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Do Individuals with Benign Vocal Fold Lesions Have Increased Vocal Load Due to Nuanced Differences in Language Use?

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DO INDIVIDUALS WITH BENIGN VOCAL FOLD LESIONS HAVE INCREASED VOCAL LOAD DUE TO NUANCED DIFFERENCES IN LANGUAGE USE?

by

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Abstract

Individuals who engage in larger amounts of voice use have greater vocal loads, which may contribute to the development of benign vocal fold lesions (BVFL). The Personality traits of extroversion and talkativeness has been a predominant theory about increased vocal load in those with BVFL. Ambulatory monitoring has verified increased vocal use in those with BVFL, adding intensity and fundamental frequency to describe vocal load. Three vocally healthy women and three women with BVFL provided conversation and narrative language samples that underwent language analysis. Descriptive analyses of language samples revealed those with BVFL used up to twice as many words in conversation compared to healthy controls. Those with BVFL also presented with more determiners, whereas healthy controls used more adverbs during conversation language samples. Findings suggest that those with BVFL do indeed use more words to communicate and addressing aspects of communication style may be important in reducing vocal load.

Keywords: VOICE DISORDERS, VOCAL LOAD, TALKATIVENESS, PRAGMATICS, EXECUTIVE FUNTIONING

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Introduction

Benign vocal fold lesion (BVFL) is a general term that refers to vibration-induced lesions, or injuries, that occur within the mucosa of the vocal folds (Colton, Casper, & Leonard, 2011). These types of injuries can appear abruptly or gradually when an individual uses their voice excessively or inefficiently. Included in the category of BVFLs are nodules, polyps, and cysts, which disrupt the ability of the vocal folds to vibrate periodically. Aperiodic vibration results when BVFLs inhibit complete medial closure. This glottic gapping results in air escape and increased turbulent noise. Further, BVFLs may inhibit the regularity of the mucosal wave, resulting in chaotic vibrations (Colton et al., 2011) perceived by the listener as breathiness and hoarseness. One main contributor to BVFLs is a person's *vocal load* or the amount and degree of voice use one experiences throughout the day (Hunter et al., 2020). An individual's vocal load may act as a major contributor to the development and progression of BVFLs.

In the current literature, there is an observed relationship between one's personality and one's likelihood of developing BVFLs (Roy, Bless, & Heisey, 2000a; 2000b). Those with social, more extroverted personalities tend to talk more, and thus, increase their vocal load. Furthermore, those with outgoing personalities tend to choose professions that require increased talking, thereby compounding the increase in vocal load (van Mersbergen, 2011). The predominant theory that personality or temperament is the main behavioral contributor to a high vocal load, with subsequent BVFLs, aims to explain vocal load in this population. Although personality type may be associated with increased risk for BVFL, it does not account for the fact that many extroverted individuals do not have BVFLs. Given that the prevalence of voice disorders ranges from 3 – 9% of the population (Roy et al., 2004; Roy et al, 2005), it seems reasonable that there are far more extroverted individuals without voice disorders than those with voice disorders. Thus, personality cannot be the only contributor to the development of BVFLs.

Although personality may be a factor explaining the behavioral aspects of BVFL, there are other elements to consider, including physiology, environmental conditions, and communication style. Physiology, which contributes less to the behavioral aspects of BVFLs, can be an underlying factor, that in combination with increased talkativeness, may predispose one to BVFLs. Specifically, genetic factors determine the number of myofilaments in the basement membrane zone (Gray et al., 1994) of the vocal folds. Individuals with fewer myofilaments have less protection against the shearing and stress forces along the mucosal tissues of the vocal folds and are more susceptible to phonotrauma following vocal events. Additionally, protection from these shearing forces may be observed in biological males, whose vocal folds are longer, with larger surface areas that distribute collisional forces more widely. Males may also have increased amounts of hyaluronic acid in the superficial layers of the vocal folds, which also cushion and protect the tissues from shearing and stress forces.

The isolated contributions of temperament and physiology may combine to create an interaction factor that contributes to vocal fold tissue health beyond their respective, individual contributions. Temperamental factors influence the nature and degree to which an individual experiences emotion, such as stress (Patrick, Curtin, & Tellegen, 2002). Studies have revealed a strong association between prevalence of voice disorders, psychological stress, and poor mental health (depression, anxiety, phobia; Nerrière et al., 2009; Vertanen-Greis et al., 2018). Increased autonomic arousal as experienced in stressful situations results in increased contact time in vocal fold vibration (van Mersbergen & Delaney, 2013; van Mersbergen, Lyons, & Reigler, 2015), which translates to increased impact (Titze, Svec, & Popolo, 2003). Thus, chronic autonomic arousal, which is temperamentally driven, may increase the vocal load of an individual (via increased impact) and elevate the propensity for vocal folds to develop BVFLs.

What has been studied far less, but nonetheless may be a major contributor to increased vocal load, is the communication style of an individual. Communication style, dictated by cultural conventions (Arasaratnam, 2007) and environmental situations (Anand, Bottalico, & Gray, 2019) or cognitive abilities could also be considered in the development of BVFLs (Bambini et al., 2021). Culturally influenced communication patterns are shaped by familial and societal communication norms by which they are governed. In some cultures, it is typical to speak to others with minimal words and prosody (Rossi, 2020), while other cultures tend to speak to others boisterously and often (Cunningham & Vyatkina, 2013). The environment in which a person communicates can also influence this communication style. If an individual is regularly in loud environments, as is often the case in employment, they may have to increase their volume, thereby increasing the degree of their vocal load. Finally, cognition has a role in the formation of an individual's communicative style. It is possible that a person's pragmatic skills and executive function (EF) skills can shape the efficiency of their communication style. If one's communication style results in more vocal interjections (hum's and ah's), elaborations on a given topic, increases in volume to portray emotion, or repetitions for emphasis, this increase in word usage, and therefore increase in vocalization, would influence overall vocal load which is a factor in the development of BVFLs (Hunter et al., 2020). The aim of this research study is to focus on communication style and how an individual's language skills contribute to the amount of spoken language, therefore impacting their vocal load. This study will investigate how language and executive functioning that influence pragmatic skills in individuals with and without BVFLs.

Literature Review

Voice is the product of vocal fold vibration, with which we use to communicate and express our emotions. Voice quality is what distinguishes one person's voice from another and is determined by the integrity of the vocal fold mucosa. When a person's voice is affected by a voice disorder, such as vocal nodules, it can negatively affect their means of communication by impacting their ability to use their voice to its full extent. Voice disorders are the most common of communication disorders, affecting 10% of the general population across the lifespan (Titze & Abbott, 2012), thus warranting further research as to how they are acquired.

The subset of voice disorders of interest in this study, referred to as benign vocal fold lesions, is a general term that denotes vibration-induced lesions, or injuries, that lie within the mucosa of the vocal folds (Colton et al., 2011). The vocal folds are made up of five layers including the thyroarytenoid muscle, deep lamina propria (LP), intermediate LP, superficial LP, and epithelium. The basement membrane zone (BMZ) secures the outer two layers, the epithelium and the superficial layer of LP. During phonatory trauma, the sheering and stressing that impact the mucosa (Titze, 1994, 2000), causes the BMZ connective tissue to break away from the superficial layer of the LP creating injury resulting in edema and thickness. This thickness is called vocal nodules. Although less is known about the state of the BMZ regarding polyps and cysts, there is some evidence of BMZ abnormalities. The development of BVFLs is a result of phonotrauma that is more than what the body can manage. Behaviors such as yelling or excessive talking can lead to the development of BVFLs. Therefore, the amount and manner of talking of an individual can be a contributing factor in the individual's likelihood of developing BVFLs.

Increased vocal load leads to BVFL

Phonotraumatic events, those which predispose individuals to various forms of repetitive strain injuries on the vocal folds, can take multiple forms in single events such as shouting at a soccer match or in extended voice use with few breaks, such as teaching all day. In recent years, phonotrauma has been quantified using accelerometry and measures such as vocal distance, or vocal miles (Titze, 2003, Svec, Titze, & Popolo, 2005). Individuals who engage in larger amounts of voice use, or vocal miles are thought to have greater vocal loads (Hunter et al. 2020) and an individual's vocal load can act as a major contributor to the development and progression of BVFLs. Vocal loads are known to be greater in certain professions, such as educators, clergy, and salespeople (Ohlsson, Andersson, Södersten, Simberg, & Barregård, 2012). Titze, Hunter, & Svec, (2007) followed teachers for two weeks, recording voice use using accelerometry and found that those with high levels of voice use often underestimated the amount that they vocalized. Interestingly, they suggested that professionals with heavy vocal loads may underestimate the amount of talking they do, which might predispose them to take fewer vocal breaks throughout the day. Without protective vocal-rest periods, excessive phonotrauma and BVFL may result.

The exact pathophysiology of BVFLs is beyond the scope of this study but a short discussion of their development is necessary to understand how BVFLs occur. Impairment in the vocal fold layers, particularly in the basement membrane zone is partially due to the number of myofilaments adhering the mucosal layer of the vocal folds to more underlying layers. The make-up of myofilaments is genetically determined, and if one or both parents of an individual had fewer myofilaments, that individual may also have fewer myofilaments and be prone to BVFLs, simply due to genetics (Gray et al., 1994). These genetic factors may be particularly important when considering those who need to talk during inopportune times such as during an upper respiratory illness. Those with weaker basement membranes might be more prone to injury during transient illness where they are required to talk, as is often the case with educators.

Additionally, females are more predisposed to BVFLs than males due to physical size of the larynx and extracellular differences in vocal fold (VF) mucosa (Colton et al., 2011). Although pre-pubescent male and female larynges are similar in size, a male larynx experiences rapid growth due to the influx of testosterone during puberty. A female larynx experiences significantly less growth such that it is approximately one-third smaller larynx than a male larynx after puberty. The growth of the thyroid cartilage of the larynx creates disproportionally longer vocal folds in males, resulting in two important factors: (1) The vocal folds vibrate at a lower frequency resulting in fewer incidences of vibratory impact or phonotrauma; (2) There is more surface area along the vocal folds to distribute the force created by collision during phonation (Hunter et al., 2011). Furthermore, studies show less hyaluronic acid in female versus male VF mucosa (Ward et al., 2002). Hyaluronic acid is a polysaccharide, found in the extracellular matrix of human cells and is especially abundant in areas that require high shock absorbency like the vocal folds. Because male VFs have a higher level of shock absorbency, they typically sustain less phonotrauma. However, genetics and physiological individual differences alone do not necessarily account for the development of BVFLs.

Voice and personality

Traditionally, the association between personality and voice disorders has been the principal theory as to the behavioral motivation for increased vocal load. In a series of investigations, Roy, Bless, & Heisey (2000a, 2000b) proposed a theory that certain personality profiles are susceptible to certain voice disorders. Using Eysenck's Personality Questionnaire and the

Multidimensional Personality Questionnaire, they identified three personality trait dimensions, referred to as "The Big Three": 1) Neuroticism/Negative Emotionality (N/NE), 2) Extraversion/Positive Emotionality (E/PE), and 3) Constraint versus Disinhibition (CON; Clark & Watson, 1999). Extraversion and neuroticism are key players in their Trait Theory of Voice Disorders, in that, they found that extroversion distinguished those with functional dysphonia and vocal nodules (Roy, Bless & Heisey, 2000a). E/PE describes the willingness to engage and confront an environment, including a social environment. Persons that display *high* E/PE (colloquially known as extraverts) tend to be dominant, sociable, and active, whereas *low* E/PE persons (colloquially known as introverts) are prone to be quiet, unsociable, passive, and careful. N/NE pertains to the extent to which a person perceives the world as threatening or distressing. Low N/NE scoring people tend to be calm and emotionally stable, while high N/NE individuals are inclined to feel high levels of negative emotion or are highly reactive to environmental stimuli.

Roy and Bless' (2000) Trait Theory of Voice Disorders (TTVD) include the terms *neurotic extraverts,* those that tend to overtly act out, and *neurotic introverts,* those that tend to feel negative emotions but are not socially potent or active. They link these dimensions to the disordered groups of interest (functional dysphonia and vocal nodules), where the neurotic introvert aligns with the pathogenesis of functional dysphonia, and the neurotic extrovert aligns with the pathogenesis in vocal nodules development.

The TTVD was tested in a controlled experiment where a group with functional dysphonia was compared with a group with social anxiety and a healthy control group (van Mersbergen, Patrick & Glaze, 2008). This study used positive, neutral, and aversive mental imagery scripts in a with-in subject paradigm using self-report, psychometric, and psychophysiological measures. The authors found that compared with the healthy controls those with FD demonstrated increased measures of NE/N and CON, increased measures of autonomic activation association with emotion, and reduced emotional expression. These results appear to support the TTVD demonstrating that in emotional conditions, individuals with FD regulate emotions by regulating behavioral responses to emotions and may be selectively suppressing negative affect, while allowing more normal modulation and variation of physiological activity and experienced mood for positive affect (van Mersbergen et al., 2008). However, the translation of introversion and reduced vocal function have yet to be linked and there may be many other contributors to this dysfunction.

