower BAS fun seeking, though all of these effects were negligible to small in magnitude.

A stepwise pattern in correlation magnitude differences was found for BIS, neuroticism, and extraversion. Specifically, internalizing symptoms were most strongly associated with BIS and neuroticism, followed in order by SCT, ADHD-IN, and ADHD-HI (see Table 1). ADHD-HI symptoms were positively associated with extraversion, whereas ADHD-IN, SCT, and internalizing symptoms were each negatively associated with extraversion in descending order. ADHD-HI was also the only domain significantly positively correlated with BAS drive and was more strongly associated than the other psychopathology domains with BAS fun seeking. ADHD-IN symptoms were more strongly correlated than SCT symptoms with lowered conscientiousness, and SCT symptoms were in turn more strongly correlated than both ADHD-HI and internalizing with conscientiousness. No differences emerged between the psychopathology domains in relation to agreeableness or openness (see Table 1).

3.3. Path Analyses

Table 2 shows the unique effects (standardized partial regression coefficients) of SCT, ADHD-IN, ADHD-HI, and anxiety/depression dimensions in relation to BIS/BAS sensitivity and Big 5 personality dimensions⁴.

3.3.1. SCT, ADHD, and anxiety/depression dimensions in relation to BIS/BAS.—A clear, differential pattern emerged for the SCT and the other psychopathology dimensions in relation to BAS: ADHD-HI was significantly uniquely associated with higher drive, fun seeking, and reward responsiveness whereas anxiety/depression was significantly uniquely associated with lower drive, fun seeking, and reward responsiveness. ADHD-IN was significantly uniquely associated with lower drive and reward responsiveness. SCT was unassociated with either BAS drive or BAS reward responsiveness but significantly uniquely associated with higher BAS fun-seeking. In terms of BIS sensitivity, higher levels of SCT and anxiety/depression each uniquely predicted significantly higher BIS, whereas higher levels of ADHD-HI uniquely predicted significantly lower BIS, and ADHD-IN was not uniquely associated with BIS (see Table 2).⁵

3.3.2. SCT, ADHD, and anxiety/depression dimensions in relation to the Big 5.—In the model examining Big 5 traits (see Table 2), higher levels of SCT were uniquely associated with significantly lower extraversion and conscientiousness and also associated with significantly higher neuroticism. Anxiety/depression was also uniquely associated with

⁴Site was generally unassociated with personality and all significant correlations were small in magnitude (all $r_s < |.09|$). Further, an analysis of variance (ANOVA) was applied to the personality scores to determine the magnitude of site effects. The η^2 values ranged from .0004 (BAS Drive) to .01 (Big 5 Openness) with the average effect size for the 10 personality variables being .003 ($SD = .003$). Although the effect size for site was small, to be conservative, site was nevertheless included as a covariate in the path models.

⁵In this study, we used the BIS scale as originally developed (Carver & White, 1994). However, following a more recent revision of the RST that incorporates a freeze response (i.e., FFFS) (Gray & McNaughton, 2000), some investigators have separated the original BIS scale into separate anxiety and FFFS subscales (Heym et al., 2008; Heym et al., 2015; Poythress et al., 2008). We conducted supplemental analyses to examine whether the pattern of findings changed when using separate BIS-anxiety (4 items; $\alpha = .71$) and BIS-FFFS (3 items; $\alpha = .57$) subscales. Regression results using these separate BIS subscales yielded the same overall pattern of results as those presented in Table 2.

significantly lower extraversion and higher neuroticism, as well as lower agreeableness. Higher levels of ADHD-IN were uniquely associated with significantly lower extraversion and conscientiousness. Finally, higher levels of ADHD-HI were uniquely associated with significantly higher extraversion and conscientiousness, in addition to lower agreeableness.

4. Discussion

This study tested the hypotheses that SCT symptoms would be differentially related from ADHD symptom dimensions to personality, and that SCT and internalizing symptoms would be more similarly related to personality. We evaluated these hypotheses in a large sample of undergraduate students from five universities and used measures representing both the RST and FFM models of personality. As such, this study contributes to our understanding of SCT and also informs our understanding of ADHD since previous studies in this area have only examined ADHD dimensions in relation to either the RST or FFM model of personality. The findings from this study lead to two primary conclusions. First, each of the psychopathology dimensions examined in this study had a distinct pattern of associations with personality. Second, SCT evidenced similar associations as anxiety/depression for some personality domains (i.e., higher BIS and neuroticism, lower extraversion), but SCT and anxiety/depression also differed in their associations with other personality domains.

