Title: A Preliminary Investigation of ADHD Characteristics in Adults who Stutter

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Abstract

Purpose: Recent studies have shown that many children who stutter may have elevated characteristics of Attention Deficit Hyperactivity Disorder (ADHD) (e.g., Druker et al., 2019). Although childhood ADHD commonly persists into adulthood (Roy et al., 2016), it is unclear how many adults who stutter experience aspects of ADHD (e.g., inattention or hyperactivity/impulsivity). This study sought to increase understanding of how ADHD characteristics might affect individuals who stutter by evaluating : (a) whether elevated ADHD characteristics are common in adults who stutter, (b) whether elevated ADHD characteristics in adults who stutter were significantly associated with greater adverse impact related to stuttering, and (c) whether individual differences in RNT and Effortful Control influenced this relationship.

Method: 254 adults who stutter completed the *Adult ADHD Self-Report Scale* (ASRS; Adler et al., 2019; Kessler et al., 2005), the *Perseverative Thinking Questionnaire* (PTQ, Ehring et al., 2011), the *Adult Temperament Questionnaire* short form (ATQ, Evans & Rothbart, 2007), and the *Overall Assessment of the Speaker's Experience of Stuttering* (OASES, Yaruss & Quesal, 2016). Data were analyzed via multiple linear regression to determine whether the number of inattention or hyperactivity/impulsivity characteristics was significantly associated with RNT, Effortful Control, or Adverse Impact related to stuttering.

Results: Almost one-quarter of participants (23.2%; 60/254) self-reported experiencing 6 or more inattention characteristics, while fewer participants (8.3%; 21/254) self-reported experiencing 6 or more hyperactivity/impulsivity characteristics. Participants with lower Effortful Control and higher levels of both RNT and Adverse Impact were significantly more likely to self-report experiencing more inattention characteristics.

Discussion: Many adults who stutter may exhibit previously unaccounted for characteristics of ADHD, especially inattention. Results highlight the value of continued research on the intersectionality of stuttering, ADHD, and attention, and the importance of individualizing therapy to the needs of each unique person who stutters.

Attention is a term that represents many cognitive operations. For example, Posner's theory of attention describes three main attention networks: *alerting*, or efficiency of signal detection; *orienting* to salient stimuli; and *vigilance* toward a particular task or state (Posner, 1980; Posner et al., 1980; Posner & Petersen, 1990). Large, functionally distinct brain networks formed from multiple brain regions are associated with these functions (Bressler & Tognoli, 2006; Corbetta et al., 2008; Petersen & Posner, 2012; Posner & Petersen, 1990; Sonuga-Barke & Castellanos, 2007). When compared to children who do not stutter, children who stutter may have differences in functional brain systems that support processes related to attention (Chang et al., 2018; see also Petersen & Posner, 2012; Posner & Petersen, 1990; Posner & Rothbart, 2007; Rothbart, 2007; Rothbart & Rueda, 2005, for discussion of attentional networks). Methods used to investigate differences in attention and other cognitive processes in children who stutter have included electrophysiology (Kaganovich et al., 2010; Piispala et al., 2016, 2017, 2018), behavioral tasks (Choi et al., 2013; Eggers et al., 2012, 2013; Eichorn et al., 2018; Schwenk et al., 2007), parent-reported measures (Anderson et al., 2003; Eggers et al., 2010; Felsenfeld et al., 2010; Karrass et al., 2006), and a combination of behavioral and parent-reported measures (Anderson & Wagovich, 2017; Howell et al., 2004; Ntourou et al., 2018; Walsh et al., 2019). Though alternative research findings exist (see Johnson et al., 2012), the majority of these studies have shown that certain aspects of attention are different in children who stutter compared to children who do not stutter (see Ofoe et al., 2018, for review). In particular, evidence suggests that many children who stutter demonstrate an increased occurrence of characteristics of attention deficit hyperactivity disorder (ADHD) as compared to children who do not stutter (Donaher & Richels, 2012; Druker et al., 2019; Embrechts et al., 2000; Oyler, 1994).

According to the Diagnostic and Statistical Manual of Mental Health Disorders (DSM-V), ADHD is "a neurodevelopmental disorder defined by impairing levels of inattention, disorganization, and/or hyperactivity-impulsivity… [that] often persists into adulthood, with resultant impairments of social, academic and occupational functioning" (*Diagnostic and Statistical Manual of Mental Disorders*, 2013, p. 32). A formal diagnosis of ADHD requires (1) elevated numbers of inattention and/or hyperactivity/impulsivity symptoms (i.e., 6 or more symptoms, hereafter called "characteristics," in one or both categories), (2) that these characteristics be present before the age of 12, (3) that these characteristics occur in two or more settings (e.g., home and school), (4) that these characteristics interfere with quality of life, and (5) another disorder cannot better explain these characteristics (*Diagnostic and Statistical Manual of Mental Disorders*, 2013, pp. 59–60).[1] Druker et al. (2019) investigated the presence of ADHD characteristics in 185 preschool-aged children who stutter using the ADHD Rating Scale-IV (McGoey et al., 2007; Power et al., 2001), a caregiver-completed screener of ADHD characteristics based on the Diagnostic and Statistical Manual of Mental Disorders 4th edition's (DSM-IV) criteria. The authors found that over 50% of their participants demonstrated elevated characteristics of ADHD. The authors also indicated that 25% of those children with elevated ADHD characteristics required more time to achieve therapy outcomes than children without elevated ADHD characteristics. Research evidence outside of stuttering has shown that 50% to 65% of children with ADHD will continue to exhibit characteristics of ADHD in adulthood (Roy et al., 2016), yielding an adult ADHD prevalence of 4.4% to 5% in the general population

[1] In this paper, the phrase "*elevated* ADHD characteristics" is used to highlight the fact that people may exhibit inattention and hyperactivity/impulsivity characteristics but not carry a formal diagnosis of ADHD. That is, these characteristics may not be present to the degree required by diagnostic criteria but still have an impact on a person's daily life. (see Brown & Casey, 2016; Kóbor, Takács, Urbán, & Csépe, 2012; Overbey, Snell, & Callis, 2010). The use of the term *elevated* is also consistent with recent research in stuttering and ADHD (Druker et al., 2019).