Likewise, there has yet to be research further investigating the theory pertaining to vocal nodules. No experimental studies have directly linked the personality profiles of those with BVFL with behaviors that result in excessive voice use. Additionally, no studies have analyzed the type and form of vocal use beyond the quantification of vibratory forces (Assad, et al, 2019). Hence, there is less of a direct causal relationship between personality and voice-related behaviors in those with BVFL.

Stress and emotion

One avenue for determining a causal relationship between personality and voice use is to study the effects of personality on voice use. Because those with BVFL present with increased N/NE, they are more likely to be stress reactive. Although it is a normal human response to a challenge or demand, such as increased voice demand, stress can negatively affect a person's mood, body, and behavior leaving them susceptible to increased blood pressure (Holt-Lunstad & Clark, 2014) and impaired memory (Peavy et al., 2009). Chronic stress, or long-term stress, may cause anxiety, depression, fatigue, or excessive drug or alcohol use (McEwen, 2017).

Stress is also a contributor to the dysfunction of vocal use and is associated with the presence of personality-driven voice problems (Dietrich & Abbott, 2014; el Uali Abeida, et al., 2013). Dietrich & Abbott (2014) used systolic blood pressure, electromyography, and personality to measure the difference between high stress-induced extra-laryngeal activity and low stress-induced extra-laryngeal activity. They employed a modified Trier Social Stress Test (Kirschbaum et al., 1993) by adding rumination about a fictitious job interview to evoke autonomic responses. The results of their research showed strong evidence that low extroversion played an essential role in high extra-laryngeal activity during stress exposure. In a similar study, Helou and colleagues (2018) used the same protocol but measured intrinsic muscle activity and found that those with increased autonomic activation also presented with increased thyroarytenoid activation during their stressors. Both authors suggested that stress may influence vocal behaviors differently depending on the individual, where some individuals may respond to stress more laryngeally than others, calling them vocal responders to stress (Helou et al., 2018) reflecting a term previously coined in the literature *laryngoresponders* (Aronson, 2009, pp 121). A literature review by Giddens and colleagues (2013) concluded that an increase in fundamental frequency (f_o) was the most commonly identified effect of stress and suggested laryngeal muscle tensions, specifically the cricothyroid muscle, could be the primary reactor causing the increase in f_o. This increase in frequency would contribute to increased load and phonotrauma by increasing the number of times the vocal folds collide in any given second.

Despite this burgeoning area of voice research, the focus of stress and impaired voice use appear to support the development of functional dysphonia and not BVFL. However, the Classification Manual of Voice Disorders, (Verdolini & Branski, 2014) suggest that those with stress-related voice disorders fall within two categories of muscle tension dysphonia: those without lesions and those with lesions. This classification scheme was developed based on previous literature that has loosely linked stress to BFVLs. Their theoretical discrimination between those with primary muscled tension dysphonia and those with secondary muscle tension dysphonia has been largely, albeit informally, due to genetics, particularly of the basement membrane zone, and environment, mostly in employment demands.

Although there is solid evidence that increased voice use leads to BVFL. The main explanations on the development of BVFL have mainly focused on genetics, environment, personality, and stress leading to aberrant vocal behaviors that, in the context of increased voice use, develop into BVFLs. These contributions to the development of BVFL may be necessary but are insufficient to explain how an individual develops these lesions. Additionally, it only explains this development in a patient-seeking population. Itt is unknown is how many individuals with BVFL do not seek treatment and if those who do seek treatment do so for other, hidden communicative dysfunction. Furthermore, these explanations do not explain why some individuals with similar genetic, personality, and environmental demands do not get BVFLs. Given that the prevalence of voice disorders ranges from 3 – 9% of the population (Roy et al., 2004; Roy et al, 2005), it seems reasonable that there are far more extroverted individuals without voice disorders (not to mention BVFL) than those with voice disorders. Thus, personality cannot be the only contributor to BVFL.

This gap in knowledge suggests additional factors that may be prevalent in the population of those with BVFL. Research into increased vocal behaviors have solidly determined that impact stress is a main cause of these lesions. Much of this work employs accelerometry, which measures the vibration of the area immediately above the sternal notch and infers vocal fold vibration and extent of vibration from the frequency and intensity of the accelerometry signal

(Titze et al, 2003). This measure captures the raw vocal signal, filtering out resonatory and articulatory behaviors. Measuring purely vocal signals, and not other aspects of the speech signal, allow for better calculations of what is happening at the level of the larynx. However, the increase in the specificity of measuring laryngeal impact comes at the cost of losing the main point of most vocalizations: communication. Thus, we know how much voice use occurs, and in what environments it is used, but we do not have information on what is being communicated and why that communication is so prolific. For the purpose of this study *communicative productivity* will be defined as the amount of verbal communication generated by an individual. *Communicative productivity* would logically also influence the amount of voice use and cumulative *impact force* on the vocal folds. Investigating aspects of language use may reveal additional contributing factors that influence vocal load.

Pragmatics, Language Skills, and Executive Function

Pragmatics is one of the five language domains and involves transmitting information to others in socially appropriate and functional ways (Hoff, 2018). Pragmatics, along with phonology, morphology, semantics, and syntax, are the building blocks of language use and contribute to higher order language skills. Therefore, language use may affect communicative efficiency, such that ideas are transmitted quickly and accurately. With less sophisticated or unnecessarily augmented language, inefficient or ineffective communication may obligate a speaker to use more words to explain themselves, thus directly affecting their vocal load. Pragmatic skills include the ability of an individual to appropriately use language in context and include the ability to take conversational turns, contribute on-topic statements, terminate conversation, or recognize topic closing cues. Thus, without reasonable pragmatic skills, a speaker might keep talking.

Traditionally, moderately to severely impaired pragmatic skills have been studied in and have become a diagnostic criterion for identifying pathological conditions such as autism spectrum disorder (Posar & Visconti, 2022). However, less is known about pragmatic differences in generally healthy individuals or if these differences go undetected because they may be observed as "talkativeness" or "extroverted." Furthermore, pragmatic differences may be symptomatic of underlying deficits in expressive language, social motivation, and executive functioning, all of which might impact the degree to which someone vocalizes.

Given that pragmatics requires the ability to integrate language into specific environments and situations, other cognitive skills are required, such as attention to environmental cues, memory to recall past events and situations, and executive control to inhibit speech when appropriate. These cognitive functions, or executive functions, may contribute to a pragmatic deficit, contribute to language overuse, or both. To consider this, a definition of EF for the purposes of this study may be necessary.

According to Diamond (2013), executive functions (EF) are a set of mental processes that allow one to self-regulate in order to achieve goals and include the following three main categories: inhibition, working memory, and cognitive flexibility. These three categories enable the ability for cognitive function such as planning and organizing, and self-monitoring to occur (Diamond, 2013). Diamond describes inhibition as involving one's ability to control their attention, behavior, thoughts, and emotions to negate a strong internal urge or external temptation, and instead do what is appropriate or required in the moment. Inhibitory ability might allow an individual to control speaking, and thus vocalizing, in situations that are not optimal for communication. She further defines working memory as the ability to mentally hold information without any perceptual stimuli and use the information for cognitive manipulation such as critical for reasoning, considering alternatives, and making connections with old and new knowledge and new. A fragile working memory could result in increased voice use in the form of verbal rehearsal (verbalizing steps to a task aloud to oneself), filler words (using "um's," "uh's," or "like's" when speaking), and repetitions (repeating a word or phrase when one is trying to organize a thought). Finally, Diamond (2013) states that cognitive flexibility, builds upon working memory and inhibition, and involves the ability to change perspectives, think "outside the box," and task shift. Working memory and cognitive flexibility facilitate planning and organizing, relying on the ability to sequence and categorize. Poor organization during speech may cause someone to repeat one's self while trying to explain ideas. Lastly, she describes self-monitoring, or self-regulation, as a process that allows one to regulate one's emotion and motivation (Vinney, van Mersbergen, Connor, & Turkstra, 2015). For example, a person with poor self-monitoring or self-regulation may not be able to inhibit interjections during another person's speaking turn, especially when a thought comes to mind that they would like to talk about next. They may also be easily distracted by environmental changes or interruptions such as alarms, sirens, or other background noise. Thus, EF are a set of mental processes that allow one to self-regulate to achieve a goal. If communication were the goal, inhibition, working memory, and cognitive flexibility (executive functions) seem to be necessary within a social setting and may be of upmost importance to successfully communicate or interact with another person.

Pragmatic skills and EF are clearly related but two separate constructs. However, it is possible they may influence one another at times. One study by Bambini et al. (2021) used two pragmatic assessments (*Assessment of Pragmatics Abilities and Cognitive Substrates* test and the Implicatures task) to assess expressive and receptive pragmatic skills along with assessments to measure working memory, inhibition, cognitive flexibility, and theory of mind. They found that pragmatic skills of the participants were predicted by overall executive functions scores, suggesting that executive functions play a supportive role in pragmatics.

The focus of this study is to investigate differences in communication productivity in those with BVLF and compare them to those without BVFL. This study will employ both measures of pragmatic language and executive functioning given that it is likely that pragmatic deficits may be due to executive functioning deficit.

Purpose of the Study

Increased vocal load can contribute to the development of benign vocal fold lesions. However, the cause of increased vocal load is not yet clear (el Uali Abeida, et al., 2013). The purpose of this study is to examine language and executive functioning in individuals with BVFLs to investigate potential areas of study in future research examining increased voice use in this population. In this descriptive, exploratory analysis, we explored the possible role of language use in the development of BVFLs. Based on previous literature, we expected that individuals with BVFL will use more words to communicate with others than individuals without BVFLs. The exploratory nature of this research assessed aspects of language usage in the domains of pragmatics and executive function. We hypothesize that participants with BVFL with increased communicative productivity will present with evidence of poorer executive functioning compared to healthy controls. During direct questioning and conversation, we compared two types of data: anticipated data (increased talking) and explanatory data (structure of the language). Language sample analysis included 1.) word count per language sample 2.) number of words per speaking turn, 3.) percent of filler words, 4.) overlapping speech, 5.) interruptions, 6.) ratio of repair/revisions to total number of utterances, and 7.) backchannelling, based on past research that tracks increased talking in those with BVFLs (Titze, 2003, Svec, Titze, & Popolo, 2005). We chose aspects of language that might naturally increase the number of words such as amount of filler words ("uh," "um," etc.) during speech. Additionally, we chose aspects of pragmatic language such as overlapping speech and interruptions during conversation and aspects related to executive functioning such as repairs and revisions during s language samples.

Methods

Description and Design

This quasi-experimental, observational study is an exploratory and comparative descriptive analysis of language sampling from representative individuals with and without BVFL. This research project received Institutional Review Boards (IRB) approval prior to participant recruitment and data collection. There were no payment transactions between the research team and participants as participants volunteered for the study.

This study was conducted by a research team that included one lead graduate student researcher, one supervising professor employed by the University of Memphis (U of M), seven coders, and three confederates. The lead student researcher conducted participant intake, voice evaluation, administration of subtest 1 and subtest 2 of the Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES), collection of language samples, and analysis of language samples using SALT. The lead student researcher also transcribed and coded language samples.

Participant Selection

General Description

Participants in this study were separated into two groups: a BVFL group and healthy control (HC) group. Inclusion criteria for both groups included English speaking adults with ages ranging from 22 to 53 years old. There were three individuals in the BVFL group who presented with benign vocal fold lesions and three in the HC group who presented with typically functioning voices, absent of voice disorders, gender voice dysphoria, and any neurological or structural impairments to the vocal mechanism. Participants were recruited by flyers and advertisements posted on social media, distributed via emails, and word of mouth from the U of

M School of Communication Sciences and Disorders and the greater Memphis community. The recruitment descriptions highlighted participant characteristics such as age range and voice quality.

Inclusion and exclusion criteria were established through a formal voice evaluation that included aspects of the informal intake, an auditory perceptual assessment of vocal quality, and a visual assessment which included looking briefly at the vocal folds using a dental mirror to establish group membership (HC group or BVFL group). The voice evaluation elicited vocalization on vowels and sentences to assess maximum phonation time, s:z ratio, and perceived vocal effort at "normal" and "loud" volumes and visualization by having a small dental mirror placed behind their molars.

All participants were administered the Perceived Stress Scale-10 and Emotional Regulation Questionnaire (ERQ) and scored similarly to each other on all measures. One participant scored a 25 on the PSS while the other five participants scored an average of 16. See the Appendix B for tests results for each participant.

