WEEK-TO-WEEK STUTTERING VARIABILITY

by

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LIST OF ABBREVIATIONS

Abbreviation	Description
CWS	Children who stutter
AWS	Adults who stutter
PWS	People who stutter
SLD	Stuttering-like disfluencies
SSI-4	Stuttering Severity Instrument-4
ICF	International Classification of Functioning, Disability, and Health framework
%SS	Percent syllables stuttered
ND	Normal disfluencies
UTBAS-6	Brief Version of the Unhelpful Thoughts and Beliefs About Stuttering Scales
OASES	The Overall Assessment of the Speaker's Experience of Stuttering
STAI	State-Trait Anxiety Inventory
AWDS	Adults who do not stutter

1. LITERATURE REVIEW

The presence of overt disfluencies is a characteristic feature of stuttering that has traditionally been used for the purpose of diagnosing stuttering and measuring treatment outcomes. Speech-language pathologists routinely count the number of disfluencies across a variety of speech samples from children who stutter (CWS) and adults who stutter (AWS) to determine the frequency of stuttering (measured in percent syllables stuttered (%SS)) and its severity (Bloodstein & Ratner, 2008). These measures are further used to determine treatment outcomes. This type of assessment fails to consider the entirety of the stuttering disorder and the variability that accompanies it (Constantino et al., 2016). Exploring variability of overt disfluencies and factors correlated with variability provides all stakeholders (parents, adults who stutter, speech-language pathologists, researchers) with a better understanding of the entirety of the disorder. Increasing our understanding of factors that may influence the variability of stuttering can allow for the development of more accurate and comprehensive evaluation and management procedures as we strive to ease the frequent feelings of frustration this variability brings among AWS (Tichenor & Yaruss, 2021).

The initial diagnosis of stuttering in childhood is based on the presence of stuttering-like disfluencies (SLD) and any associated secondary behaviors. However, a thorough understanding of stuttering needs to account for all behaviors, overt and covert, that make up the stuttering disorder in childhood, adolescence, and adulthood. Currently, the Stuttering Severity Instrument-4 (SSI-4) is commonly used to determine stuttering severity, which is only part of the entire experience of stuttering. The entire experience of stuttering is best explored through the International Classification of Functioning,

Disability, and Health (ICF) framework (Yaruss & Quesal, 2004; Yaruss, 2007). The ICF is a framework used to organize and described functioning and disability of all disabilities. This framework can be applied to the overt (i.e., disfluencies) and covert characteristics associated with stuttering. Covert characteristics of stuttering may involve limitations in activities and restrictions in participation. Limitations in activities include daily tasks such as exchanging greetings with neighbors, while restrictions in participation concern overall life goals such as selecting a career. Even more, environmental and personal factors can further influence the impact stuttering has on people. Environmental factors relate to modes of daily communication, support from family and friends, listener attitudes, and services or policies available. On the other hand, personal factors may include feeling embarrassed or ashamed of stuttering, avoiding speaking certain words or speaking in general, and thinking poorly of themselves. Overall, applying the ICF framework to stuttering allows us to see that a stuttering severity score based on one or two speech samples is likely not a very reliable or representative measure (Yaruss & Quesal, 2004; Yaruss, 2007). The purpose of this exploratory study is to compare these measures, along with measures of self-reported beliefs, experiences, and anxiety related to stuttering, to understand the variable nature of the disorder. See Table 1 for a detailed description of each measure. A description of stuttering and how it is diagnosed is provided below followed by a discussion of the current research on stuttering variability. While the variability of stuttering has been thoroughly reported on, only a few studies have begun exploring the characteristics of this variability.

Table 1. Measurement and Diagnosis of Stuttering

Measures	Descriptions	Examples
Stuttering frequency: percent syllables stuttered (%SS)	Stuttering-like disfluencies (SLD)	Part-word repetitions (e.g., li-li-like this), sound prolongations (e.g., llllike this), or silent blocks (e.g., like th-------is).
	Normal disfluencies (ND)	Incomplete phrases, revisions, whole word repetitions, and interjections (e.g., "uh", "er", "well") (Bloodstein & Ratner, 2008, p. 6).
Stuttering severity	Stuttering Severity Instrument-Fourth Edition (SSI-4; Riley, 2009)	Frequency of SLD, average duration of SLD, and a physical concomitant rating based on combined scores from a reading and speaking task
	Weighted disfluency method (Ambrose & Yairi, 1999)	Frequency and average duration of SLD per 100 syllables of speech.
Thoughts and beliefs	Brief Version of the Unhelpful Thoughts and Beliefs About Stuttering Scales (UTBAS-6; (Iverach et al., 2016)	Ratings on how *frequently* you have these thoughts, how much you *believe* these thoughts, and how *anxious* these thoughts make you feel (e.g., "I'll never be successful because I stutter", "I'll never finish explaining my point – they'll misunderstand me")
Personal experiences	The Overall Assessment of the Speaker's Experience of Stuttering (OASES; Yaruss & Quesal, 2010)	"How often do you say exactly what you want to say even if you think you might stutter?" "How do you feel about your speaking ability?"
Anxiety	State-Trait Anxiety Inventory (STAI; Spielberger, 1989)	"Do you feel calm, secure, upset, etc."

How Stuttering is Defined and Diagnosed

Stuttering is generally described as stoppages in the forward flow of speech that vary in frequency and/or duration (Guitar, 2019). More specifically, stuttering includes core behaviors, secondary behaviors, and feelings and attitudes. The core behaviors of stuttering are called stuttering-like disfluencies (SLD). Stuttering-like disfluencies that most people who stutter experience are repetitions (e.g., re-re-repetitions), prolongations (e.g., ppppprolongations), and blocks (e.g., b----locks). Secondary behaviors are learned behaviors that are triggered by the experience or anticipation of stuttering moments. These include escape behaviors (e.g., tensing/freezing up or pushing), postponement behaviors (e.g., normal disfluencies), and avoidance behaviors such as not speaking in

certain situations. Lastly, attitudes and feelings, both helpful and unhelpful, stem from reactions towards stuttering. The speakers may develop feelings of embarrassment, frustration, fear, and/or shame. Some of these unhelpful feelings may develop into attitudes that become more permanent beliefs about the self or listeners. Each of the three components of stuttering (i.e., core behaviors, secondary behaviors, and feelings or attitudes) vary in degree from person to person and contribute to the frequency and severity of stuttering (Guitar, 2019).

The diagnosis of stuttering is based on the presence of disfluencies in speech, measured from two or three speech samples recorded during an assessment session (Bloodstein & Ratner, 2008). Furthermore, stuttering treatment outcomes are determined by measuring the change in the frequency and severity of core stuttering behaviors. While stuttering frequency and severity continue to remain the preferred criteria for diagnosis and treatment outcome measurement, research indicates that stuttering frequency and severity can vary, often to a large degree, across speaking situations and day-to-day for many AWS (Blood et al., 1997; Constantino et al., 2016; Karimi et al., 2013; Maruthy & Sharma, 2018). Table 1 summarizes common measures used to diagnose stuttering.

Scholars who have evaluated the day-to-day variability of stuttering highlight the need for further analyses of this phenomenon. Further exploration of this phenomenon may allow for a better understanding of the factors influencing stuttering variability and any notable patterns to the variability.

Stuttering Variability

This section discusses the current research on stuttering variability. The measures and tasks discussed, including the STAI (state and trait anxiety) Short Form, the Brief

UTBAS-6 (unhelpful thoughts and beliefs about stuttering), the OASES-A (Overall Assessment of the Speaker's Experience of Stuttering) reading samples, conversation samples, monologue speech samples, and daily probes were included in the current exploratory study. The discussion follows.

While overt disfluencies are a prominent feature of stuttering that are easily observable and measurable, they have been documented to be extremely variable from one situation to the next as well as from one day to the next (Blood et al., 1997; Bloodstein & Ratner, 2008; Constantino et al., 2016; Karimi et al., 2013; Maruthy & Sharma, 2018). This variability can affect the willingness or ability to say what they want to say, and it can even dissuade them from pursuing occupations that involve talking on the phone (Tichenor & Yaruss, 2019). While the variability of stuttering is well documented, our understanding of the factors that influence variability is limited. A deeper understanding of stuttering variability can help inform more comprehensive methods for the evaluation and behavioral treatment of stuttering by directly measuring and addressing factors that are found to influence variability (Karimi et al., 2013). There is a dearth of empirical studies that have explored inter- and intra-subject variability of stuttering disfluencies in adults, and the exploration of this phenomenon is scarce (Blood et al., 1997; Constantino et al., 2016).

Overall, research demonstrates that stuttering disfluencies are highly variable and inconsistent across situations, time, and people who stutter (PWS). This variability has a documented range of less than 5% syllables stuttered (%SS) for some PWS and greater than 20%SS for others (Constantino et al., 2016; Karimi et al., 2013; Maruthy & Sharma, 2018). Significant differences in %SS are also found between speaking situations and

tasks on the same day and between days. The range of stuttering variability on the same speaking tasks, performed at different times, ranges from as low as 6%SS difference to as high as 20%SS difference (Constantino et al., 2016). Similarly, the range of stuttering variability between different tasks such as speaking on the telephone (mean = 9.4 %SS) versus general conversation (mean = 7.7 %SS) and speaking on the telephone (mean = 9.4 %SS) versus presenting to a group (mean = 6.7 %SS) has been documented (Karimi et al., 2013). While there is always going to be variability in stuttering, it is important to explore these unexpected variations in stuttering frequency (Karimi et al., 2013). While this variability in stuttering frequency is well documented, using only one or two measures fails to capture what may contribute to unexpected day-to-day and situation-by-situation variability of stuttering.

Unexpected variations in stuttering were explored by recording 20 different speech samples over a single day from 10 AWS (Karimi et al., 2013). Participants spoke an average of 33,617 syllables over the day. The mean %SS was determined for each participant based on their consolidated samples. Then, individual participant data were randomized into 1000-syllable samples. The mean %SS was determined for each of these randomized syllable sets to evaluate unexpected variations. Unexpected variations occurred when the mean %SS of the randomized 1000-syllables exceeded three standard deviations from the individual participant's mean %SS for the entire day. The analyses revealed five of the 10 participants experienced unexpected variations in %SS by exceeding their control limits on two or more occasions. Interestingly, nonrandom variation patterns and random more severe %SS patterns were found to occur most often in the morning. This may be attributed to increased familiarity with communication

partners by the end of the day, but there were no clearly identified factors contributing to this variability.

Few efforts have objectively identified factors contributing to stuttering variability; however, life impact and stress has been positively correlated with the phenomenon. Constantino et al. (2016) found a significant positive correlation between stuttering life impact using the Overall Assessment of the Speaker's Experience of Stuttering for Adults (OASES-A) and individual stuttering variability ranges. People with higher day-to-day variability of stuttering reported higher scores on the OASES-A. Another study, evaluating personal factors and stuttering variability, found AWS experienced more SLD on high-stress days than on low-stress days (Blood et al., 1997). More daily stress was also felt among AWS than adults who do not stutter (AWDS). Furthermore, AWS experienced more daily stress related to intercommunication than the AWDS. This category included 12 items, and over half of the items concerned speaking outcomes, feelings of embarrassment, or interactions with authority figures. While life impact and stress are correlated with stuttering variability, further analyses of daily stuttering severity, baseline state and trait anxiety (e.g., STAI; Spielberger, 1989), baseline life impact of stuttering (e.g., OASES; Yaruss & Quesal, 2010), and baseline unhelpful beliefs about stuttering (e.g., UTBAS-6; Iverach, et al., 2016) would allow for a more comprehensive understanding of stuttering variability.