Previous studies examining ADHD in relation to personality focused solely on BIS/BAS or the Big 5 and did not consider related domains of SCT and internalizing symptoms. Findings from the current study indicate that it may be important for studies to also consider the closely related construct of SCT. For instance, although all four psychopathology dimensions were significantly bivariate correlated with several personality domains (lower BAS reward responsiveness, conscientiousness, and agreeableness, as well as higher BIS and neuroticism), the magnitude of these associations significantly differed. Several stepwise patterns were found, including for extraversion, conscientiousness, BIS, and neuroticism. Models of psychopathology implicate neuroticism as a key contributor to most psychopathologies, though more clearly with internalizing than with externalizing psychopathologies (Kotov et al., 2017; Lahey et al., 2017). Indeed, in line with the proposition that “neuroticism may be the core of internalizing psychopathology” (Griffith et al., 2010), anxiety/depression symptoms had the strongest association with neuroticism in both the bivariate correlation and path model analysis in the present study. SCT symptoms had the second strongest bivariate association with neuroticism and was the only other psychopathology dimension to remain associated with higher neuroticism in the path model examining unique effects. The findings for BIS largely paralleled those for neuroticism. Considered together, these findings support the possibility that SCT may ultimately be best conceptualized as falling within the internalizing domain of psychopathology (Becker & Willcutt, 2018). A clear priority for future research is to directly test whether SCT best fits as a first-order domain within the higher-order internalizing domain (Lahey et al., 2017).

Although there were similarities between SCT and anxiety/depression, it is important to note that there were also differences in their associations with multiple personality dimensions. For instance, anxiety/depression symptoms were consistently correlated more strongly than

SCT with lower BAS reward responsiveness and fun seeking (though these correlations were small in magnitude). Fun seeking includes a willingness to try new things, acting on the spur of the moment, and craving excitement. As expected, ADHD-HI symptoms were also significantly associated in both correlation and path analyses with increased BAS fun seeking. Although it was expected that ADHD-HI would be associated with fun seeking, why might SCT also be uniquely associated with fun seeking? First, it is important to note that the effect size of this association was small and potentially negligible, making replication of this finding important before drawing any conclusions. Nevertheless, although speculative in the absence of data, there are likely multiple pathways to SCT symptoms. Almost nothing is known regarding the etiology of SCT, but one potential cause of SCT may be insufficient or poor quality sleep (Becker, Epstein, et al., 2018; Garner et al., 2017; Langberg et al., 2014). In line with this possibility, Wood and colleagues (Wood, Lewandowski, et al., 2017) noted that “the use of alcohol, marijuana, or other substances and/or poor sleep habits might contribute to a college student feeling ‘sluggish’ or ‘lethargic’” (p. 8). While biological factors likely contribute to SCT (Moruzzi et al., 2014), environmental and lifestyle factors (e.g., poor sleep habits, substance use) may also contribute to SCT. These lifestyle factors are especially prominent among college students, and some students who engage in “fun seeking” proclivities may experience SCT as a result. Indeed, SCT is not uniquely associated with fun seeking in childhood (Becker et al., 2013), and so the positive association between SCT and fun seeking may only emerge among adolescents and adults who are more likely to have poor sleep hygiene and are exposed to behaviors such as substance use. Further, among the BAS sub-domains, fun seeking is most clearly related to substance and alcohol use in college students (Franken & Muris, 2006; O’Connor et al., 2009; Voigt et al., 2009). Although psychopathology was the independent variable in the current study, the cross-sectional design does not allow for testing directionality. It may be that college students high in fun seeking in turn have poorer sleep and increased alcohol/substance use, which in turn contributes to SCT. Clearly, studies are needed to directly test the possibility that some adults experience SCT as a result of engaging in “fun seeking” behaviors, optimally with longitudinal data that can better speak to causality and potentially bidirectional pathways.