(Barkley et al., 2008; Kessler et al., 2006). Thus, it is still unknown whether a notable proportion of adults who stutter also exhibit elevated inattention/hyperactivity characteristics, given the apparent co-occurrence of ADHD and stuttering in younger children.

ADHD is a heterogeneous condition that may manifest differently across individuals. For example, individuals with more inattention (ADHD-I) and fewer hyperactivity/impulsivity characteristics differ in attentional functioning associated with Posner's attention networks compared to individual s with elevated levels of both characteristics (ADHD-C). Huang-Pollock et al. (2006) found that while both ADHD-I and ADHD-C groups exhibited significant differences from people without ADHD in Posner's vigilance system, the ADHD-C group but not the ADHD-I group demonstrated significant differences with activation/alerting than people without ADHD (see Berger & Posner, 2000; Sergeant et al., 1999, for discussion of activation/alerting as a state of readiness to respond). Therefore, given that many children who stutter demonstrate elevated ADHD characteristics (Donaher & Richels, 2012; Druker et al., 2019; Embrechts et al., 2000; Oyler, 1994), exploring how adults who stutter may experience inattention and hyperactivity/impulsivity characteristics will help to elucidate individual experiences of stuttering and provide fruitful lines of future research investigating how attentional functioning and the stuttering condition may interact.

To date, much of the research on ADHD in individuals who stutter has focused on children (Donaher & Richels, 2012; Druker et al., 2019; Embrechts et al., 2000; Oyler, 1994). Nevertheless, there is some preliminary evidence that many adults who stutter may also exhibit elevated ADHD characteristics. Alm & Risberg (2007) collected self-report data on earlier childhood attentional deficits from 32 adults who stutter using the Wender Utah Rating Scale (WURS; Ward et al., 1993). The authors found that 41% of the adults who stutter self-reported

more childhood ADHD-related characteristics than a control group of adults who did not stutter. Examples of how ADHD-related behaviors in Alm & Risberg's study may have an adverse impact on adults who stutter included: being inattentive, daydreaming, being tense, being restless, having difficulty concentrating, and being easily distracted. A growing body of research indicates that many adults who stutter demonstrate attentional differences compared to adults who do not stutter (see Doneva, 2019, for review). Such findings highlight the need for further consideration of potential implications of attentional differences (specifically, characteristics of inattention and hyperactivity/impulsivity). This need is supported by research suggesting that attentional processing is critical for language formulation (see Roelofs & Piai, 2011, for review) and necessary for establishing well-learned motor movements that are essential for fluent and effortless speech (Maxwell et al., 2003; Posner, 1967; Schmidt, 1975). As noted above, some previous research has explored ADHD characteristics in small groups of adults who stutter (Alm & Risberg, 2007), but it is not yet clear if these attentional differences are present in larger samples of adults who stutter or if certain individuals who stutter are more prone to these characteristics—and their adverse sequelae (e.g., negative impact associated with attentional differences or with stuttering itself)—than other individuals who stutter.

Adverse Sequelae Related to ADHD and Stuttering

A vast literature shows that ADHD frequently comes at a high cost to social functioning, emotional functioning, and quality of life (see Wehmeier et al., 2010, for review). The DSM-V, which requires adverse impact related to attentional difficulties in order for a formal diagnosis of ADHD to be applied, echoes the importance of such literature (*Diagnostic and Statistical Manual of Mental Disorders*, 2013). Compared to peers who do not have ADHD, children and adolescents with ADHD are more likely to experience adverse impact relating to academic

performance (Barkley, 2006; Barkley et al., 2008; Breslau et al., 2011; Kuriyan et al., 2013), to have more difficulty forming relationships (Coghill et al., 2006), to have fewer close friendships (Meltzer et al., 2003), and to experience higher anxiety and depression (Escobar et al., 2005; Larson et al., 2011). Parents also report that their children and adolescents with ADHD have significantly lower self-esteem than peers (Sawyer et al., 2002). Adults with ADHD have been shown to experience substantially more activity limitations and participation restrictions, such as difficulty with money management, driving, and maintaining employment (Barkley et al., 2008). Overall, this research highlights the importance of considering the potential adverse impact of ADHD and its characteristics in the evaluation and treatment of individuals who stutter.

Numerous studies have shown that many adults who stutter experience adverse impact related to the stuttering condition (Blumgart et al., 2010; Boyle, 2018; Craig et al., 2009; Craig & Calver, 1991; Gabel et al., 2004; Gerlach et al., 2018; Klein & Hood, 2004; Tichenor & Yaruss, 2019b; Yaruss, 2010; Yaruss & Quesal, 2004). For example, many people who stutter experience negative thoughts, feelings, and behaviors as a result of being a person who stutters (Blumgart et al., 2010; Tichenor & Yaruss, 2019a, 2020b). People who stutter also commonly experience limitations in more general life activities (Yaruss & Quesal, 2004), as well as lower employment opportunities and decreased earning potential compared to peers (Gerlach et al., 2018; Klein & Hood, 2004; Palasik et al., 2012). Considering the adverse impact related to stuttering in clinical work and research is vital for improving understanding of the condition and for providing more effective intervention for people who stutter.