Overall, overt stuttering behaviors greatly vary across speaking tasks/situations and day-to-day even on the same task. For some, stuttering tends to be less variable and for others, it tends to be more variable. While Karimi et al. (2013) and Maruthy and Sharma (2018) did not identify any discernible pattern to the variability, Constantino et

al. (2016) did find a significant positive correlation between OASES-A scores and variability. Stress was also a factor contributing to stuttering variability (Blood et al., 1997). In the study by Blood et al. (1997), participants rated their daily perceived fluency levels and perceived stress levels which formed the basis to including daily probes in the current exploratory study. Other studies have reported on the relationship between anxiety and stuttering (Iverach et al., 2011). A daily probe on sleep would also be an important measure to its relationship with anxiety (STAI; Spielberger, 1989). Another study by Tichenor and Yaruss (2021), found that adults who stuttered ofen discussed a "loss of control" feeling as part of stuttering moments. These subjective measures of stuttering severity and variability may be more helpful to our understanding of stuttering variability than the frequently used objective measures (Tichenor & Yaruss, 2021). Further exploration of personal accounts of stuttering experiences, in addition to the previously discussed measures, could allow for future opportunities to directly measure and address factors that are found to influence stuttering variability.

Purpose and Research Questions

PWS often wonder why they are fluent one day yet seem to stutter on every word the next day. This may dissuade them from pursuing certain jobs or even taking on different employee roles. The correlation of stuttering variability and life impact scores from the OASES-A have provided some insight into how the phenomenon affects the person. Extending the analyses of personal factors and stuttering variability is important to gain a deeper understanding of day-to-day stuttering variability. This can be achieved by gathering more comprehensive data at baseline that includes state and trait anxiety (STAI; Spielberger, 1989) and unhelpful thoughts and beliefs about stuttering (UTBAS-

6; Iverach et al., 2016) in addition to the life impact of stuttering (OASES; Yaruss & Quesal, 2010) and stuttering severity (SSI-4; Riley, 2009).

Studying variability of stuttering is important not only from the perspective of objective assessment of stuttering, but also because many factors (e.g., stress and anxiety) are thought to influence stuttering variability, but their effects are just beginning to be understood. Exploring these effects is important because stuttering variations are correlated with communication satisfaction, and because individual stuttering variability ranges correlate with a negative impact on the speakers' life (Constantino et al., 2016; Karimi et al., 2013).

The purpose of this study was to explore the variability of stuttering and potential factors correlated with day-to-day stuttering variability. These types of findings are important considerations during the clinical treatment and assessment of stuttering, in addition to the daily activities of PWS. Specifically, the variability of stuttering makes stuttering difficult to manage which is why this study assessed and evaluated how baseline stuttering frequency and severity, state and trait anxiety, and beliefs about stuttering influenced day-to-day variability of stuttering frequency and perceived stuttering severity. The following research questions guided this study:

1. What is the overall pattern of disfluencies (stuttering-like and normal) and stuttering severity across days?
2. Is there a difference in the variability of stuttering-like disfluencies and normal disfluencies based on speaking task (i.e., conversation, reading, and monologue)?

3. Is stuttering variability correlated with scores on the OASES-A (overall impact of stuttering), SSI-4 (severity), STAI (state and trait anxiety), and UTBAS-6 (unhelpful thoughts and beliefs about stuttering)?
4. Is daily stuttering frequency and severity correlated with self-reported levels of stuttering severity, stress, and sleep?

2. METHODS

Participants

Five adults with a prior diagnosis of stuttering participated in this study. The Institutional Review Board (IRB) approved all materials prior to beginning recruitment. A personal recruitment message with a link to an electronic consent form was emailed to stuttering specialists who forwarded the message to adults who stuttered. The participants who consented to the study were directed to a Qualtrics survey that included demographic questions about their sex, age, ethnicity, education, employment, and marital status. Their individual responses to the demographic questions are shown in Table 3. Three participants identified their sex as male, and two participants identified as female. Three of the participants identified their ethnicity as White, and two of the participants identified their ethnicity as Hispanic or Latino. The five participants had a mean age of 26.80 years (range 20-49) with a standard deviation of 11.14. Three of the participants were employed while the other two were students. One participant was unmarried, one was married, one was in a relationship, and two were single.

Procedures

Informed consent from each participant was requested electronically using Adobe Sign. After participants consented to the study, they were provided with a link to a Qualtrics survey that included a brief demographic and stuttering background questionnaire, the STAI (state and trait anxiety) Short Form, the Brief UTBAS-6 (unhelpful thoughts and beliefs about stuttering), and the OASES-A (Overall Assessment of the Speaker's Experience of Stuttering). These measures were included in this study because they provided unique insights and correlations to stuttering variability discussed

in the literature review above. Once the survey was completed, speech samples and responses to daily probes were conducted via Zoom Video Communications Inc. (2020) twice a week for three consecutive weeks. Each interview lasted approximately 15 minutes and included the following tasks: reading sample, conversation sample, monologue speech sample, and daily probes. Previously mentioned studies discussed how the frequency of stuttering varies between these three speech tasks that are often used for evaluation and research purposes. Daily probes for stress, sleep, anxiety, stuttering variability, and stuttering severity were included due to previous exploration of these factors in people who stutter and because of the unique insights subjective measures have provided in the past. The order of elicitation of the three speech samples was randomly varied for each session to reduce any order effects. All sessions were audio and video recorded for data analyses.

Materials and Measures

Demographic and Stuttering Background Questionnaire. The questions covered the participants' age, sex, ethnicity, education, marital status, employment status, age at onset of stuttering, family history of stuttering, and a detailed history of stuttering treatment. None of the participants reported family history of any other speech/language/communication disorder. Stuttering treatments were chosen from a drop-down option and "other" treatments could be added. Treatment options included: Education about speech and stuttering, Identification of stuttering when it happens, Fluency Shaping/Smooth Speech/Slow Prolonged Speech, Stuttering Modification (e.g., holding your stuttering moment and changing it), Stuttering Openly/Disclosure, Discussing thoughts and feelings about stuttering, and Pseudo-stuttering/Stuttering on

purpose. P01 was the only participant who reported receiving medical treatment for their stuttering in the past when they participated in a medication treatment study. They were also the only participant who reported using a Speecheasy device to reduce their stuttering. This device is worn behind the ear and temporarily reduces the occurrence of stuttering through auditory feedback. P04 was the only participant who added cinematherapy as an "other" treatment option. Cinematherapy was described as gaining an accepting attitude toward their stutter. Lastly, P02 was the only participant enrolled in stuttering therapy at the time of data collection. We do not have any evidence of the impact of any behavioral treatment on stuttering variability. Individual demographics and responses to the stuttering background questionnaire are shown in Table 3.

Table 2. Participant Demographics and Stuttering Background

Demographic & stuttering background questions	Participants				
	P01	P02	P03	P04	P05
Sex	Male	Male	Male	Female	Female
Age in years	49	21	20	21	23
Ethnicity	White	Hispanic or Latino	White	Hispanic or Latino	White
Education	Doctorate	Some college	Highschool diploma or GED	Highschool diploma or GED	Some college
Employment	Employed, 40+ hrs./wk.	Not employed or looking for work	Not employed or looking for work	Employed, 1-39 hrs./wk.	Employed, 1-39 hrs./wk.
Marital status	Unmarried	Single	Relationship	Single	Married
Approximate age of stuttering onset in years	4-6	2-4	2-4	6-10	Over 10
Self-rated stuttering severity average (1=very mild, 5=moderate, 9= very severe)	7	7	3	4	6
Self-rated change of stuttering severity over time	Varies	Increased over time	Decreased over time	Varies	Varies
Family history of stuttering	Sibling	Father	Maternal Grandparent	Father	No

History if anxiety disorder diagnosis	No	Yes	No	No	No
History of stuttering therapy	Yes	Yes	Yes	Yes	Yes
Types of stuttering therapy received	Education Identification Fluency Shaping/ Smooth Speech/Slow Prolonged Speech Stuttering Modification Stuttering Openly/ Disclosure Thoughts and feelings Pseudo-stuttering	Education Identification Fluency Shaping/ Smooth Speech/Slow Prolonged Speech Stuttering Modification Stuttering Openly/ Disclosure Thoughts and feelings Pseudo-stuttering	Education Fluency Shaping/ Smooth Speech/Slow Prolonged Speech Thoughts and feelings	Education Identification Fluency Shaping/ Smooth Speech/Slow Prolonged Speech Stuttering Modification Stuttering Openly/ Disclosure Thoughts and feelings Pseudo-stuttering Other: Cinematherapy	Education Identification Fluency Shaping/ Smooth Speech/Slow Prolonged Speech Stuttering Modification Stuttering Openly/ Disclosure Thoughts and feelings Pseudo-stuttering
Approximate age first received stuttering therapy in years	4-6	2-4	Over 10	6-10	6-10
Approximate years receiving stuttering therapy	8	5	3	2	15
How helpful was speech therapy?	A lot	Very	Somewhat	A lot	A lot

Standardized Assessments. Participants completed three standardized assessments via Qualtrics before beginning the first Zoom session.

1. Brief Version of the Unhelpful Thoughts and Beliefs About Stuttering Scales (UTBAS-6) (Iverach, et al., 2016)
2. State-Trait Anxiety Inventory (STAI) (Spielberger, 1989)

3. The Overall Assessment of the Speaker's Experience of Stuttering (OASES) (Yaruss & Quesal, 2010)

In addition to the assessments listed above, the speech samples (see details in the section below) were analyzed for frequency, duration, and physical concomitants (i.e., distracting sounds, facial grimaces, head movements, movements of the extremities) to determine stuttering severity using the SSI-4 (Riley, 2009) for each data collection session.

Speech Samples. Three speech samples were collected and recorded from each participant each session: one reading sample, one monologue sample, and one conversation speech sample. The participants read "The Grandfather Passage" (Van Riper, 1963). Monologue samples were gathered from six different open-ended questions. Open-ended questions included the following: "Tell me about where you live", "Tell me about your day", "Tell me about your family", "Tell me about your job/schooling", "Tell me about your hobbies", "Tell me about your history with stuttering" (Constantino et al., 2016; Maruthy & Sharma, 2018). The conversation topics related to the monologue topics. The order of elicitation of the monologue, conversation, and reading samples was randomly varied each session to reduce any order effects on stuttering frequency.