All six participants were biological females. The term "female" will be used to refer to the participant's biological sex and is not intended to refer to their gender. Females were employed in this research given the prevalence rate of BVFL is four times more likely with biological females than males (Roy et al., 2005).

Groups

Benign Vocal Fold Lesion Group. The BVFL group consisted of three individuals who will be referred to as BVFL 1, BVFL 2, and BVFL 3 throughout this paper. BVFL 1 was a 25-year-old Caucasian female who reported a consistently hoarse voice and received a diagnosis of vocal nodules immediately after participating in this study. BVFL 2 was a 53-year-old Caucasian female who reported experiencing a chronically hoarse voice for several years and is a mother of two high school aged children. BVFL 3 was a 30-year-old Caucasian female who did not report any current voice issues but reported a history of voice difficulty consistent with BVFL lesions. Upon visualization, she presented with an hourglass configuration during laryngeal examination. An hourglass configuration is a glottal closure pattern described as the typical pattern found in BVFL where a gap exists anteriorly and posteriorly from the point of contact along the vocal fold (Poburka & Patel, 2021)

Healthy Control Group. The HC group consisted of three individuals who will be referred to as HC 1, HC 2, and HC 3 throughout this paper. HC 1 was a 29-year-old Caucasian female, and HC 2 was a 27-year-old African-American female, and HC 3 was a 22-year-old Caucasian, non-binary assigned female at birth. After participation in this study, HC 3 reported receiving a diagnosis of autism spectrum disorder. All HC participants presented with normal vocal fold configuration during laryngeal examination.

Confederates and Coders

Confederates. Confederates were graduate students, ages 24-25 years, and were used to facilitate organic conversation. The participants were told that the confederates were participants in the study and to use prepared prompts to engage in conversation with one another. The confederates were pre-briefed prior to engagement with participants by the lead student researcher. They were provided with the conversational prompts in advance and were instructed to engage in conversation with the participant as naturally as possible. Confederates went through at least two trial runs with the lead researcher to familiarize themselves with the questions, what they might say to facilitate conversation, and how to respond to participant's speech. They were instructed to stay neutral in their opinions, ask facilitating questions such as "why do you think that?" and to let the person talk and keep it as natural as possible. . The role of the confederate was disclosed to each participant at the end of the experiment.

Coders. The team of coders included speech-language pathology graduate students, ages 24-33 years, at the University of Memphis who transcribed and coded all language samples. These students received formal SALT transcription and coding training as part of their course work as well as a training refresher from the lead student researcher. Additionally, a mandatory transcription and coding training was required for all coders for quality assurance. The training the coders received included explanation of and practice transcribing and separating utterances, using SALT transcription conventions, and using customized codes for repair/revision and backchanneling. These customized codes were added to differentiate between the types of filler words and their function within the utterance. The coders practiced transcribing and coding sample transcripts prior to transcribing and coding samples used for this study. The coders were blinded to which group the participants were assigned to during the transcribing and coding process.

Observational Environment

Set Up

Room. Participants, confederates, and experimenter 1 were seated in a quiet room with minimal distractions. The participant sat next to the experimenter and the confederate across from both participant and experimenter. A microphone was placed in front of the participant and an additional microphone in front of the confederate. Next to the experimenter was a cart that contained the materials necessary for the voice evaluation. Additionally, the computer employed during the gathering of self-report data was next to the experimenter on an adjacent counter.

Instrumentation and Software. All conversational and narrative language samples were recorded using a portable recorder (Zoom H6, Tokoyo) recording at 48 kHz and 24-bit depth. Audio signals were captured using Behringer C-2 Matched Studio Condenser Microphones (Willich, Germany) placed on the tabletop in front of the participant and confederate. Visualization of the vocal folds for the voice evaluation employed a laryngeal mirror (24 mm) and a headlamp (Energizer LED Pro360) as a light source. The intake form and all self-reports were administered through Qualtrics XM.

Systematic Analysis of Language Transcripts (SALT) software was used to analyze and extract a Standard Measures Report from participants' conversational and narrative language samples. The Standard Measures Report included pragmatic data (i.e., fillers, overlapping phrases, interruptions) and semantic data (i.e., total number of words). A post-hoc analysis was completed by extracting a Grammatical Categories Analysis from participants' conversational language samples to help interpret results. SALT is a language sample analysis software that reviews and systematically evaluates an individual's language output describing an individual's language abilities and uses. SALT provided a numerical breakdown of grammatical and linguistic components, such as total number of words produced by each speaker, number of words per speaking turn, percentage of filler words, percentage of overlapping utterances, percentage of interruptions, and revisions and repairs compared to total number of utterances.

Stimuli

Topics were elicited for the language samples from each participant using prompts designed by the researcher. All stimuli were presented to all participants to enable comparisons between participants. All participants engaged in the same prompts that fell into two categories: conversational and narrative prompts. All prompts were provided in a randomized order for each participant.

Conversational Prompts. A conversational language sample was elicited using a series of open-ended conversational prompts designed by the researchers to facilitate conversation between the participant and the confederate. Prompts served as a starting point for the conversation and confederates did not steer the conversation back to the prompt topic if it veered from the original topic. See Appendix A for all conversational prompts.

Narrative Prompts. A narrative language sample was elicited using a series of direct questions designed by the researchers to elicit a narrative-style response from the participant. These questions included the statements like "Tell me about your morning routine," "Tell me how you would draw this animal" (a picture of an animal was given), and "Tell me how you would change a tire," etc. See Appendix A for all narrative prompts.

Measures

Self-report

The following self-report measures were administered throughout the experiment. The order of each questionnaire was counterbalanced to avoid any effect that language sampling might have had on any given measure. There was no specific hypothesis for these measures, rather they were used to describe participant personality, stress, emotion regulation, and cognitive abilities, given that past literature investigating those with BVFL employed these measures, or measures commensurate with these, these measures provided descriptive data on participants allowing for comparison with other studies.

Multidimensional Personality Questionnaire-brief from (MPQ). The MPQ (Patrick, Curtin, & Tellegen, 2003), a 155-item self-report measure with a structure of a choice between two statements, assessed the temperamental traits of Positive Emotionality/Extroversion, Negative Emotionality/Neuroticism, and Behavioral Constraint/Psychoticism. These three temperamental factors, related to Eysenck's three factors, have been linked to genetic factors and behavioral tendencies (Eysenck & Eysenck, 1975). Additionally, Roy and colleagues (2000b) have found a relation between personality and certain voice disorders using the MPQ (Roy, Bless, & Heisey, 2000b). The MPQ has thirteen subfactors that have been used to assess personality of those with vocal fold nodules (Roy, Bless, & Heisey, 20000b). This measure served as a comparison measure to other studies of personality and voice. Given the small number of participants, we did not expect group differences.

Behavioral Inhibition System/Behavioral Activation System (BIS/BAS). The BIS/BAS (*Carver & White, 1994*), based on Gray's theory of behavioral inhibition and behavioral activation, is a 20-item self-rated four-point scale, with anchors from "strongly agree" to "strongly disagree". The scale further breaks down the BAS scale into three subfactors with distinct aspects of appetitive drive, Reward Responsiveness, Drive and Fun Seeking. This theory is the foundational theory that the Trait Theory of Voice Disorders bases the assumptions that temperament leads to behaviors that predispose one to voice disorders. This measure assessed an individual's tendency for behavioral inhibition and activation and may provide interpretation for study findings. If those with BVFL lesions use more words during conversation and narrative speech, and the score more highly in behavioral activation, findings would be commensurate with the Trait Theory of Voice Disorders and may be less to do with language usage.

Perceived Stress Scale-10 (PSS). The PSS (Cohen & Williamson, 1988) is a 10-item questionnaire using a five-point scale, with anchors from "never" to "very often", that was designed to assess stressful life events and circumstances that are prone to triggering or aggravating disease symptoms. Because research has shown that life stresses can lead to certain voice disorders (House and Andrews, 1987; 1988), this scale was used to assess the degree of stress of participants and assessed the level of stress participants experience.

Emotional Regulation Questionnaire (ERQ). The ERQ (Gross & John, 2003) is a 10-item questionnaire employing a seven-point scale, with anchors from "strongly agree" to "strongly disagree", that was intended to measure an individual's tendency to regulate their emotions in two ways: cognitive reappraisal and expressive suppression. This measure was used to describe group differences in the way they manage emotional experiences. Past research confirmed that emotional regulation may be a factor in voice disorders with a behavioral genesis (van Mersbergen, Patrick, Glaze, 2008).

Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES). The FAVRES (MacDonald & Johnson, 2005), a standardized assessment created to assess executive function in adults with acquired brain injury, assesses functional skills that require planning, organization, cognitive flexibility, attention, problem-solving, self-monitoring, and decision making across four subtests. Although no history of brain injury is suspected in our population of interest, the subscales in this inventory that assessed high-level cognitive functioning served as a measure that might direct data interpretation. If individuals with BFVL present with challenges in executive functioning, then inferences drawn from the language sampling analysis may include aspects of executive functioning performance. Only subtest 1 and subtest 2 were used for the purpose of this study to avoid potential fatigue effects due to the length of the assessment, therefore the results of this assessment are not comprehensive. Subtest 1 and subtest 2 measured complex problem solving, planning, thought organization, decision making, and verbal reasoning as it relates to simulated real world tasks. Subtest 1 included planning an event given information about hypothetical time constraints, scheduling conflicts, and persons attending the event. Subtest 2 included scheduling a workday according to hypothetical tasks, scheduling constraints, and professional dispute.

Language Sampling Analysis

Language Sampling Data. The data extracted from the language sample analysis included the number of words used per language sample, number of words per speaking turn during conversation, percentage of filler words per language sample, percentage of overlapping phrases per language segment, percentage of interruptions per language sample, and ratio of repairs and revisions to total number of utterances. The language samples for each participant include a conversational sample and a narrative sample.

Number of words during a language sample. The total number of words used during each sample was tallied to determine the amount of language usage for each language sampling condition. Only words included in the main body of the utterance were included in this measure. Filler words and other mazes, such as repeated words for emphasis, were not included. If those with BVFL present with increased vocal load as observed in past literature (Assad et al., 2017) then we would expect that they would present with a greater number of words per language sample.

Number of words per speaking turn during conversation. The number of words per used by each participant used determined the amount of vocal load for each sample. The number of words an individual used to answer questions and produce narratives would provide a quantitative measure of language productivity as defined above. This measure provided information on the degree to which participants allowed conversation partners speaking time and may reflect aspects of communication dominance or inability to close topics if participants spend more speech time during conversations than their confederate partners.

Percentage of filler words. The percentage of filler words indicated the percentage of the words produced were words that did not add meaning or context to the utterances, but increased vocal load. Filler words, such as "uh" or "um" are typically used to give the speaker time to think, express uncertainty, or fill silence. The percentage of filler words provided data about whether filler words are contributors to increased vocalization apart from total number of words (Clark & Fox Tree, 2002). The words "um" and "uh," along with the interjections, such as "like," "ya know," and "so," were coded as fillers for each language sample.

Percentage of overlapping phrases. The percentage of overlapping phrases present in each language sample provided information on the degree to which participants allowed conversation partners to finish their speaking turn before starting their own. Overlapping phrases were identified as words spoken by both the participant and the confederate at the same time and were marked according to SALT transcription conventions. This measure provided behavioral information about participants' pragmatic skills related to conversational turn taking and EF skills related to inhibition. Speaking while the conversation partner is still talking is indicative of difficulties with either identifying cues indicating the end of an utterance or turn, or the ability to refrain from interjecting during the other speaker's turn.

Percentage of interruptions. The percentage of interruptions refers to the number of utterances the participants interrupted their conversational partner's speaking turn. This measure has similar indications of overlapping phrases in that it provided behavioral information about how often the participants' failed to allow their speaking partner time to finish their thought and took over the speaking turn or the partner discontinued their speaking turn in response to the interruption from their conversational partner. Interruptions were differentiated from overlapping phrases as a speaker started speaking, the conversation partner stopped speaking. This measure provided behavioral information about pragmatic skills related to turn taking and executive function related to inhibition. Like overlapping phrases, interruptions are indicative of difficulties with either identifying cues indicating the end of an utterance or the ability to refrain from interjecting during the other speaker's turn.

Ratio of repairs and revisions to total number of utterances. The repair/revision to total-number-of-utterances ratio in each language sample provided information about the number of repairs or revisions participants made compared to the number of utterances they produced in each language sample. Repairs and revisions were identified as moments when the speaker backtracked their statement to fix a disorganized utterance, used an unintended word/phrase, used unintended grammar, or corrected a misunderstanding expressed by their conversational partner. This ratio provided data about participants' language organization and executive functioning skills related to attention and inhibition. The degree of the ratio is indicative of thought organization, which requires the abilities to attend to the topic, formulate an on-topic thought, then verbalize that thought in an organized fashion. Decreased attention at any given time could impact topic maintenance and organized verbal output, thus increasing the need for speaker repairs and revisions. Decreased inhibition could also impact topic maintenance and organized verbalization of thoughts by increasing the likelihood of interference caused by new ideas or environmental factors, thus increasing the need for speaker repairs and revisions.