Discussions of adverse impact related to both ADHD characteristics and stuttering underscore the fact that individuals who have ADHD and other concomitant disorders, such as anxiety and depression, experience *greater* adverse impact than individuals who have ADHD

alone (see Meinzer et al., 2014; Schatz & Rostain, 2006, for review). Likewise, adults who stutter who also have elevated ADHD characteristics may experience greater overall adverse impact related to stuttering than those individuals who stutter who do not have elevated ADHD characteristics. A better understanding of the adverse impact experienced by adults who stutter who also have elevated ADHD characteristics may ultimately allow clinicians to better understand what their clients are experiencing. This additional knowledge, in turn, may lead to more effective and comprehensive treatment, as it has done in the field of ADHD research (see Wehmeier et al., 2010, for discussion). At present, however, it is not known how common ADHD characteristics are in adults who stutter. It is also unknown if adults who stutter who also exhibit elevated levels of ADHD characteristics experience greater adverse impact than individuals who stutter without elevated levels of ADHD characteristics.

Individual Differences in Adverse Impact: Repetitive Negative Thinking

Individual differences in specific attention-related constructs that are particularly relevant to stuttering research may further explain the amount of adverse impact that a person who stutters and has elevated ADHD characteristics may experience. For example, Repetitive Negative Thinking (RNT) is the habit of engaging in negative "repetitive, prolonged, and recurrent thought about one's self, one's concerns, and one's experiences" (Watkins, 2008, p. 163). Individuals who engage in RNT more frequently devote more attentional resources to negative information; this allocation reduces the availability of attentional processes for other tasks (Donaldson et al., 2007; Koster et al., 2013; Lo et al., 2012). Commonly experienced examples of adverse impact related to RNT include reductions in social support, poor problem solving, increased anxiety, increased likelihood of self-harm, and increased tendency for substance abuse (see Nolen-Hoeksema et al., 2008; Wrosch & Scheier, 2003, for discussion of

adverse impact relating to RNT). A tendency to engage in RNT might compound the difficulties experienced by a person who stutters if they are already experiencing difficulties with attention. Moreover, research evidence has shown that individuals with ADHD who more frequently engage in RNT experience more adverse impact than individuals who engage in RNT to a lesser degree. For example, Mitchell et al. (2013) explored RNT in 81 adults with ADHD and 43 adults without ADHD. Of the 81 adults who had ADHD diagnoses, 34 had diagnosed depression, and 38 had other diagnoses, such as anxiety. The authors found that RNT was the most common in people with ADHD who *also* had concomitant depression. Additionally, the group of people with ADHD who did not experience depression reported more RNT than people who did not have ADHD diagnoses. These data indicate that adults who have ADHD and concomitant disorders, such as depression, are at increased risk for more repetitive negative thoughts and their negative sequelae.

Similarly, individuals who stutter who engage in higher levels of RNT are more likely to experience greater adverse impact related to stuttering. Tichenor & Yaruss (2020b) explored RNT in 313 adults who stutter to determine whether those who stutter engaged in RNT more than the general population and whether RNT was associated with differences in the adverse impact related to stuttering or with individual differences in temperament. While the group of adults who stutter did not engage in RNT more often than the general population, those who did engage more frequently in RNT experienced significantly *more* adverse impact relating to stuttering. Because research evidence shows that adults with ADHD and concomitant disorders experience high rates of RNT (Mitchell et al., 2013), and because engaging in RNT comes at cost to quality of life (Nolen-Hoeksema et al., 2008), adults who stutter who also have elevated ADHD characteristics are at risk for even greater adverse impact if they engage in RNT.

Individual Differences in Adverse Impact: Effortful Control

Individual differences in certain aspects of temperament may further specify the amount of adverse impact on individuals who stutter who also have elevated ADHD characteristics. Rothbart defined temperament as "individual differences in emotional, motor, and attentional reactivity measured by latency, intensity, and recovery of response, and self-regulation processes such as effortful control that can modulate reactivity" (Rothbart, 2007, p. 207; Rothbart & Derryberry, 1981). Effortful Control is "the ability to inhibit a dominant response to perform a subdominant response, to detect errors, and to engage in planning" (Rothbart & Rueda, 2005, p. 3). Increased Effortful Control allows individuals to "more flexibly approach situations they fear and inhibit actions they desire" (Rothbart & Rueda, 2005, p. 3). Individuals with ADHD often have lower Effortful Control than peers without ADHD (González-salinas et al., 2012; Samyn et al., 2011), and there is some evidence that lower Effortful Control can predict the number of inattention characteristics a person who has ADHD experiences. Specifically, Martel and Nigg (2006) explored ADHD characteristic profiles in 179 children (92 with ADHD, 52 without ADHD, 35 with ambiguous diagnoses). They found that lower Effortful Control was significantly associated with more inattention characteristics in children with ADHD. This finding is meaningful because the number of inattention characteristics that a child experiences can directly correspond to the likelihood of screening positive for ADHD (see Kessler et al., 2005). College-aged adults with ADHD who have lower Effortful Control experience higher frequencies of risk-taking behaviors associated with driving, substance abuse, sexual activities, compulsive buying, and credit card misuse (Graziano et al., 2015). This finding suggests that individuals with ADHD who have lower Effortful Control may be at increased risk for greater adverse impact in their lives.