Daily Probes. After collecting speech samples, verbal probes were administered over Zoom to determine the participants' self-perception of stuttering severity, stuttering variability, stress, anxiety, and sleep for the day. These probes took two minutes or less to complete. For each probe, the participant was asked to respond on a 7-point scale with the fourth point indicating average, and three initial and the three final points indicating

below and above-average ratings. Probes were administered using the following prompt: Please rate the following using the 7-point Likert scale when compared to your normal.

1. Your stuttering severity today
2. Your stuttering variability today
3. Your overall stress level today
4. Your overall anxiety level today
5. Your overall sleep last night*

**For this probe, a higher number is positive, which is the opposite for the remaining four probes where a higher number indicates a negative impact.*

Data Analyses

OASES-A, STAI Short Form, Brief UTBAS-6. The Overall Assessment of the Speaker's Experience of Stuttering - Adults (OASES; Yaruss & Quesal, 2010; OASES-A) was administered online via Qualtrics. Participants rated all applicable items within each of the four evaluation sections (i.e., general information, reactions to stuttering, communications in daily situations, and quality of life). For each section, their points were totaled and divided by the number of items they completed in that section to calculate the impact score. Then, their impact score determined their impact rating of either mild (1.00-1.49), mild-moderate (1.50-2.24), moderate (2.25-2.99), moderate-severe (3.00-3.74), and severe (3.75-5.00) for each section. Lastly, their overall impact score was calculated by adding their points from all four sections and then dividing their total points by the total number of items they completed to determine their overall impact rating.

Each participant also completed the State and Trait Anxiety Inventory (STAI; Spielberger, 1983) for Adults Short Form. This is a shortened version of the full 40-item version that is used to evaluate trait and state anxiety. Trait anxiety refers to a relatively constant level of anxiety that a person experiences, while state anxiety is the level of anxiety that a person experiences when they perceive a stressful, dangerous, or threatening situation (STAI; Spielberger, 1983). The probe for trait anxiety was "indicate how you generally feel" (e.g., I feel rested): almost ever, sometimes, often, or almost always. An example probe for state anxiety was "indicate how you feel right now" (e.g., I feel rested): not at all, somewhat, moderately so, or very much so. State anxiety levels are often influenced by trait anxiety levels, therefore a person experiencing higher levels of trait anxiety will also experience higher levels of state anxiety due to the person perceiving a greater number of situations as threatening. Conversely, trait anxiety is not influenced by stress. Each of the short forms (T-Anxiety and S-Anxiety) consist of 10 items that include a weighted score of 1 to 4. A total score is determined for each form by adding up the weighted scores. Higher scores on the STAI Short Form represent higher trait and state anxiety.

Lastly, higher scores on the brief version of the UTBAS-6 screening that the participants completed before the interview sessions represented more unhelpful thoughts and beliefs associated with speech-related anxiety of adults who stutter (UTBAS-6; Iverach, et al., 2016). Total scores on the brief UTBAS-6 can range from 18 to 90. The mean scores on the brief UTBAS-6 screening that was administered to a sample of 337 adults who stutter (136 with social anxiety disorder) resulted in a mean of 43.94 with a standard deviation of 17.1. Brief UTBAS-6 scores can be converted to an equivalent full

UTBAS-6 score if needed. A score of 38 or higher is considered an indicator of a social anxiety disorder in adults who stutter.

Speech Samples and Stuttering Severity. The recorded speech samples were transcribed verbatim and coded for disfluencies. For reading samples, the original script was used for coding unless lines needed to be omitted or adjusted to what the participant verbalized. Autogenerated captions through Zoom Video Communications Inc. (2020) transcription software were used for the initial monologue and conversation transcription drafts. The author listened through the recording one time to finalize the transcriptions of all three speech samples before identifying the middle 300 syllables of each sample (Constantino et al., 2016; Maruthy & Sharma, 2018). Each speech sample was copied and pasted into a syllable counter and a total syllable count was generated. Then, 300 was subtracted from this total to give us a remainder. The remaining number was divided by two to determine how many syllables needed to be omitted from the top and bottom of the sample. The number of syllables that needed to be removed from the top was subtracted from the total syllable count to get a new total. Syllables were removed from the top until the new total was reached. Lastly, syllables were removed from the bottom of the transcription until the syllable counter verified 300 syllables remained. The author then listened to the transcription for a second time and coded the 300 syllables for stuttering-like and normal disfluencies. Each stuttering-like disfluency was also coded for the duration of the stuttering moment. The frequency of stuttering was determined by calculating the percent of stuttered syllables for each 300-syllable speech sample. This calculation was further used to determine the severity ratings based on the SSI-4 instrument. The SSI-4 severity ratings also depended on the average duration of stuttering

moments and the total physical concomitant ratings that were given by the coder based on observations made from the video recorded speech samples. Physical concomitants were evaluated within four categories: Distracting Sounds, Facial Grimaces, Head Movements, and Movements of the Extremities. Each of the four physical concomitant categories was given a score between zero and five, and the total was calculated. Calculated scores for the frequency of stuttering, duration of stuttering, and physical concomitants was totaled for each sample to determine a raw score from which stuttering severity was derived. Stuttering severity for each sample was labeled using a range from very mild to very severe.

Reliability. A total of 30 sessions were completed. Three speech samples were video recorded from each session, yielding a total of 90 speech samples (i.e., 30 conversation, 30 reading, and 30 monologue samples) that were transcribed verbatim and coded for disfluencies (stuttering-like and normal disfluencies). All samples from a single session were transcribed in one word document, resulting in a total of 30 transcript documents (3 samples/document). The documents were labeled 1-30 after initial coding was completed. A random number generator was used to randomly pick three out of the 30 sessions for intra-rater reliability and another three out of the 30 sessions for inter-rater reliability. Three sessions were recoded for intra-rater reliability after a minimum 2-week wait period. A second judge who has expertise and experience working with PWS coded 10% of the samples to establish inter-rater reliability. Intra-class correlation (ICC) coefficients and p-values were computed for inter-and intra-judge reliability of stuttering-like disfluencies, normal disfluencies, and overall. Based on the interpretation guidelines by Koo and Li (2016) for selecting and reporting intraclass correlation coefficients for

reliability research, intra-judge reliability was found to be high for SLD (ICC = .998, $p < .001$), ND (ICC = .995, $p < .001$), and overall (ICC = .996, $p < .001$). Inter-judge reliability was found to be high for SLD (ICC = .989, $p < .001$), ND (ICC = .981, $p < .001$), and overall (ICC = .986, $p < .001$).

Statistical Analyses

For the first research question, we used descriptive statistics and determined the mean, standard deviation (SD), and range of stuttering-like disfluencies (%SLD), normal disfluencies (%ND), and stuttering severity (SSI-4 score) for each day/session for each participant and across participants (group analysis). For individual participants, coefficient of variation (CV) was also calculated for the daily measures of %SLD and %ND across speech samples to decrease the possibility of floor effects or little changes occurring in participants with a lower stuttering frequency (Constantino et al., 2016). Coefficient of variation was calculated by dividing the standard deviation of %SLD across days by the mean of %SLD across days for each task (task-based) and across tasks (overall).

For the second research question, we used descriptive statistics and determine the mean, SD, and range of SLD and ND, by speaking *tasks* (i.e., conversation, monologue, reading) for each participant for each day and across participants for each day (group analysis).

For the third research question, we determined if stuttering variability (measured by Coefficient of Variation (CV)) was correlated with scores on the OASES-A (overall impact of stuttering), SSI-4 (severity), STAI Short Form (state and trait anxiety), and Brief UTBAS-6 (unhelpful thoughts and beliefs about stuttering). This was calculated by

comparing individual daily findings from research question one to the OASES-A, STAI Short Form, and Brief UTBAS-6.

For the fourth research question, we determined if the daily stuttering frequency (%SLD and %ND), variability (measured in CV for each participant), and stuttering severity (SSI-4 score) were correlated with the daily self-reported levels of stuttering severity, anxiety, variability, stress, and sleep. Group variability in stuttering frequency across days was correlated with the daily probes using the Spearman's *rho* to account for the ordinal scale used in the self-report variables. Alpha value of 0.05 was used for all comparisons. The likelihood of finding a significant result was increased due to the conduction of multiples tests. The current study is an exploratory study meant to identify possible paths forward in capturing stuttering variability.

3. RESULTS

Research Question 1: Individual and Group Patterns of Disfluencies (%SLD and %ND) and Severity (SSI-4) Across Days/Weeks

Individual trends. The mean %SLD and the mean %ND across the three speech samples were calculated for each participant, each session, and across all six sessions. Data from each participant came from two days (same day each week, when possible, see Table 9 for exact days) of the week over three consecutive weeks. For example, data were collected on three consecutive Mondays and three consecutive Wednesdays for P01. This allowed us to compare data between days (e.g., Monday vs. Wednesday), across days (e.g., Monday of each week), and across weeks. The mean %SLD and the mean %ND for each day were based on the average number of disfluencies counted from the reading, monologue, and conversation speech samples. In addition to the range, variability was determined by calculating the coefficient of variation (CV) across days to decrease the possibility of floor effects or little changes occurring in participants with a lower stuttering frequency (Constantino et al., 2016). Individual participant data for %SLD and %ND can be found in Table 4 and Table 5, respectively.

%SLD. The mean %SLD across sessions was 4.81 for P01, 2.86 for P02, 5.76 for P03, 1.57 for P04, and 22.57 for P05. P05 had the highest mean %SLD across sessions, and P04 had the lowest mean %SLD. The range of %SLD across sessions was 5.30 for P01, 3.05 for P02, 4.86 for P03, 0.55 for P04, and 3.60 for P05. P01 had the highest range of %SLD across sessions, and P04 had the lowest range of %SLD across sessions. To further evaluate individual changes in day-to-day disfluencies and directly compare to the only other study exploring day-to-day variability of stuttering (Constantino et al., 2016),

CV was calculated by dividing the standard deviation by the mean %SLD across days. The CV across days was 0.37 for P01, 0.39 for P02, 0.30 for P03, 0.21 for P04, and 0.05 for P05. Therefore, based on the CV calculations, P02 had the highest amount of day-to-day variability, and P05 had the lowest day-to-day variability. Additionally, the standard deviation was highest for P01 (SD = 1.78) and lowest for P04 (SD = 0.33) which corresponds with the participants who had the highest and lowest range calculations.

%ND. The mean %ND across sessions was 3.70 for P01, 4.46 for P02, 1.11 for P03, 2.61 for P04, and 2.23 for P05. P02 had the highest mean %ND across sessions and P03 had the lowest. The range of %ND across sessions was 0.97 for P01, 2.33 for P02, 1.00 for P03, 1.22 for P04, and 1.28 for P05. P02 had the highest range of %ND across sessions and P01 had the lowest. To further evaluate individual changes in day-to-day disfluencies, CV was calculated by dividing the standard deviation by the mean %ND across days. The CV across days was 0.09 for P01, 0.17 for P02, 0.33 for P03, 0.17 for P04, and 0.20 for P05. Therefore, based on the CV calculations, P02 had the highest amount of day-to-day variability and P01 had the lowest. Additionally, the standard deviation was highest for P02 (SD = 0.76) and lowest for P01 (SD = 0.34) which corresponds with the participants who had the highest and lowest range calculations.