SCT also differed from ADHD-IN in relation to personality in several key ways. In bivariate correlations, SCT symptoms but not ADHD-IN symptoms were significantly associated with both BAS fun seeking and openness, though as noted above the magnitude of these correlations and their differences were quite small. In addition, although both SCT and ADHD-IN were significantly negatively correlated with extraversion and conscientiousness, the negative correlation with extraversion was stronger for SCT whereas the negative correlation with conscientiousness was stronger for ADHD-IN. The pattern of findings for SCT and ADHD-IN diverged further in the path models where sex and other psychopathology dimensions were included. When examining unique effects, ADHD-IN was much more strongly associated than SCT with lower conscientiousness. Further, in the path models ADHD-IN was uniquely associated with lower BAS drive and reward responsiveness, whereas SCT was not. Conversely, SCT was uniquely associated with increased BIS and neuroticism whereas ADHD-IN was not. These findings suggest that although SCT and ADHD-IN are themselves strongly related, ADHD-IN may be more

clearly linked to lower reward sensitivity whereas SCT is more clearly linked to increased punishment sensitivity (Corr, 2004). Our findings related to the ADHD dimensions are generally consistent with prior studies that have found ADHD-HI to be uniquely related to increased BAS (and either unassociated or negatively associated with BIS) and ADHD-IN to be uniquely related to increased BIS (and either unassociated or negatively associated with BAS) (Hundt et al., 2008; Mitchell, 2010; Mitchell & Nelson-Gray, 2006). The key point of departure from previous studies is that when SCT and internalizing symptoms were also included in the model, ADHD-IN symptoms were no longer associated with BIS.

Establishing unique effects is important for the ongoing study of the validity of SCT as distinct from ADHD-IN, though we also acknowledge that regression approaches raise other methodological and conceptual issues associated with the “perils of partialling” (Lynam et al., 2006). That is, SCT and ADHD-IN are strongly correlated empirically (Becker et al., 2016) and also overlap clinically (Barkley, 2012). The picture grows even more complex when also considering the clinical overlap of SCT and ADHD with internalizing symptoms such as depression (Servera et al., 2018). It is thus somewhat difficult to know what the nature of SCT is when both ADHD and internalizing symptoms are partialled out. It is for this reason that our discussion above gave careful consideration to bivariate associations and their relative magnitudes. Nevertheless, examining unique effects after partialling is one way to test the construct validity of SCT from ADHD-IN and internalizing symptoms and, crucially, our unique effects are in line with theoretical and hypothesized associations.

4.1. Limitations and Future Directions

Several limitations of this study are important to note. First, this was a cross-sectional study that cannot determine directionality or causality. Indeed, we focused on psychopathology dimensions as predictors of personality in order to control for the covariance among the psychopathology dimensions in our analyses, but it is also worthwhile to examine personality as predictors of psychopathology. Longitudinal studies examining psychopathology and personality in adulthood remain scarce and are clearly needed (Kotov et al., 2010). Second, as in many other studies of personality, our sample consisted of university students. We sought to increase generalizability by recruiting a large sample from five universities in different regions of the United States, yet we still cannot assume that our findings generalize to all college students or adults more broadly. We contend that it is important to examine SCT in the college student population since extant studies indicate higher rates of SCT among college students as compared to the general adult population (Flannery, Becker, et al., 2016; Jarrett et al., 2017; Wood, Lewandowski, et al., 2017). Nevertheless, more studies are needed that examine SCT in adults using a broader assessment approach, including both community and clinical samples. Third, all of our measures were self-report measures which, while validated for use in college students, may contribute to mono-informant biases. Additionally, our study did not include measures of substance use or substance abuse which would be important for future studies to assess given the impact substance use/abuse may have on attentional functioning. Finally, even measures that purport to assess the same five personality dimensions differ in their foci, and the BFI used in this study does not include honesty and humility aspects of agreeableness

captured in other personality measures (Miller et al., 2011); replication across personality measures of the Big Five and FFM would bolster confidence in the findings reported herein.

4.2. Conclusion

This is the first study to examine SCT in relation to adult personality and also the first to examine ADHD dimensions in relation to both the RST and FFM models of personality. Anxiety/depression symptoms were also considered to further examine psychopathology dimensions in relation to BIS/BAS sensitivity and the Big 5 personality traits. Findings from this study indicate that the four dimensions of psychopathology examined were each connected to personality in different ways. Germane to the primary focus of this study, we found SCT to be most clearly associated with higher BIS, neuroticism, and fun seeking, as well as lower extraversion and conscientiousness. Moreover, SCT had areas of agreement – as well as departure – from all three other psychopathology dimensions examined in this study. Findings from this study add to a growing number of studies differentiating SCT from both ADHD and internalizing psychopathologies. Findings also support the hypothesis that SCT is better conceptualized within the internalizing, rather than externalizing, domain of psychopathology.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Correlations (Standard Errors) of Sluggish Cognitive Tempo, ADHD, and Internalizing Dimensions with BIS/BAS Sensitivity and Big 5 Personality Traits