Effortful Control also affects how a person who stutters experiences stuttering (see Kraft et al., 2014, 2018; Tichenor & Yaruss, 2020b). Kraft and colleagues examined relationships between the severity of observable stuttering behavior and parent-reported temperament measures in two cohorts of young children who stutter to determine which aspects of temperament were significantly associated with severity. In both cohorts (USA, n = 69; Australian, n = 98), children with lower Effortful Control were more likely to have higher observable severity as measured by both parents and clinicians (Kraft et al., 2014, 2018). Similarly, in the study of RNT described above, Tichenor & Yaruss (2020b) found that adults who stutter with lower Effortful Control were much more likely to experience greater adverse impact related to stuttering than adults who stutter who had higher Effortful Control.

This review of the relevant literature indicates that specific ADHD characteristics (inattention symptoms) and adverse sequelae of ADHD (e.g., risky financial habits, risky sexual behaviors, and substance abuse) may be more likely in people who have ADHD *and* lower Effortful Control (see Graziano et al., 2015; Martel & Nigg, 2006). Because Effortful Control in people who stutter significantly predicts adverse impact (see Tichenor & Yaruss, 2020b), adults who stutter who also have elevated ADHD characteristics may experience even greater amounts of adverse impact if they *also* have lower Effortful Control. Unfortunately, research has not previously examined the variables simultaneously.

Purpose of this Study

Research evidence suggests that many children who stutter have higher rates of ADHD characteristics—and some studies suggest the same for adults who stutter. Although ADHD characteristics frequently persist into adulthood (see Roy et al., 2016), it is unknown whether a significant portion of adults who stutter also experience elevated ADHD characteristics. It is also

unknown if individuals who stutter and have elevated ADHD characteristics are at greater risk of developing adverse impact related to the conditions, as is suggested by research on concomitant disorders and ADHD (see Mitchell et al., 2013). Finally, it is also unknown whether individual differences in characteristics associated with both conditions (e.g., more frequently engaging in RNT or having lower Effortful Control) predispose some adults who stutter with elevated ADHD characteristics to experience stuttering in more negative ways than other individuals. As such, the purposes of this study were to explore (a) whether elevated ADHD characteristics (inattention and/or hyperactivity/impulsivity) are common in adults who stutter, (b) whether elevated inattention or hyperactivity/impulsivity characteristics in adults who stutter are significantly associated with greater adverse impact related to stuttering, (c) whether individual differences in RNT and Effortful Control influence this relationship.

METHOD

Participants and Procedures

This study involved a series of online surveys distributed widely to adults who stutter. The surveys, described below, included the following instruments: the *Adult ADHD Self-Report Scale* (ASRS; Adler et al., 2019; Kessler et al., 2005), the *Perseverative Thinking Questionnaire* (PTQ; Ehring et al., 2011), the *Adult Temperament Questionnaire* short form (ATQ; Evans & Rothbart, 2007), and the *Overall Assessment of the Speaker's Experience of Stuttering* (OASES; Yaruss & Quesal, 2016). A total of 263 adults who self-reported to be individuals who stutter completed the ASRS. Of those, 101 completed the PTQ, 88 completed the ATQ, and 82 completed the OASES. There was a high amount of overlap in data from subjects who took these multiple measures: 80 participants completed both the PTQ and OASES, 80 participants completed both the ATQ and OASES, and 86 participants completed both the ATQ and PTQ. A

total of 9 participants were excluded from the analyses: 1 due to a lack of self-reported history of stuttering, 2 for being under the age of 18, and 6 because they only completed part of the ASRS. Thus, 254 subjects provided meaningful data and were included in the analysis. Demographic data, including age at the time of the survey, history of participation in self-help/support and speech therapy, and ethnicity are presented in Table 1. Some demographic data were missing for questions occurring at the end of the survey due to attrition. Table 1 summarizes the available demographic characteristics for the participants whose data were analyzed in this study across the four surveys. Consistent with prior research (Tichenor & Yaruss, 2019a; Yaruss et al., 2002), most subjects (86.2%) indicated a history of treatment for stuttering; the sample was approximately evenly split in history of self-help/support participation. Of the 254 subjects, 19 (7.5%) self-reported a pre-existing diagnosis of ADHD.

Recruitment procedures were similar to those for recently published survey studies from the Spartan Stuttering Laboratory (Tichenor & Yaruss, 2019a, 2019b, 2020a, 2020b, 2020c). Participants were recruited using a mix of convenience sampling (e.g., recruiting from personal contacts) and snowball sampling (in which recruitment cascades from one or more outlets or respondents to others: see Goodman, 1961). Various research registries from previous studies, social media outlets, personal contacts of the authors, word-of-mouth, and national and international stuttering associations were used to recruit respondents. These various outlets were also asked to share the survey with as many adults who stutter as possible to encourage a broad sampling of adults who stutter from different backgrounds and with different experiences. Because recruitment was conducted in these varied ways, response rates cannot be calculated because it is impossible to determine how many adults were ultimately contacted.

The survey was conducted via the Internet using Qualtrics (Qualtrics, 2020). All respondents self-reported that they were adults who stutter, age 18 years or older (*Mean age* = 41.05, *SD* = 16.46), and all participants provided informed consent before receiving and completing the survey. The study was deemed exempt from institutional review by the Michigan State University Human Subjects Research Protection Office under statute 45 CFR 46.101(b) 2 of the Federal Policy for the Protection of Human Subjects.