Group trends. Group data for each session and across sessions is represented by the "overall-mean" row at the bottom of Table 4 and Table 5.

%SLD. Group data for %SLD across days/sessions resulted in mean = 7.51, range = 2.54 (min. = 6.38; max. = 8.93), SD = 0.84, and CV = 0.11. A non-parametric Friedman's test of differences among repeated measures of group means for %SLD from session-to-session found no significant difference [X^2 (5) = 7.65, p =0.18] in %SLD from

between sessions. Group trends for the mean %SLD were found to be consistent across days and are displayed in Figure 1b.

%ND. Group data for %ND across days/sessions resulted in mean = 2.82, range = 0.49 (min. = 2.58; max. = 3.07), SD = 0.19, and CV = 0.07. The range of disfluencies across all participants and sessions was much lower for %ND (range = 0.49) than %SLD (range = 2.54). This was also true for CV group data of %ND (CV = 0.07) and %SLD (CV = 0.11) and A non-parametric Friedman's test of differences among repeated measures of group means for %ND from session-to-session found no significant difference [X^2 (5) = 5.01, p = 0.41] in %ND between sessions. Group trends for the mean %ND were found to be consistent across days and are displayed in Figure 1c.

Table 3. Percent of Stuttering-like Disfluencies (%SLD)

Participants	Task	Session						Mean (across sessions)	Range	SD	CV
		S1	S2	S3	S4	S5	S6				
P01	Conversation	5.82	8.67	4.67	4.00	3.33	5.33	5.30	5.33	1.87	0.35
	Reading	4.07	7.56	3.51	2.33	5.81	4.07	4.56	5.23	1.85	0.41
	Monologue	4.67	8.33	5.00	2.33	4.00	3.00	4.56	6.00	2.10	0.46
	Mean (across tasks)	4.85	8.19	4.39	2.89	4.38	4.13	4.81	5.30	1.78	0.37
P02	Conversation	3.00	2.33	3.33	5.33	3.33	5.33	3.78	3.00	1.26	0.33
	Reading	2.35	8.14	2.33	0.58	1.16	1.16	2.62	7.55	2.79	1.07
	Monologue	2.33	4.33	0.00	2.67	1.33	2.33	2.17	4.33	1.44	0.67
	Mean (across tasks)	2.56	4.94	1.89	2.86	1.94	2.94	2.86	3.05	1.11	0.39
P03	Conversation	6.00	6.00	3.00	7.33	8.00	7.67	6.33	5.00	1.84	0.29
	Reading	1.16	4.65	2.91	2.91	5.81	3.49	3.49	4.65	1.60	0.46
	Monologue	8.67	5.67	4.00	4.67	10.67	11.00	7.44	7.00	3.07	0.41
	Mean (across tasks)	5.28	5.44	3.30	4.97	8.16	7.39	5.76	4.86	1.76	0.30
P04	Conversation	1.67	1.67	0.67	1.00	0.67	0.33	0.33	1.33	0.56	1.67
	Reading	2.33	1.16	1.74	1.74	2.91	2.33	2.33	0.58	0.61	0.26
	Monologue	2.67	1.67	1.67	2.00	0.33	1.67	1.67	1.00	0.76	0.46
	Mean (across tasks)	2.22	1.50	1.36	1.58	1.30	1.44	1.57	0.55	0.33	0.21
P05	Conversation	26.00	24.00	25.00	25.00	28.33	22.67	25.17	5.67	1.92	0.08
	Reading	19.19	24.42	16.28	17.44	15.70	20.93	18.99	8.72	3.28	0.17
	Monologue	22.33	25.33	21.67	26.67	24.00	21.33	23.56	5.33	2.15	0.09
	Mean (across tasks)	22.51	24.58	20.98	23.04	22.68	21.64	22.57	3.60	1.24	0.05
Overall	Mean	7.48	8.93	6.38	7.07	7.69	7.51	7.51	2.54	0.84	0.11

Table 4. Percent of Normal Disfluencies (%ND)

Participants	Task	Session						Mean (across sessions)	Range	SD	CV
		S1	S2	S3	S4	S5	S6				
P01	Conversation	5.09	3.67	4.67	4.67	4.67	6.33	4.85	2.67	0.87	0.18
	Reading	0.58	0.00	0.58	1.74	0.00	0.58	0.58	1.74	0.64	1.09
	Monologue	4.33	7.67	6.00	4.33	5.67	6.00	5.67	3.33	1.25	0.22
	Mean (across tasks)	3.34	3.78	3.75	3.58	3.44	4.30	3.70	0.97	0.34	0.09
P02	Conversation	5.33	7.33	6.33	8.67	5.33	6.00	6.50	3.33	1.30	0.20
	Reading	0.00	0.59	0.00	0.00	0.00	0.00	0.10	0.59	0.24	2.45
	Monologue	8.67	5.33	6.33	8.67	5.00	6.67	6.78	3.67	1.59	0.23
	Mean (across tasks)	4.67	4.42	4.22	5.78	3.44	4.22	4.46	2.33	0.76	0.17
P03	Conversation	1.33	1.00	1.33	0.67	2.67	0.33	1.22	2.33	0.81	0.66
	Reading	0.58	0.00	0.00	0.00	0.00	0.00	0.10	0.58	0.24	2.45
	Monologue	2.00	1.33	2.00	1.33	2.33	3.00	2.00	1.67	0.63	0.32
	Mean (across tasks)	1.30	0.78	1.11	0.67	1.67	1.11	1.11	1.00	0.36	0.33
P04	Conversation	4.67	4.67	2.67	4.00	2.00	3.00	3.50	2.67	1.11	0.32
	Reading	0.00	0.00	0.00	0.58	0.00	0.00	0.10	0.58	0.24	2.45
	Monologue	4.67	3.00	5.67	4.33	3.67	4.00	4.22	2.67	0.91	0.22
	Mean (across tasks)	3.11	2.56	2.78	2.97	1.89	2.33	2.61	1.22	0.45	0.17
P05	Conversation	3.33	2.33	2.00	3.00	3.33	3.00	2.83	1.33	0.55	0.19
	Reading	0.58	0.00	0.00	0.00	0.00	1.16	0.29	1.16	0.49	1.67
	Monologue	1.67	2.67	4.33	4.00	4.00	4.67	3.56	3.00	1.15	0.32
	Mean (across tasks)	1.86	1.67	2.11	2.33	2.44	2.94	2.23	1.28	0.45	0.20
Overall	Mean	2.86	2.64	2.79	3.07	2.58	2.98	2.82	0.49	0.19	0.07

Individual and group stuttering severity patterns across days. Individual stuttering severity calculations (SSI-4) were determined for each session based on the participants' reading and conversation samples. The mean SSI-4 score across all sessions was highest for P05 (31.67) and lowest for P04 (12.67). Based on SSI-4 scores, P01 and P04 showed the greatest variability (P01 range = 18 to 26 and P04 range = 10 to 18) and P05 showed the lowest variability (range = 31 to 33). The greatest day-to-day variability based on CV calculations was more distinct between P01 (CV = 0.13) and P04 (CV = 0.26) than their range outcomes. The CV across days was highest for P04 (CV = 0.26) and lowest for P05 (CV = 0.03). Individual and group stuttering severity calculations for the mean, range, SD, and CV are in Table 6. Figure 1a. includes the group trends in SSI-4 data across days.

Table 5. Stuttering Severity Instrument (SSI-4)

		Sessions									
Participant	SSI-4	S1	S2	S3	S4	S5	S6	Mean	Range	SD	CV
P01	Score	22	26	21	18	19	20	21	8	2.83	0.13
	Severity	Mild	Moderate	Mild	Mild	Mild	Mild				
P02	Score	21	22	22	18	18	19	20	4	1.90	0.09
	Severity	Mild	Mild	Mild	Mild	Mild	Mild				
P03*	Score	19	19	18	18	22	20	19.33	4	1.51	0.08
	Severity	Mild	Mild	Mild	Mild	Mild	Mild				
P04*	Score	18	10	10	10	14	14	12.67	8	3.27	0.26
	Severity	Mild	Very mild	Very mild	Very mild	Very mild	Very mild				
P05*	Score	32	32	31	33	31	31	31.67	2	0.82	0.03
	Severity	Severe	Severe	Moderate	Severe	Moderate	Moderate				
Mean Score		22.4	21.8	20.4	19	20.8	20.93				

*One or more sessions were on a different day

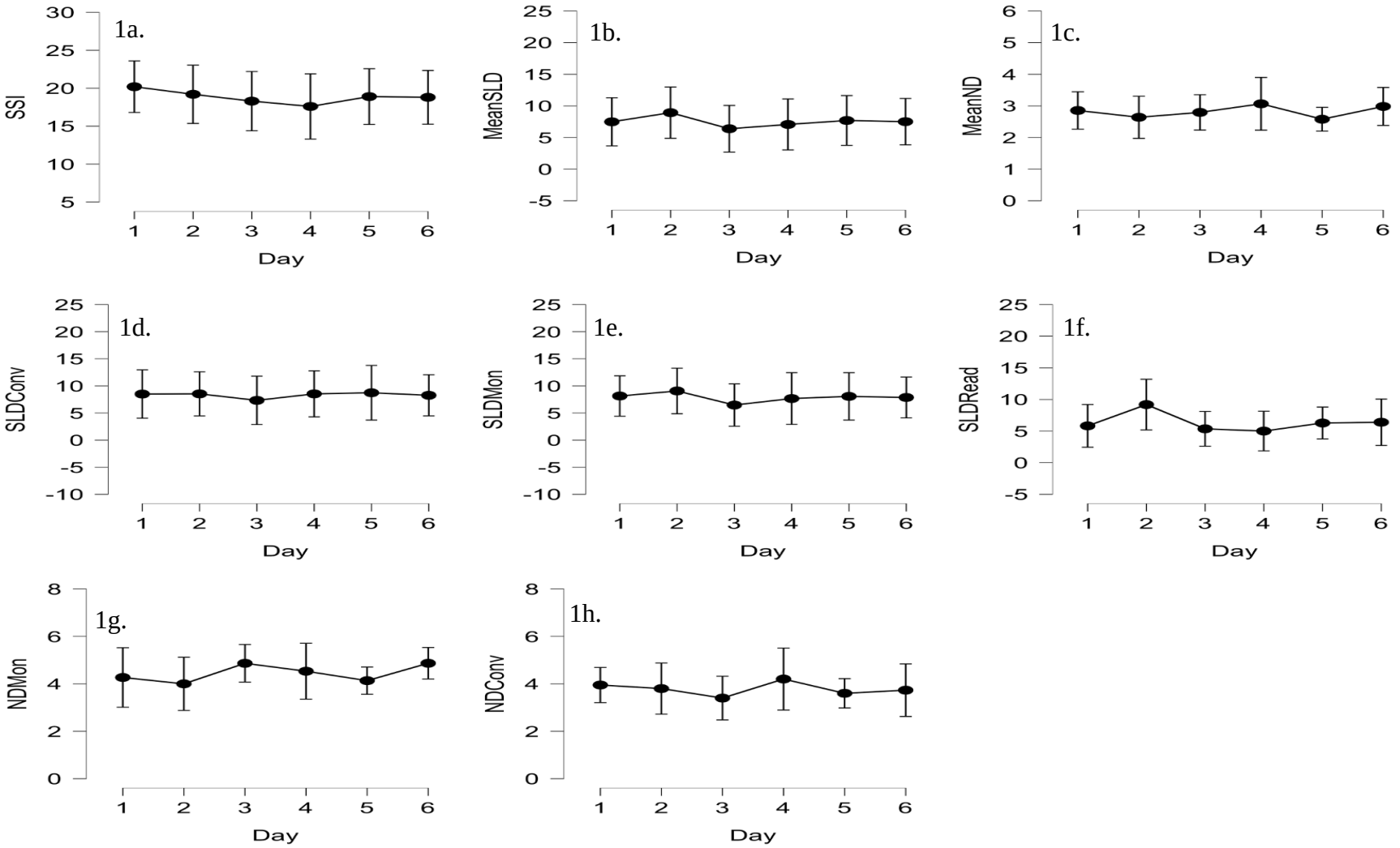

Figure 1a-1h. Average stuttering severity and frequency across days and participants. 1a. Mean SSI-4 across participants by day; 1b. Mean %SLD across participants by day; 1c. Mean %ND across participants by day; 1d. Mean %SLD in conversation task across participants by day; 1e. Mean %SLD in monologue task across participants by day; 1f. Mean %SLD in reading task across participants by day; 1g. Mean %ND in monologue task across participants by day; 1h. Mean %ND in conversation task across participants by day.