Backchannelling. Backchannelling is feedback from the listening conversational partner to show interest, attention, and understanding. Backchannelling can be observed as verbal ("mm," "mhm," "yeah," etc.) or non-verbal (facial expressions, head nodding, other gestures, etc.). Backchannelling utterances were marked like filler words and were not included in the total word count. These forms of feedback were coded with a customized code to distinguish their function and intent relative to the conversation. For the purpose of this study only verbal backchannelling was coded and reported. Given individuals with BVFL likely developed the VF pathology use backchanneling, increasing vocal load (Hunter et al. 2020). We expect increased back channeling to occur in conversation.

Procedures

After consent was given, each participant was given a tablet to complete the intake form then underwent a voice evaluation and completed subtest 1 and subtest 2 of the FAVRES. Following the completion of the FAVRES, the participants began completing the following in a randomized, alternating order: conversation with confederate, narrative tasks, and self-reports. The conversation and narrative tasks were audio and video recorded, and the audio recordings were transcribed and coded by the team of trained coders. The coders initially used Google voice typing to collect most words in the recordings then transcribed the remaining words not detected by Google voice typing software. The orthographic transcripts were checked by the lead researcher for accuracy. The coders separated utterances into independent clauses for each participant, confederate speaker in conversational samples, and researcher speaker in narrative samples. Lastly, the coders used SALT conventions to identify filler words, abandoned utterances, interrupted utterances, overlapping utterances, linked words, and unintelligible samples. Repair/revisions and backchannelling were coded using customized codes. Repair/revisions were coded with [RR] and backchannelling was coded with [BC]. The lead researcher checked all the transcripts and edited them if a code was deemed to be an error or a code was missing.

Analysis

Individual data and descriptive statistics (i.e., group means) were obtained, given the low numbers of participants and no other statistical tests were performed.

Results

Multidimensional Personality Questionnaire

Results of the MPQ revealed one notable pattern for overall temperament between the two groups. Those with BVFL presented with higher levels of Behavioral Constraint compared to HCs. When comparing the subfactors of Behavioral Constraint, it appears that HCs all scored lower on the temperament of Traditionalism, which appeared to drive this difference. One anomaly in the data occurred with BVFL 2, where her MPQ unlikely virtues subtest, a subtest that estimates the validity of the test, was outside an acceptable range. Because of this, no real conclusion can be made about her particular MPQ scores.

Observing differences in the individual subfactors, there are a few interesting trends. Those with BVFL presented with consistently high levels of Social Closeness, all scoring at or above the average norm for this sub-factor. Additionally, one of the participants with BVFL demonstrated extremely low scores in Stress Reactivity, a sub-factor that loads onto the trait Negative Emotionality/Neuroticism. There were no notable differences in the sub-factor Absorption across diagnostic groups.

Refer to table 1 for descriptive statistics for the super factors and tables 2, 3, and 4, for descriptive statistics for the subfactors of Positive Emotionality, Negative Emotionality, and Behavioral Constraint, respectively. Table 5 shows descriptive statistics for one separate subfactor, Absorption. Figures 1, 2, 3, 4, and 5 graphically display results of the three superfactors of the MPQ, subscales for the PEM scale, the NEM scale, the CON scale, and the sub-factor Absorption, respectively.

Table 1
Descriptive statistics for the Multidimensional Personality Questionnaire's three superfactors for each participant.

Multidimensional Personality Questionnaire	*Participant*	*Score*	*Group Mean*
Positive Emotionality	*BVFL1*	94	72
	BVFL2	41	
	BVFL3	81	
	HC1	79	64
	HC2	38	
	HC3	74	
Negative Emotionality	*BVFL1*	22	35
	BVFL2	53	
	BVFL3	29	
	HC1	37	42
	HC2	32	
	HC3	58	
*Behavioral Constraint**	*BVFL1*	108	93
	BVFL2	100	
	BVFL3	71	
	HC1	83	82
	HC2	85	
	HC3	79	

*Comparisons worth noting. Light font denotes an invalid score or an atypical participant.

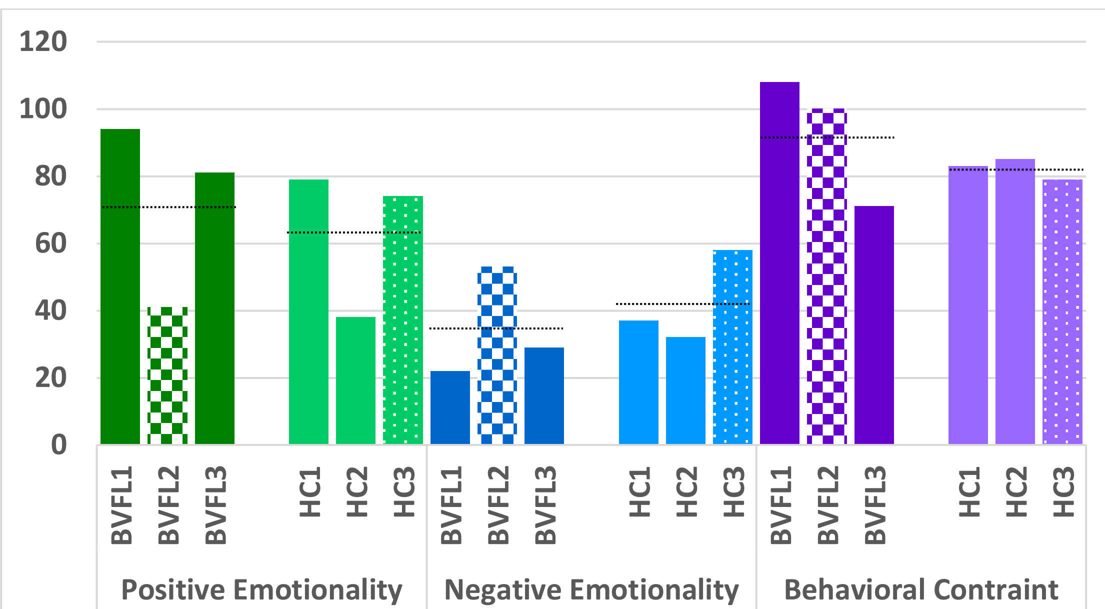

Figure 1. Super factors of the Multidimensional Personality Questionnaire for each participant. Dark shaded bars denote those with BVFLs, and light shaded bars denote HCs. Checkerboard bar denotes an invalid MPQ score. Doted bars denote an atypical healthy control. Doted lines represent group means.

Table 2
Descriptive statistics for Positive Emotionality Subscales of the MPQ for each participant.

Positive Emotionality Subscales	*Participant*	*Score*	*Group Mean*
Wellbeing	*BVFL1*	12	7.7
	BVFL2	2	
	BVFL3	9	
	HC1	6	4.7
	HC2	2	
	HC3	6	
Social Potency	*BVFL1*	9	5.3
	BVFL2	0	
	BVFL3	7	
	HC1	12	7.7
	HC2	1	
	HC3	10	
Achievement	*BVFL1*	10	6.7
	BVFL2	1	
	BVFL3	9	
	HC1	12	9.3
	HC2	5	
	HC3	11	
*Social Closeness**	*BVFL1*	12	10.7
	BVFL2	9	
	BVFL3	11	
	HC1	6	5
	HC2	4	
	HC3	5	

*Comparisons worth noting. Light font denotes an invalid score or an atypical participant.

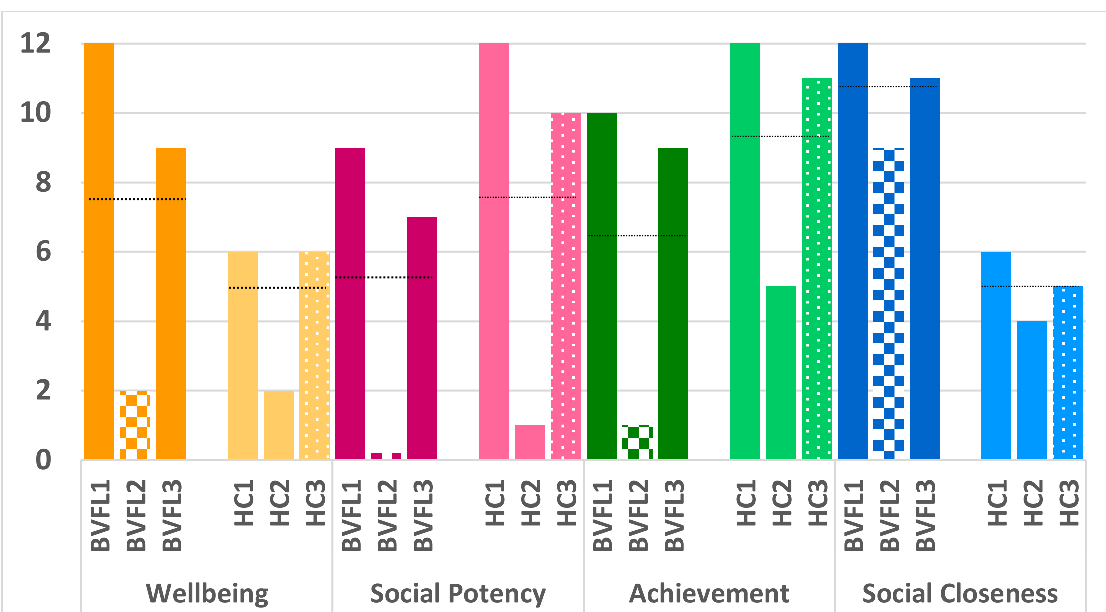

Figure 2. Subscales for Positive Emotionality on the Multidimensional Personality Questionnaire for each participant. Dark shaded bars denote those with BVFLs, and light shaded bars denote healthy

controls. Checkerboard bar denotes an invalid MPQ score. Doted bars denote an atypical healthy control. Doted lines represent group means.

Table 3
Descriptive statistics for Negative Emotionality Subscales of the MPQ for each participant.

Negative Emotionality Subscales	*Participant*	*Score*	*Group Mean*
*Stress Reactivity**	*BVFL1*	0	
	BVFL2	12	5.7
	BVFL3	5	
	HC1	11	
	HC2	7	9.3
	HC3	10	
Alienation	*BVFL1*	1	
	BVFL2	6	2.7
	BVFL3	1	
	HC1	1	
	HC2	2	3.7
	HC3	8	
Aggression	*BVFL1*	1	
	BVFL2	0	.7
	BVFL3	1	
	HC1	0	
	HC2	1	.7
	HC3	1	

*Comparisons worth noting. Light font denotes an invalid score or an atypical participant.

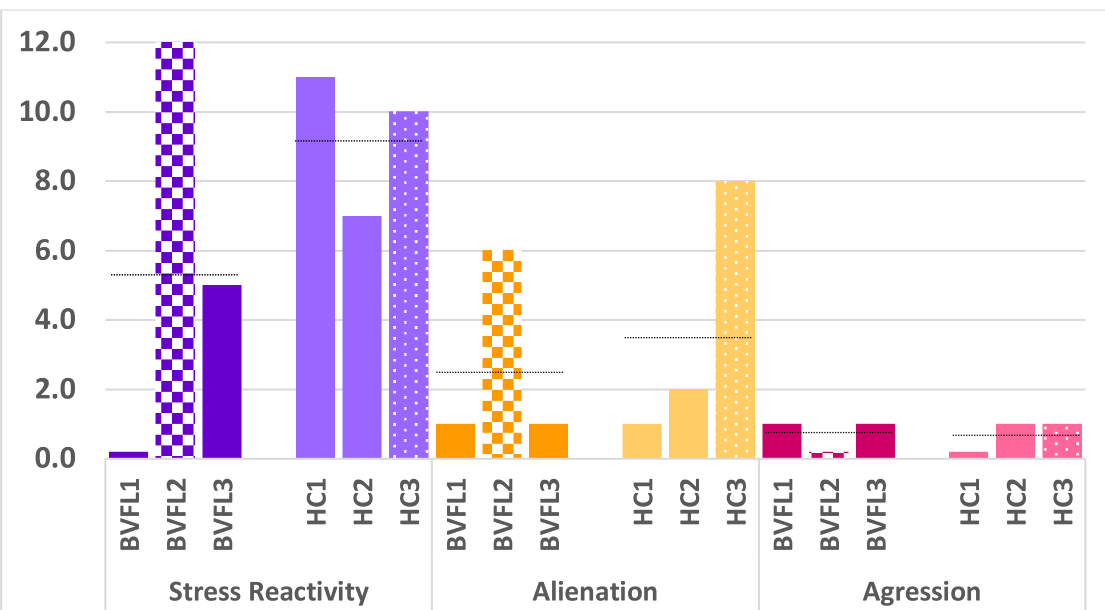

Figure 3. Subscales for Negative Emotionality on the Multidimensional Personality Questionnaire for each participant. Dark shaded bars denote those with BVFLs, and light shaded bars denote healthy controls. Checkerboard bar denotes an invalid MPQ score. Doted bars denote an atypical healthy control. Doted lines represent group means.