The Surveys

Separate Qualtrics surveys were created for each of the surveys used in this study. This strategy encourages a higher response rate by facilitating each individual survey's completion while limiting potential fatigue and attrition in the participants' responses. Each of the four surveys contained the same demographic questions. Respondents had the option of completing demographic questions only once if they provided a personal identification code or email addresses so that the data from the different surveys could be linked for comparisons across measures.

The *Adult ADHD Self-Report Scale* (ASRS; Adler et al., 2019; Kessler et al., 2005) was used to measure the presence and frequency of ADHD characteristics. The ASRS is used clinically to screen adults who may have ADHD and capture their characteristic profiles. The entire ASRS contains 18 items designed to investigate the frequency of ADHD inattention or hyperactivity/impulsivity characteristics and individual-specific profiles to aid in diagnosis (Adler et al., 2019; Kessler et al., 2005). A person with 6 or more characteristics in each of the 9 inattention or 9 hyperactivity/impulsivity items is considered to be symptomatic of ADHD (Adler et al., 2019). The 6-item screener consists of six of the 18 items which are used to identify and screen adults who are at risk for ADHD. Prior research with multiple samples of participants

has shown that results from the 6-item screener are effective for identifying confirmed ADHD diagnoses (sensitivity: 79.8-84.2%; specificity: 89.5-89.8%) and for correctly identifying most cases of ADHD based on the DSM-V (Kessler et al., 2005; Ustun et al., 2017). Still, the 6 item-screener and associated cutoff criteria were not used in this study in order to reduce the likelihood of under- or over-representing the number of positive or negative screens. Instead, all analyses were based on the raw number of self-reported inattention or hyperactivity/impulsivity characteristics. This practice is consistent with the DSM-V diagnostic criteria (*Diagnostic and Statistical Manual of Mental Disorders*, 2013).

The *Perseverative Thinking Questionnaire* (PTQ; Ehring et al., 2011) was used to measure participants' tendency to engage in RNT. The PTQ contains 15 questions that explore how intrusive and repetitive thoughts are in one's daily life. It has been shown to have good internal consistency across samples and within subscales (Ehring et al., 2011). Though prior research has shown that the PTQ contains three factors (Core Features, Unproductiveness of RNT, and Mental Capacity; see Ehring et al., 2011), the RNT total score (0 to 60) was used in the multiple linear regression equations reported below to capture the tendency for an individual to engage in RNT. This practice is consistent with the recommendations of Ehring et al. (2011, p. 211).

The short form of the *Adult Temperament Scale* (ATQ; Derryberry & Rothbart, 1988; Evans & Rothbart, 2007; Rothbart et al., 2000) was used to measure the temperament construct of Effortful Control. The ATQ short form contains 77 questions operationalizing four broad factors, each containing numerous sub-scales. It has been shown to have adequate-to-good reliability coefficients across constructs (Evans & Rothbart, 2007), and it is widely used in various fields of psychology for describing temperament. The ATQ contains four other factors:

Negative Affect, Extraversion/Surgency, Effortful Control, and Orienting Sensitivity, each comprising of various sub-components. The Effortful Control factor scale is comprised of the following sub-components: Attentional Control (ability to focus and shift attention when desired), Inhibitory Control (ability to suppress an inappropriate behavior), and Activation Control (ability for a person to perform an action when that person wants to avoid said action). A person's Effortful Control profile was scored following the factor scale instructions (i.e., summing the total Likert scores of the items comprising the factor and dividing by the number of items in the factor). This continuous Effortful Control variable was used in the multiple linear regression equations described below.

The *Overall Assessment of the Speaker's Experience of Stuttering* (OASES; Yaruss & Quesal, 2016) was used to assess the impact of stuttering on participants' lives. The OASES assesses stuttering impact via the WHO's International Classification of Functioning, Disability, and Health (ICF, WHO, 2001), by asking people who stutter to self-report how much their reactions to stuttering limit them, how much stuttering negatively impacts communication in daily situations, and how much their stuttering negatively influences their quality of life on a 100 item self-report measure. It has been shown to be a reliable and stable measure of the impact stuttering has on a person's life and is widely used to study the impact of stuttering (Yaruss & Quesal, 2006, 2016). The OASES was scored in accordance with instructions, and the OASES total score (a global measure of adverse impact related to stuttering) was used in the multiple linear regression equations described below.

All items from each of the instruments were reproduced and scored according to the instrument-specific instructions. Given that these instruments are standard assessments in their

respective fields, items were not edited. The four surveys were piloted for errors with a small group of adults who stutter before larger subject recruitment and questionnaire completion.

Data Analysis

Data recorded in Qualtrics were exported to and analyzed in R-studio (RStudio, 2020), a companion program to R (R Core Team, 2020). Various R packages were used for data manipulation, analysis, and visualization (ordinal; Christensen, 2019; lmSupport; Curtin, 2018; olsrr; Hebbali, 2020; ggpubr; Kassambara, 2020; ggiraphExtra; Moon, 2018; psych; Revelle, 2019; MASS; Venables & Ripley, 2002; reshape2, ggplot2; Wickham, 2007, 2016). All data were manually checked for data entry or coding errors. Though each of the three instruments have reliability data in the broader research literature of their fields, internal consistency measures were conducted to determine the internal stability of the measure factors within this sample of adults who stutter with Cronbach's Alpha. Internal consistency was adequate to excellent for each for the PTQ factors (Core Characteristics of RNT: $\alpha = .93$; Unproductiveness of RNT: $\alpha = .77$; Capturing Mental Capacity: $\alpha = .85$). Internal consistency was adequate for each of the ATQ factor Effortful Control: $\alpha = 76$. Internal consistency was good-to-excellent for each of the OASES factors (General Information: $\alpha = .86$; Reactions to Stuttering: $\alpha = .95$; Communication in Daily Situations: $\alpha = .94$; Quality of Life: $\alpha = .96$). Internal consistency was good on the ASRS ($\alpha = .89$).