Research Question 2: Variability of Disfluencies (%SLD and %ND) for Speech Tasks

Overall trends. For each participant, the task-based (i.e., conversation, reading, and monologue) mean, range, and variability was calculated for %SLD and %ND. The top rows, a-c of Figures 2-6, show graphs for %SLD, and the bottom rows d-f correspond with the same days of the week on the top row but shows the %ND data. Table 4 and Table 5 show individual calculations for the mean, range, SD, and CV of %SLD and %ND observed for each speaking task. Group trends for %SLD for individual speaking tasks are shown in Figure 1d-1f. Group trends for %ND during the monologue and conversation tasks are shown in Figure 1g and Figure 1h. There were no predictable patterns in %SLD and %ND across days for individual participants (see Fig 2 through 6).

%SLD. On average, most %SLD were produced during the conversation task (mean = 8.18, SD = 9.76) and the least SLD were produced during the reading task (mean = 6.40, SD = 7.09). The range of %SLD across participants was also highest for the conversation task (range = 24.84) and lowest for the reading task (range = 16.66). Similarly, the CV for %SLD was highest for the conversation task (CV = 1.19) and the lowest for the reading task (CV = 1.11). Group averages were overall consistent, but no fixed trends were found. They fluctuated day-to-day.

%ND. Calculations for %ND were more varied between tasks than the calculations for %SLD. On average, across participants and days, the highest %ND were produced during the monologue task (mean = 4.45, SD = 1.86), and the lowest %ND were produced during the reading task (mean = 0.23, SD = 0.21). Like %SLD, the range of %ND (across days) was highest for the conversation task (range = 5.28) and lowest for

the reading task (range = .48). %ND close to 0 was an expected finding for the reading task. In contrast, the CV for %ND was highest for the reading task (CV = 0.90) and lowest for the monologue task (CV = 0.42).

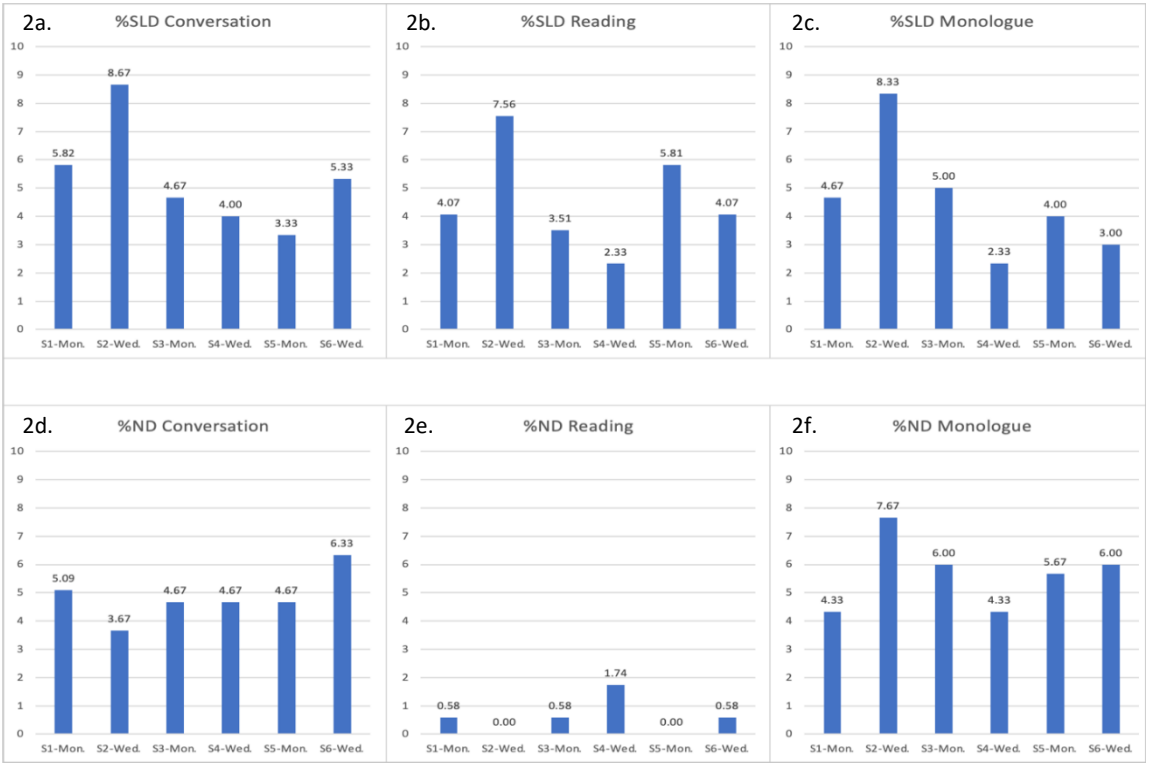

Figure 2a-2f. Day-to-day task based disfluencies for P01.

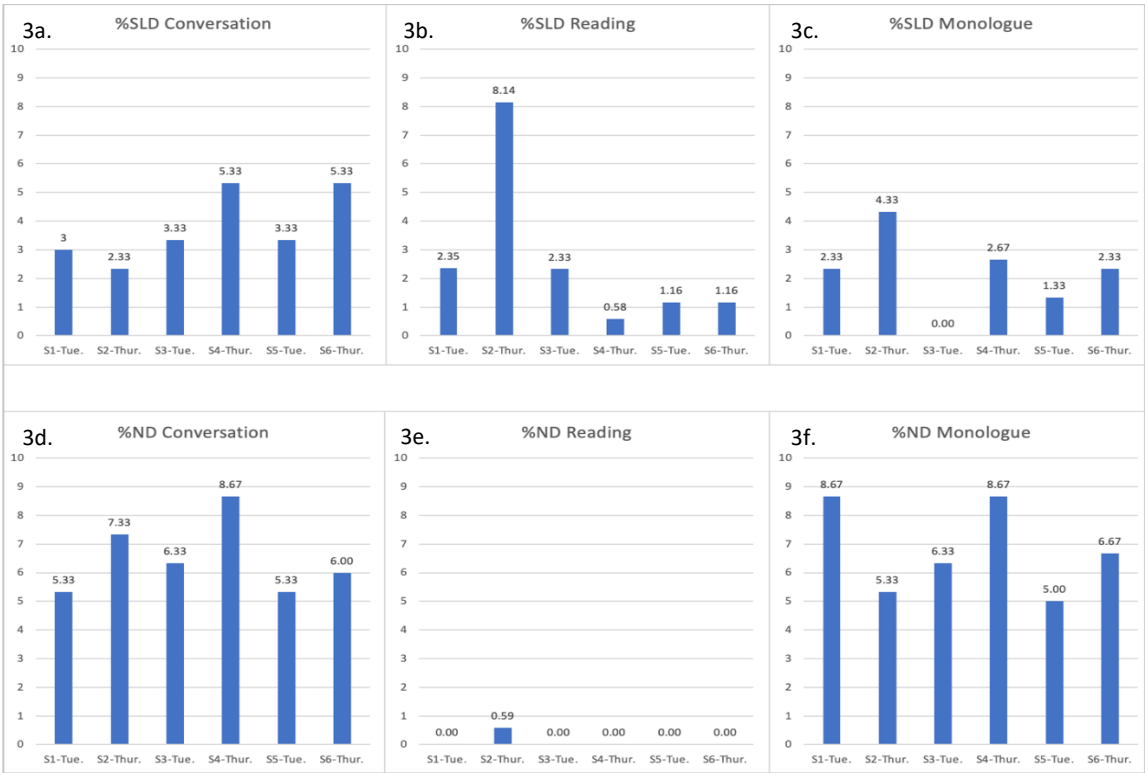

Figure 3a-3f. Day-to-day task based disfluencies for P02.

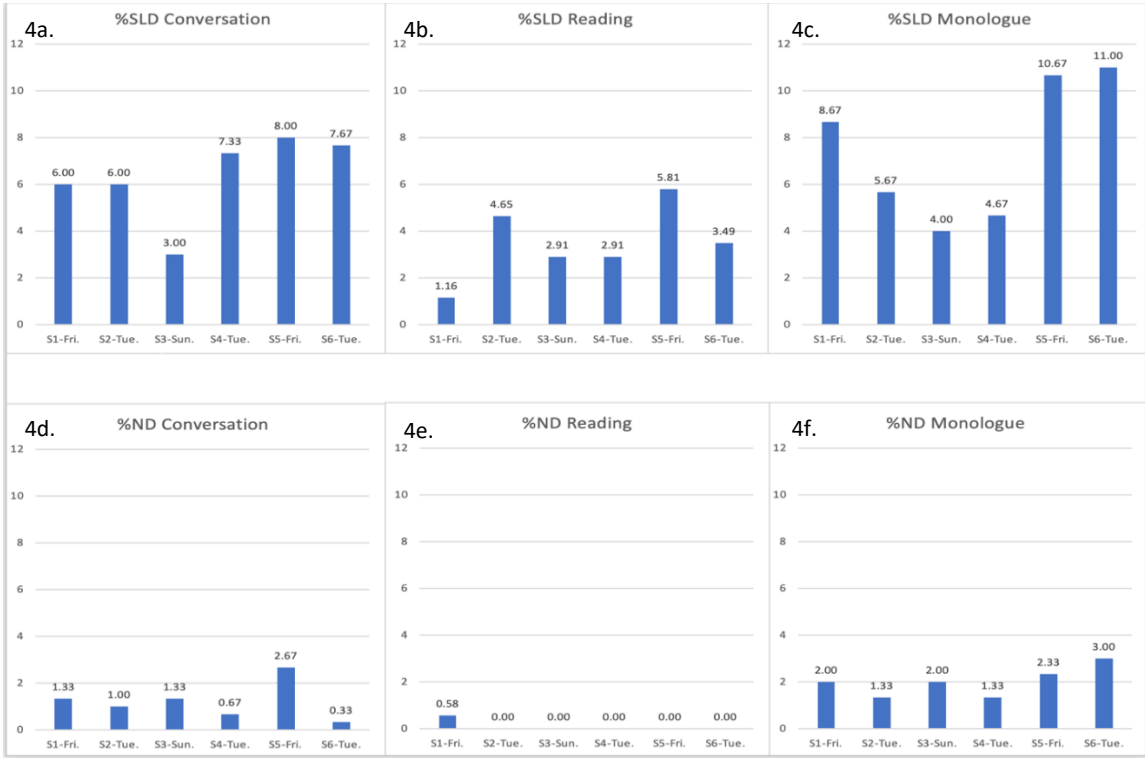

Figure 4a-4f. Day-to-day task based disfluencies for P03.