Table 4
Descriptive statistics for Behavioral Constraint Subscales of the MPQ for each participant.

Behavioral Constraint Subscales	*Participant*	Score	Group Mean
Control	*BVFL1*	11	
	BVFL2	12	10.3
	BVFL3	8	
	HC1	11	
	HC2	12	11.3
	HC3	11	
Harm Avoidance	*BVFL1*	12	
	BVFL2	11	11.3
	BVFL3	11	
	HC1	12	
	HC2	11	10
	HC3	7	
*Traditionalism**	*BVFL1*	12	
	BVFL2	9	7
	BVFL3	0	
	HC1	0	
	HC2	1	2
	HC3	5	

*Comparisons worth noting. Light font denotes an invalid score or an atypical participant.

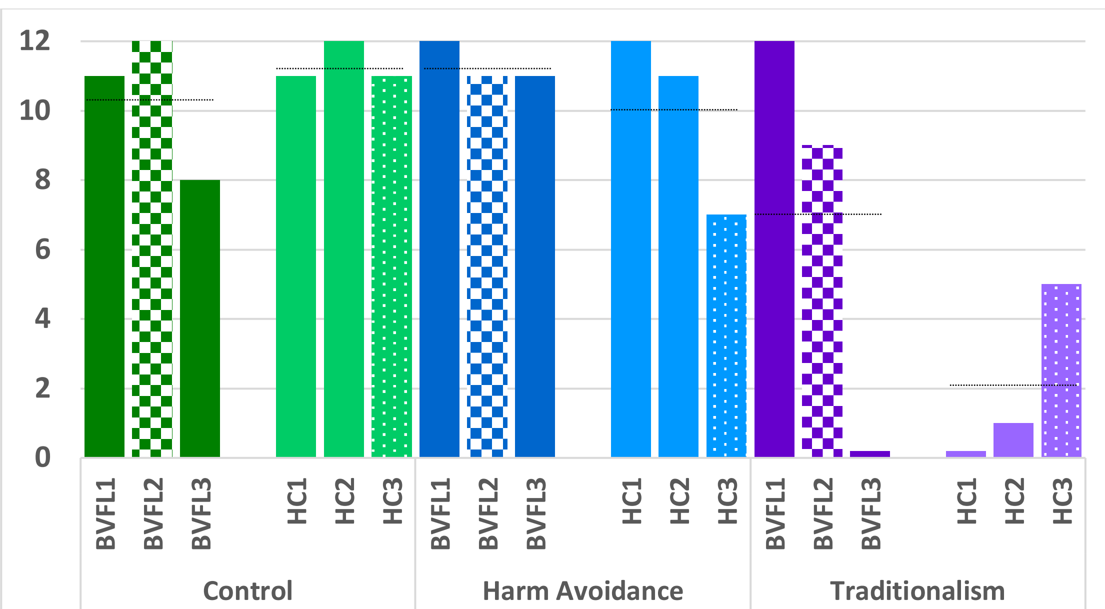

Figure 4. Subscales for Behavioral Constraint on the Multidimensional Personality Questionnaire for each participant. Dark shaded bars denote those with BVFLs, and light shaded bars denote healthy controls. Checkerboard bar denotes an invalid MPQ score. Doted bars denote an atypical healthy control. Doted lines represent group means.

Table 5
Descriptive statistics for the Absorption subscale for each participant.

Independent Subscale	*Participant*	*Score*	*Group Mean*
Absorption	*BVFL1*	11	8.3
	BVFL2	9	
	BVFL3	5	
	HC1	11	7.7
	HC2	2	
	HC3	10	

Light font denotes an invalid score or an atypical participant.

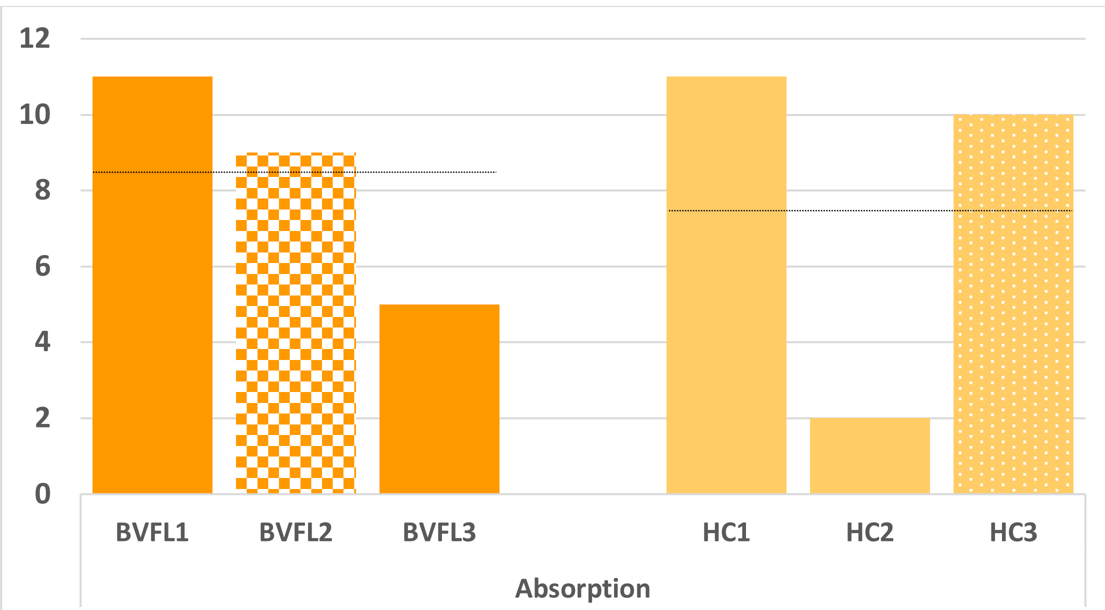

Figure 5. The **s**ubscales Absorption on the Multidimensional Personality Questionnaire for each participant. Dark shaded bars denote those with BVFLs, and light shaded bars denote healthy controls. Checkerboard bar denotes an invalid MPQ score. Doted bars denote an atypical healthy control. Doted lines represent group means.

Behavioral Inhibition System/Behavioral Activation System (BIS/BAS)

There was one difference noted between groups on the BIS subscale where the BVFL group mean was 15.3 and HC group mean was 9.7. There were no appreciable differences between the BAS subscale of Reward Responsiveness, Drive, or Fun Seeking. Table 6 lists the descriptive statistics for individuals and groups on the BIS/BAS Scale and Figure 6 graphically presents this data. Table 7 lists the descriptive statistics for individuals and groups on the three subscales of the BAS factor and Figure 7 graphically presents this data.

Table 6
Descriptive statistics for Behavioral Inhibition System/Behavioral Activation Scale for each participant.

Behavioral Inhibition System/Behavioral Activation Scale	*Participant*	*Score*	*Group Mean*
BIS	*BVFL1*	16	15.3
	BVFL2	14	
	BVFL3	16	
	HC1	7	9.7
	HC2	14	
	HC3	8	
BAS	*BVFL1*	27	29.3
	BVFL2	32	
	BVFL3	29	
	HC1	29	27.7
	HC2	31	
	HC3	23	

Light font denotes an invalid score or an atypical participant.

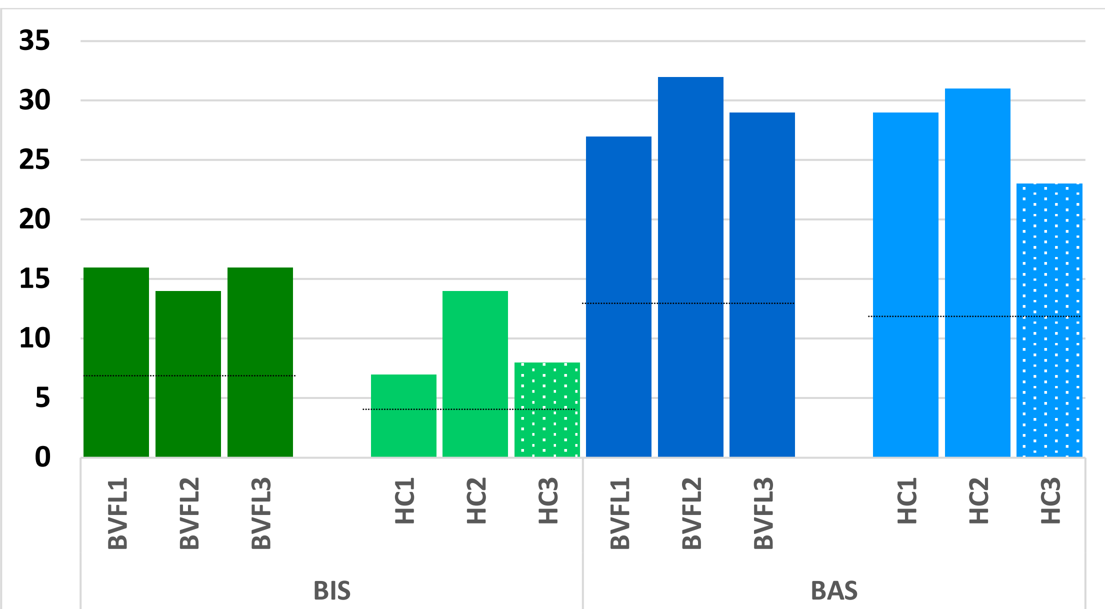

Figure 6. Behavioral Inhibition System/Behavioral Activation Scale scores for each participant. Dark shaded bars denote those with BVFLs, and light shaded bars denote healthy controls. Doted bars denote an atypical healthy control. Doted lines represent group means.

Table 7
Descriptive statistics for Behavioral Activation Scale Subscales for each participant.

Behavioral Activation Scale Subscales	*Participant*	*Score*	*Group Mean*
Reward Responsiveness	*BVFL1*	8	9
	BVFL2	8	
	BVFL3	11	
	HC1	9	8.7
	HC2	10	
	HC3	7	
Drive	*BVFL1*	9	10
	BVFL2	12	
	BVFL3	9	
	HC1	8	9
	HC2	11	
	HC3	8	
Fun Seeking	*BVFL1*	10	10.3
	BVFL2	12	
	BVFL3	9	
	HC1	12	10
	HC2	10	
	HC3	8	

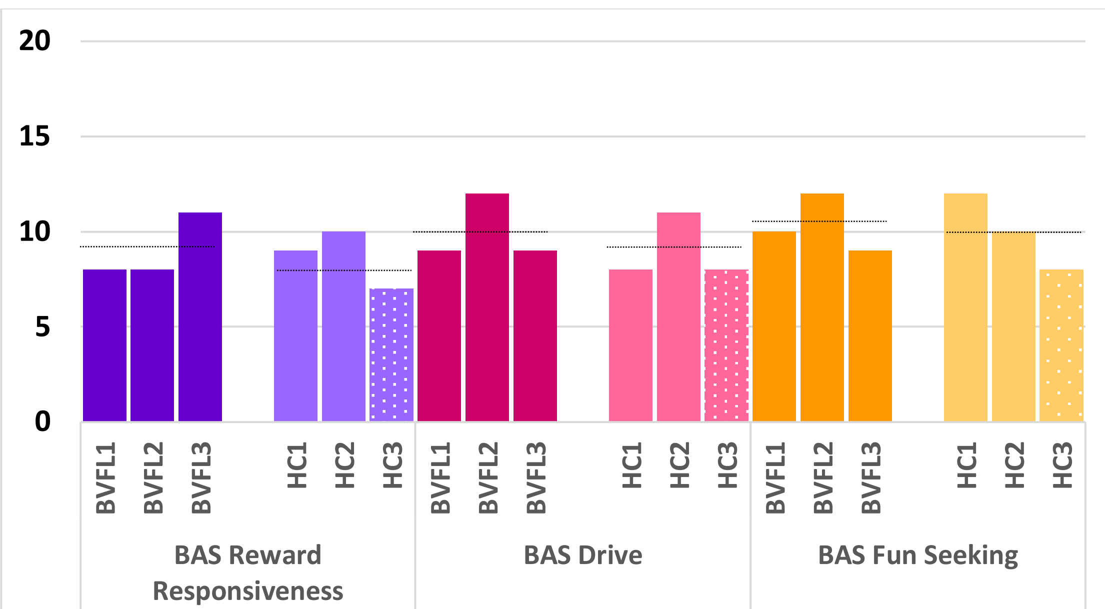

Figure 7. Behavioral Activation System subscale scores for each participant. Dark shaded bars denote those with BVFLs, and light shaded bars denote healthy controls. Doted bars denote an atypical healthy control. Doted lines represent group means.

Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES)

There were some group differences observed in the Accuracy score of the FAVRES, where those with BVFLs presented with lower means and percentile ranks for both tasks. Although one HC achieved a low percentile rank for Accuracy for the second task, overall, those with BFVL presented with a mean percentile of 69.7 compared to the HC group's mean percentile of 97. Both groups scored more poorly on the Rationale portion of the FAVRES on Task 2. Refer to Table 10 for data on the two tasks of the FAVRES.

Table 8

Descriptive Statistics for Accuracy, Rationale, Time, and Total Reasoning on the first two tasks of the FAVRES each participant.

FAVRES score		*FAVRES Task 1*				*FAVRES Task 2*			
	Participant	*Standard Score*	*Group Mean*	*Percentile*	*Group Mean*	*Standard Score*	*Group Mean*	*Percentile*	*Group Mean*
*Accuracy**	BVFL1	70		18		79		17	
	BVFL2+	70	82.7	18	45.3	51	69.7	3	12.3
	BVFL3	108		100		79		17	
	HC1	108		100		106		100	
	HC2	108	108.0	100	100	79	97.0	17	72.3
	HC3	108		100		106		100	
Rationale	BVFL1	106		100		88		21	
	BVFL2+	106	106.0	100	100.0	109	95.0	100	47.3
	BVFL3	106		100		88		21	
	HC1	106		100		99		33	
	HC2	106	106.0	100	100.0	99	102.3	33	55.3
	HC3	106		100		109		100	
Time	BVFL1	114		92		119		94	
	BVFL2+	120	116.0	100	94.7	111	98.0	77	85.5
	BVFL3	114		92		64		<1	
	HC1	120		100		116		89	
	HC2	102	110.0	56	78.0	108	114.3	71	84.7
	HC3	108		78		119		94	
Total Reasoning Subskills	BVFL1	21				19			
	BVFL2+	16	20			18	19		
	BVFL3	23				20			
	HC1	16				19			
	HC2	27	22.3			20	20.3		
	HC3	24				22			

*Comparisons worth noting. Lightly colored font denotes the participant with a diagnosis of ASD.
+Denotes the participant's age is above 50 years.

Language Sample Analysis

Conversation

One notable and obvious finding in the language sample analysis for the conversational portion included that large discrepancy in number of total words between the BVFL and HC groups. Those with BVFL used appreciably more words per utterance. Otherwise, there were no differences between the group on any other language sample category presented. See table 11 for a breakdown of values per category for each participant during conversation.

Table 9

Values for the Language Sample Analysis for Conversation.

	BVFL 1	BVFL 2	BVFL 3	*Mean*	HC 1	HC 2	HC 3	*Mean*
Total Number Words*	1584	1590	1123	1432.33	442	897	1541	960.00
Number Different Words	441	447	376	421.33	203	322	503	342.67
Type Token Ratio	0.62	0.67	0.69	0.66	0.64	0.65	0.68	0.66
Mean Words per Speaking Turn	15.96	28.05	23.06	22.36	23.75	14.35	40.31	26.14
Filler Words as % of Total Words	5.70%	6.70%	4.20%	0.06	4.20%	5.10%	6.10%	5.13%
Overlapping Speech Percentage	11%	4.60%	1.40%	0.06	0%	12.30%	0%	4.10%
Interruption Percentage	0.70%	0%	0%	0.00	0%	3.70%	0%	1.23%
Repair/Revision	19	10	9	12.67	3	11	31	15.00
Total Utterances	299	219	147	221.67	51	163	151	121.67
Ratio of Repair/Revision to Total	0.064	0.046	0.061	0.057	0.059	0.067	0.205	0.110
Backchanneling	16	0	10	8.67	0	22	2	8.00

*Comparisons worth noting. Lightly colored font denotes the participant with a diagnosis of ASD.

Narrative

There were no notable findings for the narrative sample analysis. See table 12 for a breakdown of values per category for each participant during the narrative task.

Table 10

Values for the Language Sample Analysis for Narrative.

	BVFL1	BVFL 2	BVFL3	*Mean*	HC 1	HC 2	HC 3	*Mean*
Total Number Words	318	506	465	429.67	489	257	673	473.00
Number Different Words	133	181	185	166.33	204	129	261	198.00
Mean Words per Speaking Turn	53	72.57	77.5	67.69	70.57	36.88	85.38	64.28
Filler Words as % of Total Words	2.50%	2.30%	1.70%	0.02	2.90%	2.60%	5.80%	3.77%
Overlapping Speech Percentage	2%	0.00%	0.00%	0.01	0%	0.00%	1.20%	0.40%
Interruption Percentage	0.00%	0%	0%	0.00	0%	0.00%	0%	0.00%
Repair/Revision	1	1	2	1.33	1	3	7	3.67
Total Utterances	41	57	44	47.33	52	46	80	59.33
Ratio of Repair/Revision to Total	0.024	0.018	0.045	0.029	0.019	0.065	0.088	0.057
Backchanneling	0	0	0	0.00	0	0	0	0.00

Lightly colored font denotes the participant with a diagnosis of ASD.

Post Hoc Grammatical Analysis

Grammatical Categories Analysis. After an initial passthrough of the initial language sample analysis, a grammatical categories analysis was completed to determine what types of words contributed to the increased total number of words in each participant's conversational sample. A report was generated using SALT that organized participants' words produced into parts of speech, or grammatical categories. This report included the following grammatical categories: initiators, determiners, adjectives, nouns, personal pronouns, auxiliary modals, auxiliary operators, verbs, copula forms, verb particles, adverbs, intensifiers, prepositions, existential, question words, coordinators, subordinators, infinitives, possessives, negation words, lets words, interjections, and "other."

To further explain the differences in language production between BVFL and HC groups, an additional descriptive analysis of grammatical categories was performed. We chose the four highest employed categories for each participant to report any differences between grammatical categories each participant used most. For the BVFL groups all presented with the same top four categories: Determiners, Nouns, Personal Pronouns, and Verbs. The HC group presented with a slightly different grouping of their top four employed grammatical categories. HC 3 presented identically to the BVFL group, but HC 1 and HC 2 presented with more Adverbs and less

Determiners than participants in the BVFL group. See table 13 for a breakdown of the grammatical categories used in the conversational language sample. See table 14 for percentage of each grammatical category compared to total number of words used in the conversational sample. Given the large discrepancy between the BVFL group and the HC group with respect to number of words spoken, for each participant the category was divided by that the participant's number of words to

normalize results. No differences in pattern were noted.

Table 11
Values for the Grammatical Breakdown of Conversation samples.

	BVFL 1	BVFL 2	BVFL 3	HC 1	HC 2	HC 3
Initiators	1	2	0	0	1	3
Determiners	122	155	116	39	65	148
Adjectives	93	87	63	19	38	90
Nouns	295	321	226	96	175	342
Personal Pronouns	269	179	127	62	111	166
Other Pronouns	57	53	38	6	36	38
Auxiliary Modals	22	23	14	7	9	11
Auxiliary Operators	57	35	23	11	30	25
Verbs	280	275	158	75	159	238
Copula Forms	48	51	40	14	26	45
Verb Particles	20	10	14	5	10	23
Adverbs	106	88	74	44	68	110
Intensifiers	21	19	12	9	12	24
Prepositions	103	108	81	34	65	119
Existential	0	1	3	0	3	1
Question Words	9	13	1	2	16	6
Coordinators	98	91	74	25	44	70
Subordinators	51	56	33	14	42	65
Infinitives	27	37	18	9	21	30
Possessives	0	0	0	0	0	0
Negation Words	50	31	13	11	32	26
Lets Words	0	5	0	0	0	0
Interjections	35	37	34	1	35	7

*Comparisons worth noting. Green shaded areas represent the four top categories from the BVFL group, blue shaded areas for the HC group, and the yellow shaded area for the participant with a diagnosis of ASD.

Table 12

Normalized Values for the Grammatical Breakdown of Conversation Samples in Percent.

	BVFL 1	BVFL 2	BVFL 3	HC 1	HC 2	HC 3
Initiators	0.063	0.126	0.000	0.000	0.111	0.195
Determiners	7.702	9.748	10.329	8.824	7.246	9.604
Adjectives	5.871	5.472	5.610	4.299	4.236	5.840
Nouns	18.624	20.189	20.125	21.719	19.509	22.193
Personal Pronouns	16.982	11.258	11.309	14.027	12.375	10.772
Other Pronouns	3.598	3.333	3.384	1.357	4.013	2.466
Auxiliary Modals	1.389	1.447	1.247	1.584	1.003	0.714
Auxiliary Operators	3.598	2.201	2.048	2.489	3.344	1.622
Verbs	17.677	17.296	14.069	16.968	17.726	15.445
Copula Forms	3.030	3.208	3.562	3.167	2.899	2.920
Verb Particles	1.263	0.629	1.247	1.131	1.115	1.493
Adverbs	6.692	5.535	6.589	9.955	7.581	7.138
Intensifiers	1.326	1.195	1.069	2.036	1.338	1.557
Prepositions	0.063	0.126	0.000	0.000	0.111	0.195
Existential	0.000	0.063	0.267	0.000	0.334	0.065
Question Words	0.568	0.818	0.089	0.452	1.784	0.389
Coordinators	6.187	5.723	6.589	5.656	4.905	4.543
Subordinators	3.220	3.522	2.939	3.167	4.682	4.218
Infinitives	1.705	2.327	1.603	2.036	2.341	1.947
Possessives	0.000	0.000	0.000	0.000	0.000	0.000
Negation Words	3.157	1.950	1.158	2.489	3.567	1.687
Lets Words	0.000	0.314	0.000	0.000	0.000	0.000
Interjections	2.210	2.327	3.028	0.226	3.902	0.454

Discussion

Self-report Measures

Results of the MPQ revealed some notable patterns for overall temperament between the two groups. Those with BVFL presented with higher levels of Behavioral Constraint compared to HCs. When comparing the subfactors of Behavioral Constraint, it appears that HCs all scored lower on the subfactor of Traditionalism, which appeared to drive this difference. The fact that those with BFVL presented with *higher* levels of Behavioral Constraint is counterintuitive, given that past literature suggests that this population has increased impulsivity and higher levels of Attention Deficit Hyperactivity Disorders (D'Alatri et al., 2015; Garcia-Real et al., 2013; Hamdan et al., 2009, 2009; Moodley et al., 2019). This profile suggests that vocal behaviors would be constrained, not disinhibited. Thus, it is likely that the elevated scores on the Behavioral Constraint factor in those with BFVL have more to do with makeup of the sample of participants, specifically, two graduate students and one working mother, and the control group was not age matched. It is entirely possible that in the larger pool of individuals with BVFL, Behavioral Constraint is lower and that our representative sample is unique to a university environment.

Observing differences in the individual subfactors, there are a few interesting trends. Those with BVFL presented with consistently high levels of Social Closeness, all scoring at or above the average norm for this sub-factor. This is not surprising given that the Trait Theory of Voice Disorders predicts that those with BVFL would have temperaments higher in Positive Emotionality/Extroversion and the Social Closed sub-factor loads onto this trait. There were no observable differences between groups in any of the other subfactors on this particular trait. Additionally, one of the participants with BVFL demonstrated extremely low scores in Stress Reactivity, a sub-factor that loads onto the trait Negative Emotionality/Neuroticism. Given that those with BVFL present with a personality profile with increased neuroticism, this finding seems counter-intuitive. One interesting finding was about the subfactor Absorption. Although there were no differences across diagnostic groups, those who scored higher than normal in the Absorption scale identified as singers who became speech language pathology students. Given that this scale represents individuals high in sensory awareness and integration, it appears to be identifying individuals who have increased training in auditory sensations.

Executive Functioning

The original intention of the FAVRES was to assess an individual's verbal reasoning and executive functioning strategies after having acquired a brain injury. As such, this measure may not be a comprehensive assessment of executive functioning in non-brain injured adults. Regardless, two BVFL (BVFL 1 and BVFL 2) scored in the 70th percentile on Accuracy on subtest 1 while BVFL 3 and HCs scored in the 108th percentile. This finding suggests that these individuals may have difficulty attending to details or difficulty extracting important or relevant information necessary to make the most accurate choices. There were no noted differences in Rationale or Time scores on subtest 1 between the two groups. Interestingly, the BVFL group had an average percentile score of 12.3 on Accuracy and an average percentile score of 47 .3 on Rationale on subtest 2. The HC group had an average percentile score of 72.3 on Accuracy and 55.3 on Rationale on subtest 2. Although test sub-scores were within normal limits, these outcomes could be a result of waning attention to instructions, test familiarity, or fatigue. The findings noted in the BVFL group suggest that a deeper investigation into high-level executive functioning might be warranted particularly aspects of attention to detail, extracting relevant information, and decision making. However, more theoretical work is necessary before linking these executive functions with voicing behaviors.