Multiple linear regression was performed to determine whether Effortful Control, RNT, Adverse Impact related to stuttering (Total OASES score), or interactions among and between these variables could significantly predict ASRS characteristic profiles (e.g., the number of inattention or hyperactivity/impulsivity characteristics a person experiences). Multicollinearity was assessed through variance inflation factors (VIF). Effortful Control, Adverse Impact, and

RNT did not demonstrate VIF values high enough to raise concerns about multicollinearity (VIF > 10, see Kennedy, 2003; Neter et al., 1985). All predictors were investigated for normality visually via quantile plots and statistically via Shapiro-Wilk tests (Shapiro & Wilk, 1965). These included: Adverse Impact (*Mean OASES Total Score* = 2.60, *SD* = 0.72), RNT (*Mean PTQ Total Score* = 28.22, *SD* = 10.58), Effortful Control (*Mean Effortful Control Factor Score* = 4.57, *SD* = 0.74), inattention (*Mean Number of Characteristics* = 3.14, *SD* = 2.50), and hyperactivity/impulsivity (*Mean Number of Characteristics* = 2.34, *SD* = 2.11). Results indicated normal distribution for all predictors except for the inattention and hyperactivity/impulsivity variables of the ASRS. Both of these variables skewed positive, indicating that most individuals self-reported lower numbers of inattention and hyperactivity/impulsivity characteristics (See Figure 1 for the distribution of both inattention and hyperactivity/impulsivity characteristics reported by participants). Models were built iteratively with the three single predictors followed by interactions and compared via adjusted R^2. Given that listwise deletion is unbiased when the probability of complete cases is independent of the outcome variable (Bartlett et al., 2014; Newman, 2014; White & Carlin, 2010) and that missing data points in this study were independent of the outcome variable (i.e., no ASRS data were missing for subjects included in the regression equations, see Allison, 2002, for discussion), missing data were deleted listwise.

Results

The research questions in this study involved exploring both the specific ADHD characteristic profiles (i.e., inattention and hyperactivity/impulsivity) that may occur in adults who stutter and individual differences within these areas. Almost one-quarter of participants (23.2%; 59/254) self-reported 6 or more inattention characteristics on the ASRS. Fewer

participants (8%; 21/254) self-reported 6 or more hyperactivity/impulsivity characteristics on the ASRS.

To determine how Adverse Impact, Effortful Control, and RNT might relate to the number of inattention or hyperactivity/impulsivity characteristics a person reported experiencing, various multiple linear regression models were built using the three predictors and all possible interaction terms. That is, all three predictors were entered together without interactions in the initial inattention and hyperactivity/impulsivity models. Inclusion of all interaction terms allowed for the possibility that individual differences in Adverse Impact, Effortful Control, and RNT might differentiate individuals with different amounts of inattention or hyperactivity/impulsivity characteristics. The raw data showing the relationships between Adverse Impact, Effortful Control, and RNT are visualized in Figure 2. Visual inspection reveals positive relationships between both Adverse Impact and RNT and the number of self-reported inattention characteristics. Visual inspection reveals a negative relationship between Effortful Control and the number of self-reported inattention characteristics. An initial model (Model 1) was built using the three predictor variables with no interaction terms. Model 1 explained a significant amount of the variance of inattention $F(3,69) = 9.13$, $p < .001$, $R^2 = .28$, $R^2_{Adjusted} = .25$, $f^2 = .40$. The effect size of this prediction was very large (Cohen, 1988). Specific information about the variables in the model can be found in Table 2. Only Effortful Control (not RNT or Adverse Impact) significantly predicted the number of self-reported inattention characteristics.

Other models were built using different combinations of interaction terms and compared to this baseline model. A comparison of adjusted R^2 across the models determined that the best-fitting model predicting inattention characteristics consisted of the three predictors and the interaction of RNT and Adverse Impact (Model 2). This model (RNT, Effortful Control, Adverse

Impact, and the interaction of RNT and Adverse Impact) explained a significant amount of the variance of inattention $F(4,68) = 9.97$, $p < .001$, $R^2 = .37$, $R^2_{Adjusted} = .33$, $f^2 = .59$. The effect size of this prediction was very large (Cohen, 1988). Details concerning the variables in Model 2 are presented in Table 2. RNT, Adverse Impact, and Effortful Control all significantly predicted the number of inattention characteristics. As shown by the interaction term's significance, RNT moderated the relationship between Adverse Impact and inattention characteristics. Figure 3 contains a scatterplot of the relationship between the number of inattention characteristics and total Adverse Impact, where individual observations are colored to represent the amount a participant engages in RNT (PTQ total score) for that individual participant. Regression lines for predicted relationships between specific PTQ total scores (i.e., 0, 20, 40, 60) have been added to Figure 3 to aide visualization of the significant interaction. Together, these results indicate that individuals who more frequently engaged in RNT and also experienced greater Adverse Impact related to stuttering self-reported significantly higher number of inattention characteristics.

Adjusted R^2 comparison determined that the best-fitting model predicting hyperactivity/impulsivity contained only the three predictors (RNT, Effortful Control, and Adverse Impact). The model with these variables did not explain a significant amount of the variance of hyperactivity/impulsivity ($F(1.8,69) = 1.357$, $p = .26$, $R^2 = .06$, $R^2_{Adjusted} = .02$). Details concerning individual variables in the model are presented in Table 3.