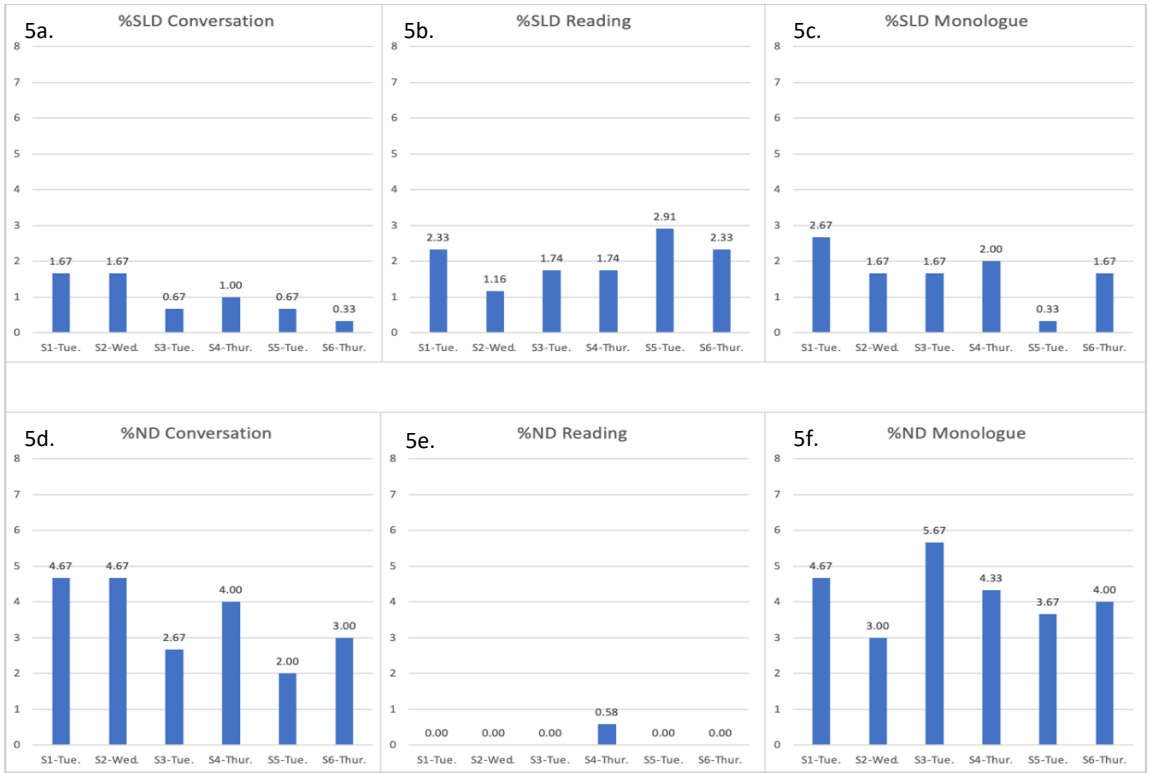

Figure 5a-5f. Day-to-day task based disfluencies for P04.

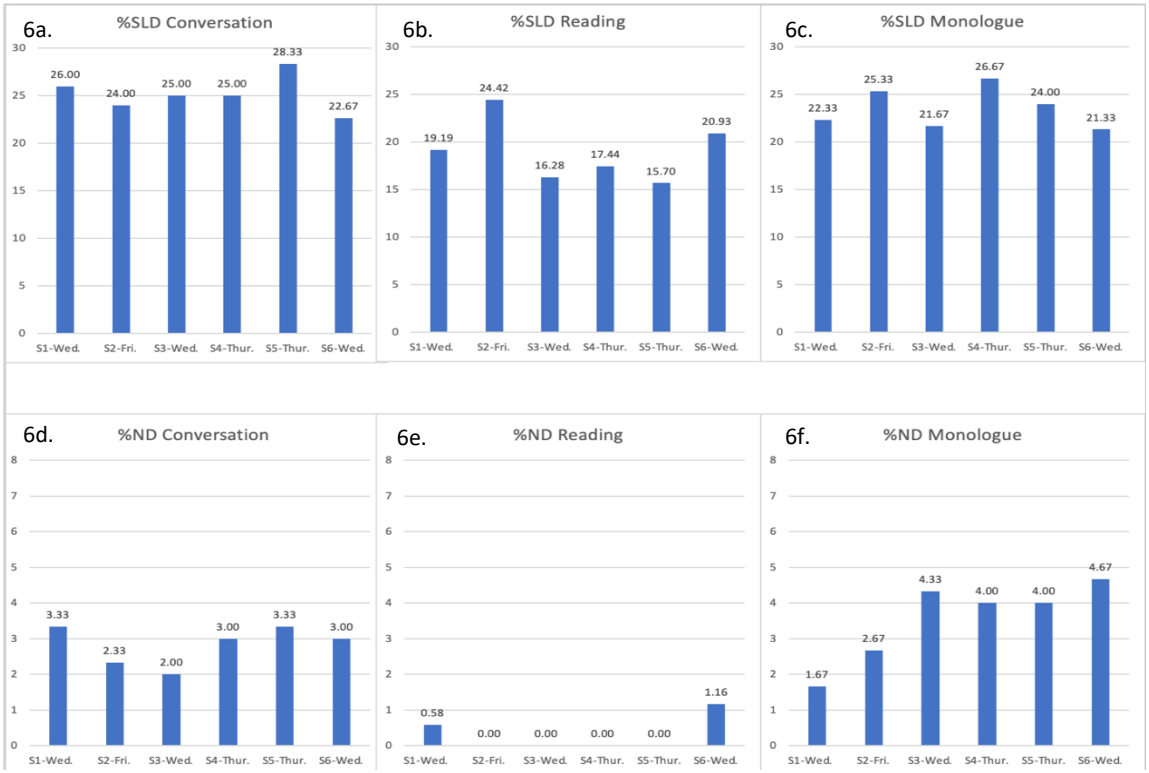

Figure 6a-6f. Day-to-day task based disfluencies for P05.

Research Question 3: Correlations Between Stuttering Variability and Standardized Assessments

Several important trends were observed between stuttering variability (CV) and OASES-A (overall impact of stuttering), SSI-4 (severity), Short Form STAI (state and trait anxiety), and Brief UTBAS-6 (unhelpful thoughts and beliefs about stuttering). Based on Spearman's *rho* calculations, significant positive correlations were found between CV conversation and UTBAS ($r_s = 0.9$, $p < .001$), CV conversation and STAI trait ($r_s = 0.9$, $p < .001$), and CV overall tasks and OASES-A total scores ($r_s = 0.9$, $p < .001$). Specifically, P05 had the lowest UTBAS score (21) and the lowest stuttering variability (CV = .08) across the six sessions for the conversation tasks. In comparison, P04 had the highest UTBAS score (42) and the highest stuttering variability (CV = 1.67) across the six sessions for the conversation tasks. P04 also had the highest STAI-trait

score (29). Comparisons between stuttering variability and OASES-A total scores found that P02, who had the highest OASES-A total score (2.50), also had the greatest variability in %SLD (CV = 0.39) across all three tasks (i.e., reading, conversation, and monologue) and sessions. Similarly, P05 had the lowest OASES-A total score (1.87) and the lowest stuttering variability (CV = .05) across speaking tasks and days. A positive correlation between OASES-A total scores and overall CV was observed for all five participants. A positive correlation was also observed between CV values for %SLD during reading tasks and OASES-A total scores. P01 had the lowest OASES-A total score (1.87) and the lowest stuttering variability (CV = 0.17) on the reading task across days. Likewise, P02 had the highest OASES-A total score (2.50) and the highest stuttering variability (CV = 1.07) on the reading task across days. Overall, there were clear correlations between stuttering variability (CV) and unhelpful thoughts and beliefs about stuttering, stuttering variability and trait anxiety, and stuttering variability and the overall impact of stuttering. OASES-A scores are shown in Table 7. STAI and UTBAS-6 scores are shown in Table 8.

Table 6. OASES-A Section Scores and Total Scores

Participant	Section 1 (general information)	Section 2 (reactions to stuttering)	Section 3 (communication in daily situations)	Section 4 (quality of life)	Overall Impact score
P01	2.20	2.47	2.60	1.92	2.31
P02	2.45	2.90	2.80	1.76	2.50
P03	2.45	3.20	2.12	1.80	2.43
P04	2.30	2.63	2.36	1.56	2.23
P05	2.10	2.27	1.96	1.12	1.87

Table 7. STAI and UTBAS-6 Scores

Participant	STAI-sate	STAI-trait	UTBAS-6
P01	26.00	25.00	28.00
P02	15.00	20.00	36.00
P03	15.00	13.00	27.00
P04	21.00	29.00	42.00
P05	17.00	17.00	21.00

Research Question 4: Self-report Factors Impacting Stuttering

Self-ratings were obtained for each participant's average stress, anxiety, stuttering severity, stuttering variability, and sleep for that day. Higher scores reflected a negative impact for all factors except for sleep. A higher sleep score was considered positive because it indicated more sleep than average on that day. Due to the ordinal nature of the self-reported data shown in Table 9, Spearman's *rho* was calculated to determine whether any variables correlated. The findings indicated that daily self-rated stress was significantly correlated with daily self-rated stuttering severity ($r_s = 0.646$, $p < .001$) shown in Figure 7a. Additionally, daily self-rated anxiety was significantly correlated with daily self-rated stuttering severity ($r_s = 0.640$, $p < .001$) shown in Figure 7b, variability ($r_s = 0.485$, $p < .01$) shown in Figure 7c, stress ($r_s = 0.813$, $p < .001$) shown in Figure 7d, and mean %ND from each session ($r_s = 0.546$, $p < .01$) shown in Figure 7e. %SLD were not significantly correlated with any of the self-ratings. All correlation outcomes are reported in Table 10.