Table 1

Variable	BIS/BAS Sensitivity			
	BAS Drive	BAS Fun-Seeking	BAS Reward Responsiveness	BIS
SCT	-0.10 (.02) ^{*a}	0.05 (.02) ^{*a}	-0.07 (.02) ^{*a}	0.28 (.02) ^{*a}
ADHD-IN	-0.10 (.02) ^{*a}	0.03 (.02) ^a	-0.11 (.02) ^{*a}	0.21 (.02) ^{*b}
ADHD-HI	0.06 (.02) ^{*b}	0.13 (.02) ^{*b}	-0.02 (.02) ^b	0.12 (.02) ^{*c}
ANX/DEP	-0.15 (.02) ^{*a}	-0.07 (.02) ^{*c}	-0.16 (.02) ^{*c}	0.34 (.02) ^{*d}

Variable	Big 5 Personality Traits				
	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
SCT	-0.18 (.02) ^{*a}	-0.16 (.02) ^{*a}	-0.46 (.02) ^{*a}	0.46 (.01) ^{*a}	0.06 (.02) ^{*a}
ADHD-IN	-0.14 (.02) ^{*b}	-0.21 (.02) ^{*a}	-0.57 (.01) ^{*b}	0.38 (.02) ^{*b}	0.04 (.02) ^a
ADHD-HI	0.14 (.02) ^{*c}	-0.20 (.02) ^{*a}	-0.32 (.02) ^{*c}	0.30 (.02) ^{*c}	0.06 (.02) ^{*a}
ANX/DEP	-0.28 (.02) ^{*d}	-0.19 (.02) ^{*a}	-0.34 (.02) ^{*d}	0.57 (.01) ^{*d}	0.01 (.02) ^a

Note. Within each personality variable (column), correlation coefficients with different superscripts differ significantly in relation to the outcome variable at $p < .01$. ADHD-HI = attention-deficit/hyperactivity disorder hyperactivity-impulsivity. ADHD-IN = attention-deficit/hyperactivity disorder inattention. BIS/BAS = Behavioral Inhibition System/Behavioral Approach System. SCT = sluggish cognitive tempo.

* $p < .01$.

Table 2

Standardized Unique Effects (Standard Errors) of Sluggish Cognitive Tempo, Anxiety/Depression, and ADHD Dimensions on BIS/BAS Sensitivity and Big 5 Personality Traits

Variable	BIS/BAS Sensitivity			
	BAS Drive	BAS Fun-Seeking	BAS Reward Responsiveness	BIS
Sex	-0.03 (.02)	-0.02 (.02)	0.09 (.02)*	0.29 (.02)*
SCT	-0.06 (.03)	0.07 (.03)*	0.01 (.03)	0.11 (.02)*
ADHD-IN	-0.12 (.03)*	-0.04 (.03)	-0.10 (.03)*	0.01 (.03)
ADHD-HI	0.21 (.02)*	0.18 (.02)*	0.09 (.02)*	-0.06 (.02)*
ANX/DEP	-0.13 (.02)*	-0.16 (.02)*	-0.15 (.02)*	0.28 (.02)*

Variable	Big 5 Personality Traits				
	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
Sex	0.09 (.02)*	0.17 (.02)*	0.10 (.02)*	0.20 (.01)*	-0.03 (.02)
SCT	-0.15 (.02)*	-0.05 (.03)	-0.19 (.02)*	0.19 (.02)*	0.07 (.03)
ADHD-IN	-0.15 (.03)*	-0.06 (.03)	-0.49 (.02)*	-0.01 (.02)	-0.03 (.03)
ADHD-HI	0.42 (.02)*	-0.11 (.02)*	0.08 (.02)*	0.03 (.02)	0.06 (.02)
ANX/DEP	-0.30 (.02)*	-0.10 (.02)*	-0.02 (.02)	0.46 (.02)*	-0.03 (.02)

Note. For sex, 0 = male, 1 = female. All analyses controlled for site. ADHD-HI = attention-deficit/hyperactivity disorder hyperactivity-impulsivity. ADHD-IN = attention-deficit/hyperactivity disorder inattention. ANX/DEP = anxiety/depression. BIS/BAS = Behavioral Inhibition System/Behavioral Approach System. SCT = sluggish cognitive tempo.

* $p < .01$.