Discussion

This study explored (a) whether elevated ADHD characteristics (inattention and/or hyperactivity/impulsivity) are common in adults who stutter, (b) whether such characteristics are associated with increased adverse impact related to stuttering, and (c) whether individual differences in Effortful Control and RNT could further specify the amount of adverse impact

experienced by adults who stutter who also report elevated ADHD characteristics. Participants in this study reported experiencing a range of inattention characteristics: 23.6% of participants (60/254) reported at least 6 out of a possible 9 inattention characteristics on the ASRS. These data indicate that a large percentage of adults who stutter may exhibit elevated ADHD characteristics, particularly those related to inattention. These self-reported characteristics stand in contrast to the 19 participants in this sample (7.5%) who reported that they had previously received a formal diagnosis of ADHD. This result suggests that ADHD may be either under-diagnosed in the population of adults who stutter or that a significant proportion of adults who stutter may exhibit elevated but sub-clinical characteristics of inattention.

Lower Effortful Control was significantly associated with experiencing more inattention characteristics in the baseline model (see Figure 2). The interaction of RNT and Adverse Impact related to stuttering significantly predicted the number of inattention characteristics a person experienced and the regression model containing this interaction provided a better fit of the data (see Figure 3). Research has shown that individuals with ADHD and concomitant conditions experience greater adverse impact (see Meinzer et al., 2014, for review; Schatz & Rostain, 2006). Research has also shown that individuals who have ADHD and concomitant disorders, such as depression (see Mitchell et al., 2013), engage in RNT at higher rates than individuals with ADHD alone. Data from this study suggest that individuals who stutter who both engage in high levels of RNT *and* experience greater levels of adverse impact related to stuttering are statistically more likely to self-report higher numbers of inattention characteristics than if they (a) engage in RNT at lower levels or (b) experience less adverse impact related to stuttering. These data highlight the need to further consider individual differences in the intersectionality of inattention characteristics, RNT, Effortful Control, and Adverse Impact related to stuttering.

The finding that some adults who stutter experience elevated inattention characteristics is of particular importance for explaining how stuttering moments occur and vary across time and situations. Current stuttering theories generally suggest that stuttering moments occur when "linguistic and/or emotional/cognitive demands are higher" (Smith & Weber, 2017, p. 16). Attentional processing is critical for efficient and timely language formulation (see Roelofs & Piai, 2011, for review). Attentional processing is also necessary for establishing well-learned motor movements essential for fluent and effortless speech production (Maxwell et al., 2003; Posner, 1967; Schmidt, 1975). Thus, individual differences in attentional processing abilities may explain variability in the occurrence and severity of stuttering across situations and across individuals (Constantino et al., 2016; Tichenor & Yaruss, 2020c).

Potential Similarities between the Neurology of ADHD and Stuttering

While no study has directly compared neurological aspects of ADHD and developmental stuttering, prior research has suggested that these conditions share similarities (Piispala et al., 2018; Ratcliff-baird, 2001). Ratcliff-Baird (2001) and Piispala et al. (2018) explored oscillatory activity measured through electroencephalography (EEG) in adults who stutter and adults with ADHD and found that individuals from both populations exhibited heightened slow-wave activity in alpha and theta oscillatory bands during tasks that require selective inhibition of competing salient stimuli (see Ratcliff-baird, 2001, for discussion). Various studies have also found that children who stutter and children with ADHD exhibit reduced alpha-band activity between trials of an attentionally demanding cognitive task as compared to children who do not stutter (see Piispala et al., 2018, for discussion). Alpha-wave oscillations are typically more prevalent during resting periods of tasks; they decrease as cognitive effort increases and may play a role in inhibiting distracting stimuli during cognitive tasks (Kelly et al., 2006; Klimesch et

al., 2007; Pfurtscheller et al., 1996; Rihs et al., 2007). Theta-band waves have also been associated with cognitive control processes (see Cavanagh & Frank, 2014, for review). Taken together, these findings indicate: (a) that neurophysiological systems involving suppression of distractors or cognitive control may show similar patterns under some conditions in individuals with ADHD and individuals who stutter, and (b) that this difference may be apparent even when individuals are not speaking.

EEG evidence from Piispala et al. (2018) and Ratcliff-Baird (2001) complements functional imaging studies that further implicate the physiological correlates of cognitive control and processes, such as inhibitory control, which are intertwined with attention in both ADHD and stuttering. Hypoconnectivity within the default mode network, which supports internally guided attention involved in autobiographical memory and theory of mind, is associated with both ADHD and stuttering (Andrews-Hanna, 2012; Buckner et al., 2008; Castellanos et al., 2008; Chang et al., 2018; Spreng et al., 2008; Sripada et al., 2014; Xuan et al., 2012). Anomalous connectivity between the default mode network and the ventral attention network is also associated with both ADHD and stuttering (Castellanos et al., 2008; Chang et al., 2018; Corbetta et al., 2008; Sripada et al., 2014; Xuan et al., 2012). Atypical connectivity between the default mode network and other attentional networks like the ventral attention network may lead to interference from the default mode network during externally directed, cognitively demanding tasks. This intrusion of the default mode network is associated with poorer attentional performance, such as during selective attention tasks (see Weissman et al., 2006). Atypical interconnectivity within the default mode network may also decrease performance on attention-related tasks (Poole et al., 2016; Sonuga-Barke & Castellanos, 2007; Weissman et al., 2006). Overall, both stuttering and ADHD may involve atypical patterns of activity in neural systems

for cognitive control, and this may lead to anomalous employment of attention. The patterns of activity implicated in both imaging and EEG studies suggest that the neurophysiological systems that support attention are likely to be involved in both ADHD and stuttering. The current study emphasizes that understanding these systems will help to elucidate the etiology of stuttering and explain the adverse impact that is often associated with the condition. Further research is needed: (a) to understand the neurophysiology of both attention and stuttering, (b) to reveal how the conditions might interact and relate to one another, and (c) to elucidate the impact of each, both individually and in combination.