Language Sampling

The language sample analysis of the conversational samples revealed a notable difference in total number of words produced by all BVFL compared to HC 1 and HC 2. Those with BVFL appeared to use nearly twice as many words in the conversation analysis HC 3's language sample analysis looked similar to the BVFL group. HC 3 reported a diagnosis of autism approximately 6 weeks after her language sample, and so, her data did not accurately constitute a health control.

The language samples were not matched in length to keep the conversations as naturalistic as possible and to preserve the effect of interest; namely to see if those with BVFL take more words to complete a conversation. The target was not to adhere to hold conversation for a given amount of time, which might have washed out any observed effect, but to discuss a set number of topics in their entirety regardless of how much time it took. Aside from word count in the conversational sample, there were no other notable differences between BVFL and HC groups for any other language sampling measure for both conversation and narrative samples. Our sampling codes failed to identify any reason for the fact that those with BVFL indeed use more words during conversation. Thus, one could simply assume that these participants are simply talkative and might support the Trait Theory of Voice Disorders over a language or executive functioning impairment. Nonetheless, there were differences in grammatical categories analyzed through SALT that could prove useful in determining if language usage can contribute to increased vocal load. For example, using more adjectives or adverbs to be more descriptive.

Extracting the four most used grammatical categories during conversation and narrative samples for each participant, a pattern was noted. The BVFL group had the same four highest used grammatical categories: Determiners, Nouns, Personal pronouns, and Verbs. Again, HC 3's highest used grammatical categories matched the BVFL group. However, HC 1 and HC 2 differed by one category, where their four highest used grammatical categories were Nouns, Personal pronouns, Verbs, and Adverbs. The increased use of determiners, rather than adverbs in those with BVFL may point to less word-specific communication, requiring the need to use more words to communicate a thought. Alternatively, the use of increased determiners could suggest the use of more descriptive adjectives and higher syntactic complexity as a result of using more words to communicate. Further exploration on the exact use of these determiners warrants more study. Employing a determiner to convey information, rather than an adverb may suggest less sophisticated vocabulary. However, there was no appreciable difference in the use of different words, so assumptions about language sophistication might be unwarranted. Exploration into why and when these determiners are used might investigate the use of other language strategies and paralinguistic strategies. It could be that although the choice of word is less meaningful, those with BVFL may employ prosody or gestures more frequently. If so, it might suggest that this group employs a difference in language style rather than an indication of any language or executive functioning challenges.

Combined Self-report and Language Sample

The increased total word count in the BVFL group warrants further investigation. In the initial language sample analysis, there was no finding that accounted for the increase in word counts. Across both groups there was no difference in the amount of filler words, repairs/revisions, or backchannelling. But there was one notable difference in the subscale scores of the MPQ that could serve as one explanation to this increased word count in conversation, as opposed to narrative. Although BVFL 2's MPQ scores could not be interpreted accurately, BVFL 1 and BVFL 3 scored notably higher in the subscale of Social Closeness compared to the HC group. This outcome of high Social Closeness could also be related to the increased total number of words used in conversation. These individuals may find that interacting with another person is enjoyable or rewarding in some way and, in turn, motivating them to talk more. Additionally, they may feel stimulated by social interactions, therefore causing them to engage more in these types of interactions. This finding underscores the likelihood that those with BVFL language use is less likely to contribute to vocal load than temperament.

Overall, the scores on the self-report measures and the FAVRES of the HC group were more variable than those of the BVFL group, whose data appeared more consistent across all measures. Although the numbers were too low to make specific conclusions, the difference in score consistency between the BVFL and HC groups, despite all coming from a similar pool of individuals, suggests a commonality across measurement domains. Further investigations into predisposing factors in those with BVFL might benefit from employing multiple measures across multiple domains.

Limitations of the Study and Future Directions

There limitations to a study such as this one. The first limitation was the low number of participants in both the BVFL and HC groups. Higher numbers of participants in both groups could increase the strength of the data found in this study and has the potential to reveal further notable differences between these two groups that were concealed due to small sample sizes. However, the richness of language sample data comes at a cost of time and resources, and so increasing numbers in this study might prove untenable. Future studies might benefit from more automatic language sampling such as natural language processing algorithms, while using large data sets.

The choice of using conversation as a language sampling category was helpful in determining differences between groups. However, the narrative sample did not reveal any notable differences, given that interactions are highly structured there was no opportunity to observe more specific information about topic initiation, maintenance, and closure. Future studies might benefit from interactive narrative stimuli such as explaining a process to a naïve cohort.

This study employed participants who were graduate students of the same program as the acting confederates. Prior knowledge and experience with the confederates might have influenced interactions due to shared history. Employing unknown confederates might mitigate this factor. In addition, training confederates to feign challenging communication scenarios, such as communication breakdowns might elicit communication strategies that would differentiate those with BVFL and those without.

Some self-report measures did not provide any meaningful data related to the interests of this study, such as the BIS/BAS, ERQ, and PSS. These measures, which were designed and normed on different populations may not measure the appropriate constructs of communication and language use. Future studies should employ inventories that have been created to measure pragmatic language use, social stress, or social reward. Alternatively, future research could conduct an initial analysis of already existing measures and norm them on the population of those with BVFLs. This approach has been employed in the past where House and Andrews (1988) employed an already existing self-report measure of life stress and normed it on a voice-disordered population. From this population, they discovered a factor of Conflict Over Speaking Out, that was specific to this voice-disordered group. Perhaps, investigations into language deficits, executive functioning impairment, or communication style would be an important contribution to this line of research.

The largest limitation observed in this study was the logistics in conducting a study such as this one. Initial challenges in patient recruitment limited the number of voice-disordered participants. Although the researchers reached out to local speech language pathologists who regularly treated voice disorders on multiple occasions, no potential participants from the clinical community signed up for this study. Future studies should solidify access to voice-patients.

Other logistical challenges included the time intensive nature of language sampling. The cohort of coders for this project had varying degrees of time investment in this project and thus language sample analysis was slow. Oversight and training of language sample coders required more resources and oversight than originally planned. More thorough training and practice would be helpful to streamline the coding processing. In addition, coders in this study were trained on a limited and specific set of language tokens to increase coding accuracy and mitigate time investment. However, this strategy came at the cost of allowing for more rich, qualitative observations to arise. Employing and educating coders not only to code specific language tokens but also to be alerted to recurring themes and novel observations would have been useful, but beyond the scope of this project.

Conclusions

This study sought to identify language and executive functioning differences in those with BVFLs and those without. The descriptive, observational study revealed that those with BVFLs use more words during conversation and that their temperaments might be the mitigating factor in their increased voice use. Findings from the FAVRES suggest those with BVFL may have poorer executive function skills than those without. However, definite conclusions about whether or not language or executive functioning is different in this population cannot be made due to the low numbers in this study. Future studies should employ more participants and more specific measures to gain a better understanding of language or executive functioning differences.

References

Anand, S., Bottalico, P., & Gray, C. (2019). Vocal Fatigue in Prospective Vocal Professionals. J*ournal of Voice*. https://doi.org/10.1016/j.jvoice.2019.08.015

Angeleri, R., Bosco, F. M., Gabbatore, I., Bara, B. G., & Sacco, K. (2012). Assessment battery for communication (ABaCo): normative data. Behavior research methods, *44*(3), 845–861. https://doi.org/10.3758/s13428-011-0174-9

Arasaratnam, L. A. (2007). Research in intercultural communication competence: Past perspectives and future directions. *Journal of International Communication*, *13*(2), 66–73. https://doi.org/10.1080/13216597.2007.9674715

Assad, J. P., Gama, A. C. C., Santos, J. N., & de Castro Magalhães, M. (2019). The Effects of Amplification on Vocal Dose in Teachers with Dysphonia. Journal of voice: official journal of the Voice Foundation, 33(1), 73–79. https://doi.org/10.1016/j.jvoice.2017.09.011

Chang, A. & Karnell, M. P. (2004). Perceived phonatory effort and phonation threshold pressure across a prolonged voice loading task: A study of vocal fatigue. *Journal of Voice, 18*(4), 454-466. https://doi.org/10.1016/j.jvoice.2004.01.004

Clark, H. H., & Fox Tree, J. (2002). Using uh and um in spontaneous speaking. Cognition, 84, 73–111.

Clark, L. A., & Watson, D. (1999). Temperament: A new paradigm for trait psychology. In Pervin, L. A. & John, O. P. (Eds.), *Handbook of personality: Theory and research* (pp. 399-423). *(2nd ed.). Guilford Press*

Cohen, S. and Williamson, G. Perceived Stress in a Probability Sample of the United States. Spacapan, S. and Oskamp, S. (Eds.) The Social Psychology of Health. Newbury Park, CA: Sage, 1988.

Colton, R. H., Casper, J. K. & Leonard, R. (2011). Ch. 3 Morphology of vocal fold mucosa: Histology to genomics. *Understanding voice problems: A physiological perspective for diagnosis and treatment*. Wolters Kluwer/Lippincott Williams & Wilkins.

D'Alatri, L., Petrelli, L., Calò, L., Picciotti, P. M., Marchese, M. R., & Bussu, F. (2015). Vocal Fold Nodules in School Age Children: Attention Deficit Hyperactivity Disorder as a Potential Risk Factor. Journal of Voice, 29(3), 287–291. https://doi.org/10.1016/j.jvoice.2014.07.019

Dietrich, M., & Abbott, K. V. (2014). Psychobiological stress reactivity and personality in persons with high and low stressor-induced extralaryngeal reactivity. *Journal of Speech, Language, and Hearing Research*, *57*(6), 2076–2089. https://doi.org/10.1044/2014_JSLHR-S-12-0386 el Uali Abeida, M., Fernández Liesa, R., Vallés Varela, H., García Campayo, J., Rueda Gormedino, P., & Ortiz García, A. (2013). Study of the influence of psychological factors in the etiology of vocal nodules in women. Jour*nal of Voice, 27(1),* 129.e15-129.e20. https://doi.org/10.1016/j.jvoice.2011.08.012

Garcia-Real, T., Diaz-Roman, T. M., Garcia-Martinez, V., & Vieiro-Iglesias, P. (2013). Clinical and Acoustic Vocal Profile in Children With Attention Deficit Hyperactivity Disorder. Journal of Voice, 27(6), 787.e11-787.e18. https://doi.org/10.1016/j.jvoice.2013.06.013

Goldman, S. L., Hargrave, J., Hillman, R. E., Holmberg, E., & Gress, C. (1996). Stress, anxiety, somatic complaints, and voice use in women with vocal nodules: Preliminary findings. *American Journal of Speech-Language Pathology, 5*(1), 44–52. https://doi.org/10.1044/1058-0360.0501.44

Hamdan, A.-L., Deeb, R., Sibai, A., Rameh, C., Rifai, H., & Fayyad, J. (2009). Vocal Characteristics in Children With Attention Deficit Hyperactivity Disorder. Journal of Voice, 23(2), 190–194. https://doi.org/10.1016/j.jvoice.2007.09.004

Helou, L. B., Rosen, C. A., Wang, W., & Verdolini Abbott, K. (2018). Intrinsic Laryngeal Muscle Response to a Public Speech Preparation Stressor. *Journal of speech, language, and hearing research: JSLHR*, *61*(7), 1525–1543. https://doi.org/10.1044/2018_JSLHR-S-17-0153

Hoff, E. (2018). Communicative development: Learning to use language. *Language development* (pp. 206–206). essay, Cengage Learning.

Holt-Lunstad, J., Clark, B. D. (2014). Social stressors and cardiovascular response: Influence of ambivalent relationships and behavioral ambivalence. *International journal of psychophysiology, 93*, 381–389.

House, A.,O. Andrews, H.B. (1988). Life events and difficulties preceding the onset of functional dysphonia. Journal of Psychosomatic Research 32(3) 311-9.

House, A. O., Andrews, H.B. (1987). The psychiatric and social characteristics of patients with functional dysphonia. Journal of Psychosomatic Research 31(4) 483-90.