Table 8. Daily Probe Responses

Participant	Session	Self-rated stuttering severity	Self-rated stuttering variability	Self-rated stress	Self-rated anxiety	Self-rated sleep	Day of the week
P01	1	4	3	4	3	4	Mon.
P01	2	5	4	4	4	4	Wed.
P01	3	4	5	5	5	4	Mon.
P01	4	6	5	7	7	3	Wed.
P01	5	5	6	7	7	4	Mon.
P01	6	4	4	5	5	3	Wed.
P02	1	4	4	3	3	4	Tue.
P02	2	5	4	5	4	4	Thur.
P02	3	6	4	5	5	5	Tue.
P02	4	4	5	5	5	4	Thur.
P02	5	4	4	4	4	5	Tue.
P02	6	4	4	3	3	4	Thur.
P03	1	2	4	3	2	5	Fri.
P03	2	3	4	4	3	4	Tue.
P03	3	5	4	4	2	1	Sun.
P03	4	4	4	5	3	4	Tue.
P03	5	4	5	4	4	5	Fri.
P03	6	3	5	2	2	5	Tue.
P04	1	4	5	2	2	5	Tue.
P04	2	4	4	5	3	3	Wed.
P04	3	5	6	6	5	5	Tue.
P04	4	4	4	3	3	4	Thur.
P04	5	3	2	2	2	4	Tue.
P04	6	3	3	3	2	4	Thur.
P05	1	5	4	6	4	4	Wed.
P05	2	4	4	4	3	4	Fri.
P05	3	4	4	4	4	4	Wed.
P05	4	4	4	3	3	4	Thur.
P05	5	5	4	4	4	4	Thur.
P05	6	4	4	5	4	4	Wed.

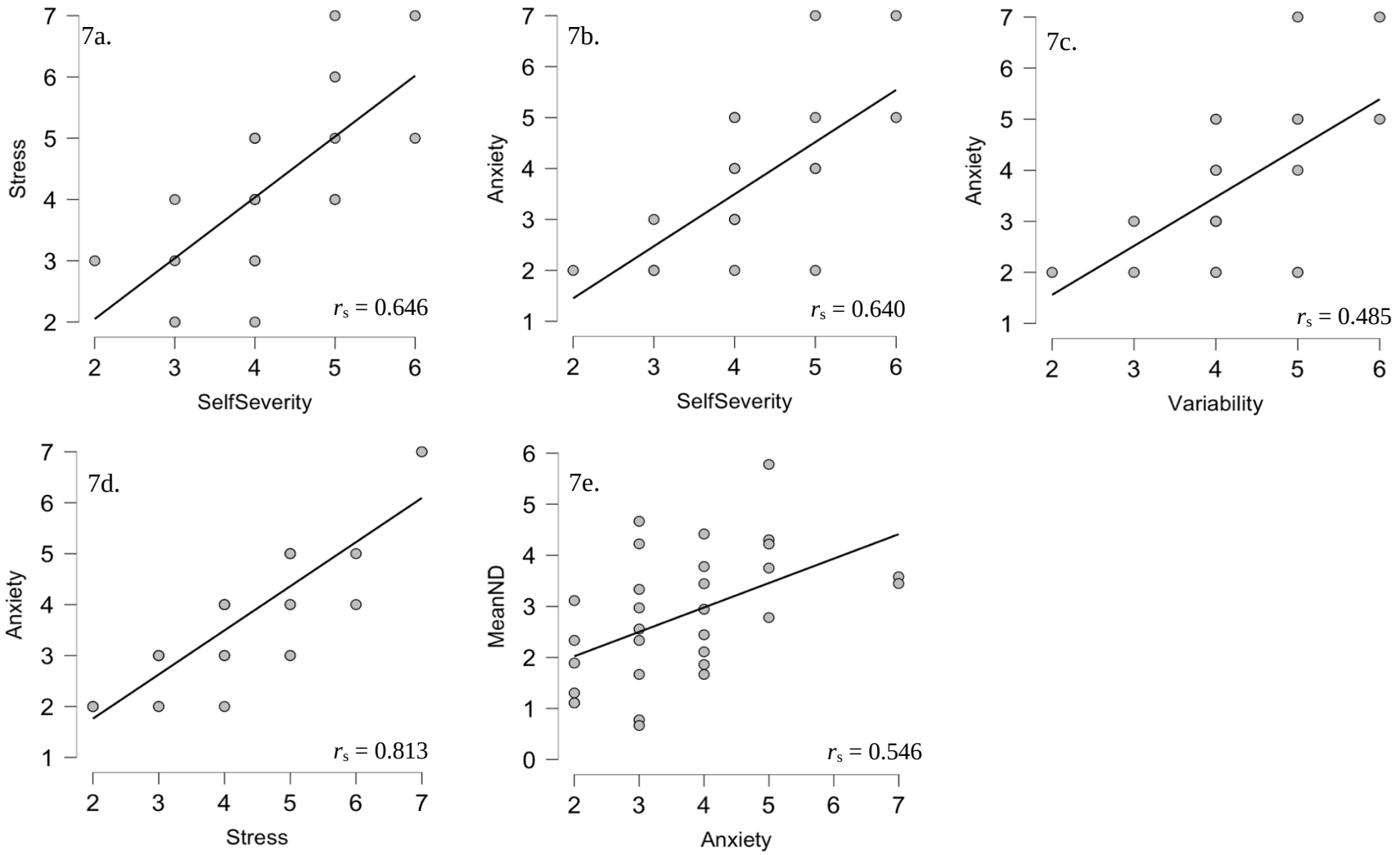

Figure 7a-7e. Significant correlations between self-reported factors and normal disfluencies. 7a. Daily self-rated stress and daily self-rated severity; 7b. Daily self-rated anxiety and daily self-rated severity; 7c. Daily self-rated anxiety and daily self-rated stuttering variability; 7d. Daily self-rated anxiety and daily self-rated stress. 7e. Individual daily mean %ND and daily self-rated anxiety.

Table 9. Spearman's Correlations

Variable		SelfSeverity	Variability	Stress	Anxiety	Sleep	SSI	MeanSLD	MeanND	TCV
1. SelfSeverity	Spearman's rho	—								
	p-value	—								
2. Variability	Spearman's rho	0.300	—							
	p-value	0.107	—							
3. Stress	Spearman's rho	0.646 ***	0.370 *	—						
	p-value	< .001	0.044	—						
4. Anxiety	Spearman's rho	0.640 ***	0.485 **	0.813 ***	—					
	p-value	< .001	0.007	< .001	—					
5. Sleep	Spearman's rho	-0.199	0.273	-0.293	-0.083	—				
	p-value	0.291	0.144	0.116	0.663	—				
6. SSI	Spearman's rho	-0.064	-0.202	-0.238	-0.186	0.274	—			
	p-value	0.737	0.285	0.205	0.326	0.143	—			
7. MeanSLD	Spearman's rho	0.040	0.011	0.046	0.055	-0.022	0.654 ***	—		
	p-value	0.833	0.955	0.809	0.775	0.910	< .001	—		
8. MeanND	Spearman's rho	0.387 *	0.151	0.255	0.546 **	-0.118	-0.287	-0.344	—	
	p-value	0.035	0.427	0.174	0.002	0.535	0.124	0.063	—	
9. CV	Spearman's rho	-0.132	0.029	-0.136	-0.017	0.358	-0.182	-0.532 **	0.144	—
	p-value	0.488	0.878	0.472	0.928	0.052	0.336	0.002	0.446	—

* p < .05, ** p < .01, *** p < .001

4. DISCUSSION

The purpose of this study was to evaluate the variability of stuttering over three weeks (i.e., six days) and determine if any individual or group factors correlate with day-to-day or task-based (i.e., conversation, reading, and monologue) stuttering variability. Percentage of normal disfluencies (%ND), percentage of stuttering-like disfluencies (%SLD), and stuttering severity (SSI-4) were coded from three speech samples (i.e., conversation, reading, and monologue) that were provided during each of the 30 sessions (6 sessions per participant). Individual self-reported data was also gathered to determine whether standardized scales (i.e., OASES-A, Brief UTBAS-6, Short Form STAI) were predictive of daily stuttering variability. Additionally, we explored whether daily self-reports (i.e., sleep, stress, anxiety, stuttering severity, and stuttering variability) were correlated to stuttering frequency and variability. A total of five adults who stutter completed the study, and the data obtained, while preliminary, yielded some interesting trends. The important trends in the results are discussed below.

Variability of Stuttering Frequency and Severity

Several studies and anecdotal reports have documented the variability of stuttering, but few studies have reported on the day-to-day and task-based variability of stuttering frequency and severity. Our findings on day-to-day and task-based variability in individual %SLD was lower compared to previous findings (Constantino et al., 2016; Karimi et al., 2013; and Maruthy & Sharma, 2018). These studies documented stuttering variability ranges of less than 5%SS for some PWS and greater than 20%SS for others. Specifically, Maruthy and Sharma (2018) found day-to-day stuttering variability to be greater than 5% for all participants. In comparison, the individual day-to-day variability

of %SLD from the current study ranged from 0.58% to 8.72%. Participant P04 had the lowest day-to-day range on %SLD (conversation = 1.34, reading = 1.75, monologue = 2.34). P05 had the highest range for reading (8.72). Overall, the highest and lowest %SLD variability calculations (CV) among participants greatly varied between tasks. Additionally, the %ND across sessions ranged from 0.58% to 3.67%. Overall, results indicated less variability in %ND for each participant except P04 and were more consistent overall. This finding does not correspond with the previous finding of more variability in %ND than in %SLD, although our findings of day-to-day variability in stuttering severity calculations (SSI-4) do correspond with previous findings (Constantino et al., 2016). Table 4 and Table 5 show individual calculations for the mean, range, SD, and CV of %SLD and %ND observed for each speaking task across all six sessions and across speaking tasks.

Individual stuttering severity (SSI-4) was determined for each session based on the participants' reading and conversation samples. The SSI-4 outcomes were heavily influenced by %SLD, but other qualitative measures of the stuttering moment (i.e., duration and physical concomitants) also influence the day-to-day variability in stuttering severity. Overall, the stuttering severity was found to be generally consistent from session to session for all participants. Day-to-day SSI-4 scores ranged from 2-8 points, and the range over days and participants was 3.4. For individual participants, this translated to minimal or no change in stuttering severity rating from session to session (see Table 6 for details). Also, the individual qualitative outcomes were overall consistent within participants except for P05, who had the highest mean SSI-4 ratings (31.67). For this participant, SSI-4 outcomes for three sessions were severe, and the other three sessions

were moderate. Yet, their SSI-4 ratings had the least amount of day-to-day variability (range = 2; CV = 0.03). Furthermore, P04 had the lowest mean SSI-4 ratings (12.67), had the highest SSI-4 variability (range = 8; CV = 0.26). Individual and group stuttering severity calculations including the mean, range, SD, and CV are shown in Table 6. Figure 1a. shows the group trends in SSI-4 data across days.