The data from this study should not be interpreted to suggest that all, or even most, people who stutter have clinically significant attentional dysregulation or ADHD. Findings also do not imply that people who stutter have the same neurological differences as those with ADHD. Instead, these results may indicate that certain neural systems, particularly those involved in cognitive control and attention, may be similarly affected in both conditions. This interpretation is consistent with the models indicating that neurodevelopmental disorders such as stuttering (Smith & Weber, 2017) and other conditions (Pennington, 2006) likely arise from multiple neurological differences that combine dynamically *and* vary between and amongst individuals. While stuttering and ADHD could share some etiological factors, several differences (both physiological and cognitive) may converge in a particular speaker and interact in unique ways during development to produce symptoms consistent with stuttering or ADHD.

Limitations and Future Directions

There are several limitations in this study that should be considered when interpreting the results and planning future research. First, the sample of adults who stutter was mainly composed of white, non-Hispanic adults from the United States of America. Future research should expand

these findings to more diverse samples of respondents who stutter to better understand how variations in attentional abilities and other characteristics might affect the experience of stuttering. This study also evaluated adults who self-reported to be people who stutter, so care should be applied when interpolating or applying these findings to children, adolescents, or adults whose stuttering was corroborated by a more detailed clinical evaluation. Inattention and hyperactivity/impulsivity characteristics, likewise, were collected via self-report and not clinical diagnoses. Thus, the total number of inattention and/or hyperactivity/impulsivity characteristics should be interpreted with caution given that participants could be subject to recall error or response bias (i.e., higher numbers of these characteristics were found in this study because people who stutter with these characteristics may have been more likely to respond to the survey). Still, the large sample size and standard recruitment methods mitigate the effect of these potential concerns.

Another limitation of this study is the structure of the ASRS questionnaire, which may introduce biases in assessing hyperactivity/impulsivity characteristics when administered to adults who stutter. The ASRS assesses hyperactivity/impulsivity symptoms using items that involve speech and communication behaviors. For example, two of the items asks, “When you’re in a conversation, how often do you find yourself finishing the sentences of the people you are talking to before they can finish them themselves?” and, “How often do you find yourself talking too much when you are in social situations” (Kessler et al., 2005, p. 248). The inclusion of these items may have led to an *underestimation* of the level of hyperactivity/impulsivity characteristics in these participants, as adults who stutter may be less likely to engage in these behaviors due to their experiences related to living with stuttering. Future research should explore hyperactivity/impulsivity characteristics using multiple ADHD measures to better account for

variations due to questions that may be sensitive to an individual's prior speech or communication experiences.

Data from this study also highlight the continued need to study ADHD characteristics in relation to stuttering intervention. Druker et al. (2019) found that children who stutter who also have elevated ADHD characteristics required increased time to achieve therapy gains; adults who stutter who have elevated ADHD characteristics may also require increased time to make gains in therapy. They may also require more individualized treatment plans to accommodate differences in attention. Future research should explore this possibility, given the findings with children who stutter.

Although a notable percentage of adults who stutter in this study self-reported elevated inattention characteristics, there is not yet enough evidence to suggest that clinicians should systematically screen for ADHD in all of their clients who stutter. At the same time, clinicians should not hesitate to refer their clients to appropriate professionals for evaluation if there is sufficient evidence to suspect ADHD on an individual-by-individual basis. More research aimed at determining and specifying both conditions' interaction and overlap may lead to more specific treatment approaches with individuals who stutter who have elevated ADHD characteristics. Such research endeavors may also benefit from collaborations with neuropsychologists or psychiatrists to explore whether some adults who stutter meet the clinical requirements for a formal diagnosis of ADHD.

Conclusions

This study explored the prevalence of ADHD characteristics in adults who stutter and examined whether ADHD characteristics and individual differences in RNT and Effortful Control might influence the experience of adverse impact associated with stuttering. Results

indicated that many adults who stutter experience elevated ADHD characteristics involving inattention (23.6%). Furthermore, decreased Effortful Control and both higher levels of RNT and greater Adverse Impact related to stuttering were significantly associated with self-reporting greater numbers of *inattention* characteristics by adults who stutter. These data highlight the need for continued research on individual differences between people who stutter and on the intersectionality of stuttering, ADHD characteristics, and attention.

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Figure Captions

Figure 1.

Caption: Participants in this study reported a range in the number of both inattention and hyperactivity/impulsivity characteristics. The raw number of self-reports for the number of both inattention/hyperactivity characteristics is visualized. Six or more characteristics are needed to be symptomatic per the DSM-V and the results are colored to indicate that threshold.

Figure 2.

Caption: The raw data concerning the relationships between RNT, Adverse Impact, and Effortful Control are visualized. Lower Effortful Control was significantly associated with self-reporting higher numbers of inattention characteristics in adults who stutter.

Figure 3.

Caption: The Interaction of Adverse Impact and RNT Significantly Predict the Number of Inattention Characteristics in Adults who Stutter. Adults who stutter who have both higher levels of RNT and greater Adverse Impact experience significantly higher numbers of inattention characteristics than adults who stutter who report experiencing only higher levels of RNT or greater Adverse Impact, respectively.