Group Trends in Stuttering Frequency and Variability

Although there were some differences in group trends between day-to-day variability of %SLD and day-to-day variability of %ND, no consistent patterns were found in the day-to-day variability of %SLD. One may expect the stuttering frequency to decrease from the first to the last session as the participant and interviewer become more familiar with each other, but this was not the case. No upward or downward trend in stuttering frequency was observed across sessions and speaking tasks for any of the five participants. Even more, data gathered on the same days of the week and at the same time of the day did not contribute to any consistent patterns in day-to-day stuttering variability. These inconsistencies are consistent with reports from prior studies (Constantino et al., 2016; Karimi et al., 2013; and Maruthy & Sharma, 2018). While notable differences were found in %SLD between the speech tasks, group trends for the mean %SLD were found to be consistent across days and are displayed in Figure 1b. Previously, Maruthy and Sharma (2018) also found no significant difference in the mean %SLD within groups. Group trends for %SLD during the three speaking tasks are shown in Figure 1d-1f. The range of disfluencies across all participants and sessions was much lower for %ND (range = 0.49) than %SLD (range = 2.55). This was also true for CV group data of %ND (CV = 0.07) and %SLD (CV = 0.11). Group trends for the mean %ND were found to be

consistent across days and are displayed in Figure 1c. On average, the conversation task had the highest %SLD across participants and days, and the monologue task had the highest %ND across participants and days. The reading task resulted in the lowest %ND across all participants and days, which was an expected finding. It is not surprising that the monologue had the highest %ND and reading the lowest %ND due to the nature of the tasks. A monologue requires the person to think and talk about a topic for approximately three minutes. Most speakers use interjections in their speech at moments when they are thinking about what they want to say. Conversely, the reading task provides the speaker with the exact words to speak, reducing the number of hesitations and interjections that would be seen in both monologue and conversational speech. Individual data can be found in Table 4 and Table 5.

Standardized Scales (OASES-A, STAI, and UTBAS-6) and Stuttering Variability

Several correlations were also observed between stuttering variability (CV) and OASES-A (overall impact of stuttering), Short Form STAI (state and trait anxiety), and Brief UTBAS-6 (unhelpful thoughts and beliefs about stuttering). Specifically, we found that stuttering variability was correlated with lower UTBAS scores and vice versa. This trend was also found among the STAI-trait score. Additionally, higher task-based stuttering variability corresponded with higher OASES-A total scores and vice versa. These correlations we are seeing make sense considering previous reports from AWS. Many AWS contribute their overt stuttering components to their internal reactions, described as a loss of control, during speaking situations (Tichenor & Yaruss, 2018; Tichenor & Yaruss, 2021). Some AWS have reported that the core stuttering behaviors (i.e., disfluencies) are the by-products of their internal feelings of being stuck. This loss

of control can be considered a stuttering moment even without the observable features of stuttering. Furthermore, anticipation, physical and emotional arousal, has been reported by AWS to occur during moments of stuttering or even days prior to speaking situations (Tichenor & Yaruss, 2018). A recent study by Tichenor and Yaruss (2021) asked 204 AWS about the variability of their external, internal, and cognitive-affective aspects of stuttering. While the frequency and severity of stuttering were reported to be the most variable aspects of stuttering, the cognitive-affective aspects of stuttering were reported to be the least variable. At the same time, an increase in negative thoughts, feelings, and behaviors were reported to be caused by an increase in stuttering variability (Tichenor & Yaruss, 2021). An increase in stuttering variability was also found by Constantino et al. (2016) to cause a greater life impact as measured by the OASES-A. For our study, the correlations between standardized scales and stuttering variability were not considered significant due to the small data set, but they can be important to consider when targeting certain therapy outcomes or furthering research concerning the variability of stuttering. OASES-A scores are shown in Table 7. STAI and UTBAS-6 scores are shown in Table 8.

Self-reports and Variability

Significant correlations were found between the self-reported factors impacting stuttering and its variability. While none of the self-reported factors (i.e., daily sleep, stress, anxiety, stuttering severity, and stuttering variability) were correlated with %SLD, they did correlate with %ND. In fact, %ND was significantly correlated with both self-rated stuttering severity and self-rated anxiety. Interestingly, Blood et al. (1997) found PWS to display and self-rate significantly more disfluencies (i.e., SLD and ND) on “high-

stress" days. The significant correlations between daily self-rated stress and daily self-rated stuttering severity, daily self-rated anxiety and daily self-rated stuttering severity, variability, and stress show that daily self-reports might be as important, possibly even more important clinical measures than %SLD and %ND. The "loss of control" feeling that was previously discussed as part of stuttering moments might not be captured by objective stuttering frequency measures (Tichenor & Yaruss, 2021); however, self-report measures of stuttering severity and anxiety would capture that. Individual self-reported data is shown in Table 9, and all correlation outcomes are reported in Table 10. Figures 7a-7e display the data points among the significant correlations.

Implications

The results of this study contribute to our knowledge of stuttering variability in three significant ways. First, we were able to further support previous research showing the high degree of stuttering variability between participants and within participants from one day to the next and between speaking tasks. Second, we provided preliminary correlations among degrees of stuttering variability and standardized assessment scores, indicating that standardized assessment scores, outside of assessing stuttering frequency for stuttering severity, might be an equal or more important factor to consider when clinically assessing stuttering. Lastly, self-reported severity and anxiety were found to be significantly correlated with daily variability of normal disfluencies, often used by some AWS as an avoidance strategy (Van Riper, 1973, as cited in Constantino et al., 2016).

These results have important clinical implications. The most obvious one is that a single assessment session will likely not yield accurate results, since our data and those of previous studies have demonstrated that stuttering frequency and severity fluctuate

considerably from day-to-day for some adults who stutter. This has even larger implications for treatment outcomes studies and clinicians who rely on simple pre- vs post-stuttering frequency and severity measurements. Based on the non-directional shifts in stuttering frequency from day-to-day, relying on these measures for treatment outcomes can result in large or small effects that may not be a result of the actual therapy. Even self-report data on stuttering severity fluctuates day-to-day. A preliminary finding that needs further study is the positive correlation between variability and scores on the UTBAS-6 and OASES. These results are promising and need to be explored further to determine whether self-report scales such as the OASES and UTBAS-6 would serve as better measures of treatment outcomes compared to stuttering frequency and severity.

In addition to the clinical implications, results from this study also have relevant implications for neurophysiological studies exploring the nature of stuttering. Since stuttering frequency and severity fluctuate from one day to the next, and based on the correlations between the self-report measures of stuttering severity and anxiety and %ND, it is likely that many PWS successfully hide their overt stuttering. Researchers need to consider collecting longitudinal data instead of simply differentiating PWS based on severity measured in a single session. Overall, the findings bring our attention to the vast unobservable complexities of stuttering.

Limitations and Future Directions

A major limitation of this study is the small sample size (N=5) which limits the generalizability of the results. Another important limitation of the study is that data was only collected over three weeks due to time constraints. Future studies should attempt to collect data longitudinally, extending over a few months to gain a better sense of

stuttering variability over time. While attempts were made to schedule data collection sessions on the same days each week, it was not possible due to varying participant schedules. We controlled for this by keeping the time of the day consistent for each participant. This was an important aspect of the study as it helps us determine whether stuttering would be more consistent on the same day and time. Future studies should attempt to better control for this variance while also increasing the number of participants.

The current findings raise several points of interest for future research directions. In addition to increasing the number of participants and the overall duration of the study to gain a better sense of long-term variability of stuttering, future studies should also consider administering standardized tests such as the OASES, UTBAS-6, and STAI at regular intervals to augment findings from this study and Constantino et al. (2016). Also, the significant correlations between self-reported factors and normal disfluencies were interesting findings that should be further evaluated to increase our knowledge on the accuracy of self-reports from AWS. Since normal disfluencies (and not stuttering-like disfluencies) were correlated with self-reports of stuttering severity, future studies could also add a self-report measure of avoidance at the end of each data collection session to determine whether the normal disfluencies were used to avoid stuttering-like disfluencies.

Conclusion

This study provided an array of insights into the day-to-day and task-to-task variability of stuttering. Task-based (i.e., conversation, reading, monologue) speech samples were gathered from five AWS over a period of three weeks (i.e., six days). Data

included stuttering frequency (i.e., %SLD and %ND), stuttering severity (SSI-4), standardized assessments (i.e., STAI, UTBAS, OASES-A), and daily self-reports (i.e., daily sleep, stress, anxiety, stuttering severity, and stuttering variability). There were no consistent patterns in group day-to-day or task-to-task variability of stuttering, yet individual stuttering variability was well documented. Personal factors from standardized assessments and daily self-reports provided the most helpful insights to stuttering variability on an individual basis and overall.

APPENDIX SECTION

APPENDIX A: Demographic & Stuttering Background Questionnaire

Participant: _____

Age: _____ Sex: _____ Ethnicity: _____

Choose the highest degree or level of school you have completed. If currently enrolled, highest degree received: (drop down)

Some high school

High school diploma or GED

One- or two-year technical diploma

Some college

Associates Degree

Bachelor's Degree

Master's Degree

Professional Degree

Doctorate

Choose the option that best describes your employment status:

(Drop down)

Employed, working 40 or more hours per week

Employed, working 1-39 hours per week

Not employed, looking for work

Not employed, NOT looking for work

Retired

Disabled, not able to work

Choose the option that best describes your marital status:

(Drop down)

Unmarried

Married

Single

In a relationship

Background and History of Stuttering:

1. Age of stuttering onset: ____years ____months *Please provide your best estimate.
2. On average, how severe do you consider your stuttering to be:

1	2	3	4	5	6	7	8	9
Very mild				Moderate				Very severe

3. Has your stuttering severity changed over time:
    a. Check boxes: Yes; increased over time; Yes, decreased over time; No change; Varies, not fixed pattern
4. Family history of stuttering? Yes/No
    a. If yes, please check all that apply: Mother, Father, Sibling, Maternal Grandparent, Paternal Grandparent, 1st cousin, 2nd cousin, other distant relative
5. Family history of any other speech/language/communication disorder: Yes/No
6. Have you ever been diagnosed with an anxiety disorder: Yes/No
7. Have you received any speech therapy for your stuttering? Yes/No

a. If Yes: (drop down)

i. Are you currently enrolled in therapy: Yes/No

ii. At what age did you first receive therapy: ____

iii. Approximately how many years have you received therapy:

iv. Did your therapy primarily focus on (check all that apply)

1. Education about speech and stuttering
2. Identification of stuttering when it happens
3. Fluency Shaping/Smooth Speech/Slow Prolonged Speech
4. Stuttering Modification (e.g. holding your stuttering moment and changing it)
5. Stuttering Openly/Disclosure
6. Discussing thoughts and feelings about stuttering
7. Pseudo-stuttering/Stuttering on purpose
8. Any Other: _____

v. Overall, helpful do you feel speech therapy has been:

(1) NOT AT ALL	(2) A LITTLE	(3) SOMEWHAT	(4) A LOT	(5) VERY

8. Have you received any other treatment for your stuttering (e.g. medical): Yes/No

a. If yes, please describe:

9. Have you ever used a device (e.g. Speecheasy) to reduce your stuttering: Yes/No

10. Have you received speech therapy for anything other than stuttering: Yes/No

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