Hunter, E. J., Cantor-Cutiva, L. C., van Leer, E., van Mersbergen, M., Nanjundeswaran, C. D., Bottalico, P., Sandage, M. J., & Whitling, S. (2020). Toward a consensus description of vocal effort, vocal load, vocal loading, and vocal fatigue. *Journal of speech, language, and hearing research: JSLHR, 63*(2), 509–532. https://doi.org/10.1044/2019_JSLHR-19-00057

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The 'Trier Social Stress Test'--a tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*(1-2), 76–81. https://doi.org/10.1159/000119004

McEwen, B. S. (2017). Neurobiological and systemic effects of chronic stress. *Chronic Stress*, *1*, 247054701769232. https://doi.org/10.1177/2470547017692328

Moodley, D.-T., Swanepoel, C., van Lierde, K., Abdoola, S., & van der Linde, J. (2019). Vocal Characteristics of School-Aged Children With and Without Attention Deficit Hyperactivity Disorder. Journal of Voice, 33(6), 945.e37-945.e45. https://doi.org/10.1016/j.jvoice.2018.06.008

Mueller, J. A., & Dollaghan, C. (2013). A systematic review of assessments for identifying executive function impairment in adults with acquired brain injury. *Journal of Speech, Language, and Hearing Research, 56*(3), 1051–1064. https://doi.org/10.1044/1092-4388(2012/12-0147)

Nerrière, E., Vercambre, M. N., Gilbert, F., & Kovess-Masféty, V. (2009). Voice disorders and mental health in teachers: A cross-sectional nationwide study. BM*C Public Health, 9.* https://doi.org/10.1186/1471-2458-9-370

Nguyen-Feng, V. N., Asplund, A., Frazier, P. A., & Misono, S. (2021). Association between communicative participation and psychosocial factors in patients with voice disorders. *JAMA Otolaryngology - Head and Neck Surgery, 147*(3), 245–252. https://doi.org/10.1001/jamaoto.2020.4956

Ohlsson, A. C., Andersson, E. M., Södersten, M., Simberg, S., & Barregård, L. (2012). Prevalence of Voice Symptoms and Risk Factors in Teacher Students. *Journal of Voice, 26*(5), 629–634. doi: 10.1016/j.jvoice.2011.11.002

Parola, A., Salvini, R., Gabbatore, I., Colle, L., Berardinelli, L., & Bosco, F. M. (2020). Pragmatics, Theory of Mind and executive functions in schizophrenia: Disentangling the puzzle using machine learning. *PLoS ONE, 15*(3). https://doi.org/10.1371/journal.pone.0229603

Patrick CJ, Curtin JJ, Tellegen A. Development and validation of a brief form of the Multidimensional Personality Questionnaire. Psychological Assessment. 2002;14(2):150-163. doi:10.1037/1040-3590.14.3.262

Peavy, G. M., Salmon, D. P., Jacobson, M. W., Hervey, A., Gamst, A. C., Wolfson, T., Patterson, T. L., Goldman, S., Mills, P. J., Khandrika, S., & Galasko, D. (2009). Effects of chronic stress on memory decline in cognitively normal and mildly impaired older adults. *The American Journal of Psychiatry*, *166*(12), 1384–1391. https://doi.org/10.1176/appi.ajp.2009.09040461

Posar, A., & Visconti, P. (2022). What underlies autism spectrum disorder? *Turkish Archives of Pediatrics*, *57*(4), 467–468. https://doi.org/10.5152/turkarchpediatr.2022.2203

Poburka, B. and Patel, R. (2021). Laryngeal Endoscopic Imaging: Fundamentals and Key Concepts for Rating Selected Parameters. *Perspectives of the ASHA Special Interest Groups, 6(4),* 736-742. https:// pubs.asha.org/doi/abs/10.1044/2021_PERSP-21-00073

Ptacek, P. H. & Sander, E. K. (1966). Age recognition from voice. *Journal of Speech and Hearing Research, 9,* 273-277. https://doi.org/10.1044/jshr.0902.273

Rossi, G. (2020). Other-repetition in conversation across languages: Bringing prosody into pragmatic typology. *Language in Society*, *49*(4), 495–520. https://doi.org/10.1017/s0047404520000251

Roy, N., & Bless, D. M. (2000). Psychological factors in voice pathology: A foundation for future research. *Journal of Speech, Language, and Hearing Research, 43*(3), 737-748. https://doi.org/10.1044/jslhr.4303.737

Roy, N., Bless, D. M., & Heisey, S. (2000). Personality and voice disorders: A multitrait-multidisorder analysis. *Journal of Voice, 14*(4), 521-548. https://doi.org/https://doi.org/10.1016/S0892-1997(00)80009-0

Roy, N., Bless, D. M., & Heisey, D. (2000). Personality and voice disorders: A superfactor trait analysis. *Journal of Speech, Language, and Hearing Research, 43*(3), 749-768. https://doi.org/10.1044/jslhr.4303.749

Roy N, Merrill R, Thibeault S, Gray S, Smith E. Voice disorders in teachers and the general population: Effects on work performance, attendance, and future career choices. Journal of Speech, Language, and Hearing Research. Published online 2004. doi:10.1044/1092-4388(2004/042)

Roy N, Merrill RM, Gray SD, Smith EM. Voice disorders in the general population: Prevalence, risk factors, and occupational impact. Laryngoscope. Published online 2005. doi:10.1097/01.mlg.0000179174.32345.41

Stoicheff, M. L. (1981). Speaking fundamental frequency characteristics of nonsmoking female adults. *Journal of Speech and Hearing Research, 24,* 437-441. https://doi.org/10.1044/jshr.2403.437

Svec, JG., Titze, IR., & Popolo, PS. (2005). Estimation of sound pressure levels of voiced speech from skin vibration of the neck. *Journal of the Acoustical Society of America, 117*(3), 1386-1394. https://doi.org/10.1121/1.1850074

Timler, G. R. (2018). Using language sample analysis to assess pragmatic skills in school-age children and adolescents. *Perspectives of the ASHA Special Interest Groups, 1*(13), 23-35. https://doi.org/10.1044/persp3.SIG1.23

Titze, I. R., Hunter, E. J., & Svec, J. G. (2007). Voicing and silence periods in daily and weekly vocalizations of teachers. *The Journal of the Acoustical Society of America, 121*(1), 469–478. https://doi.org/10.1121/1.2390676

Titze, I. R., Švec, J. G., & Popolo, P. S. (2003). Vocal Dose Measures. *Journal of Speech, Language, and Hearing Research*, *46*(4), 919–932. https://doi.org/10.1044/1092-4388(2003/072)

Tse, A. C. Y., Wong, A. W. K., Whitehill, T. L., Ma, E. P. M., & Masters, R. S. W. (2014). Analogy instruction and speech performance under psychological stress. *Journal of Voice, 28*(2), 196–202. https://doi.org/10.1016/j.jvoice.2013.03.014

van Mersbergen, M. R., (2011). Voice disorders and personality: Understanding their interactions.
Perspectives on Voice and Voice Disorders, 21(1), 31-38.

van Mersbergen, M., Patrick, C., & Glaze, L. (2008). Functional dysphonia during mental imagery: Testing the trait theory of voice disorder. *Journal of Speech, Language, and Hearing Research, 51*(6), 1405-1423. https://doi.org/10.1044/1092-4388(2008/06-0216)

Verdolini, K., Rosen, C.A., & Branski, R.C. (Eds.). (2005). Classification Manual for Voice Disorders-I (1st ed.). Psychology Press. https://doi.org/10.4324/9781410617293

Vertanen-Greis, H., Löyttyniemi, E., & Uitti, J. (2018). Voice disorders are associated with stress among teachers: A cross-sectional study in Finland. J*ournal of Voice, 34(*3), 488.e1–488.e8. https://doi.org/10.1016/j.jvoice.2018.08.021

Vinney, L., van Mersbergen, M., Connor, N., & Turkstra, L. (2015). Vocal Control: Is it Susceptible to
the Negative Effects of Self-regulatory Depletion? Journal of Voice, 30(5), 638.e21-638.e31. doi: 10.1016/j.jvoice.2015.07.016.

White, A., Deary, I. J., & Wilson, J. A. (1997). Psychiatric disturbance and personality traits in dysphonic patients. *European Journal of Disorders of Communication, 32*(3), 307–314.

Appendix A

Conversational Prompts

1. How are you?
2. Tell us about an embarrassing moment.
3. If money or time were not an object and you could travel anywhere in the world, where would you go and why?
4. What do you wish people knew about you?
5. How do you correct a misunderstanding or miscommunication when talking to someone?
6. If someone tells you "You didn't do this/that right" how do you feel about that?
    a. How do you respond?
7. When you enter a social event (party/social event, meeting, conference, etc.) describe your typical routine upon entering?
8. What are common stressors in you day-to day life?
9. What brings you joy?
10. Coke or Pepsi?
11. Goldfish or Cheez-its?
12. Manual or automatic?
13. Sam's Club or Costco?

Narrative Prompts

<u>PBJ/Cereal:</u>

"I am going to ask you to tell me about how you make something. You get to choose between a peanut butter and jelly sandwich or a bowl of cereal."

Let them make a choice.

"Tell me how you would make a (PB&J or bowl of cereal)."

<u>Animal:</u>

The participant will be given a picture of a hand-drawn pig.

"I'm going to show you a picture of an animal. Tell me how you would draw this picture."

<u>Tire/GoFish:</u>

"I am going to ask you to tell me about how you do something. You get to choose between changing a tire or playing the game "Go Fish."

Let them make a choice.

"Tell me how you would (change a tire or play "Go Fish").

<u>Routine:</u>

"Tell me about your morning routine."

Appendix B

Perceived Stress Scale-10 (PSS)

All participants but one scored within a normal range for the PSS-10 (7.1-20.3). With the exception of one participant with BVFL, who scored a 25, there were no remarkable differences among any of the other participants. Table 8 lists the descriptive statistics for individuals and groups on for the PSS-10and Figure 8 graphically presents this data.

Table 13
Descriptive statistics for the Perceived Stress Questionnaire for each participant.

	Participant	*Score*	*Group Mean*
Perceived Stress Questionnaire	*BVFL1*	15	
	BVFL2	25*	18.7
	BVFL3	16	
	HC1	16	
	HC2	17	16.7
	HC3	17	

*Comparisons worth noting.

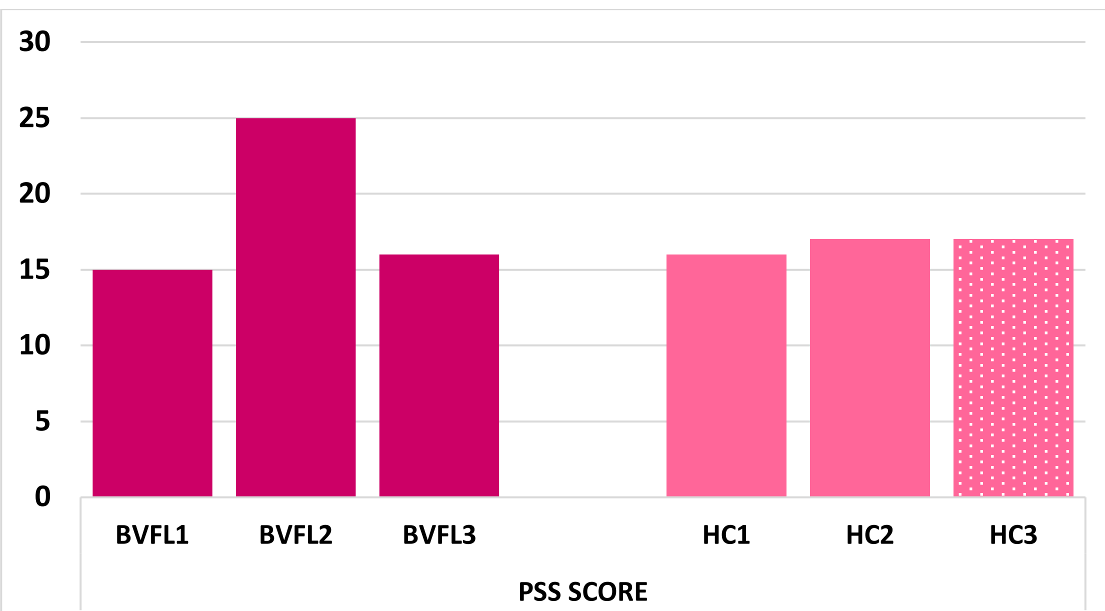

Figure 8. Perceived Stress Scale scores for each participant. Dark shaded bars denote those with BVFLs and light shaded bars denote healthy controls. Doted bars denotes an atypical healthy control. Doted lines represent group means.

Emotional Regulation Questionnaire (ERQ)
The were no distinct differences between groups on the ERQ. Table 9 lists the descriptive statistics for individuals and groups for the ERQ and Figure 9 graphically presents this data.

Table 14
Descriptive statistics for the Emotion Regulation Questionnaire for each participant.

Emotion Regulation Questionnaire	*Participant*	*Score*	*Group Mean*
Cognitive Reappraisal	*BVFL1*	36	
	BVFL2	29	30
	BVFL3	26	
	HC1	25	
	HC2	30	24
	HC3	18	
Expressive Suppression	*BVFL1*	10	
	BVFL2	16	11
	BVFL3	8	
	HC1	11	
	HC2	15	15
	HC3	19	

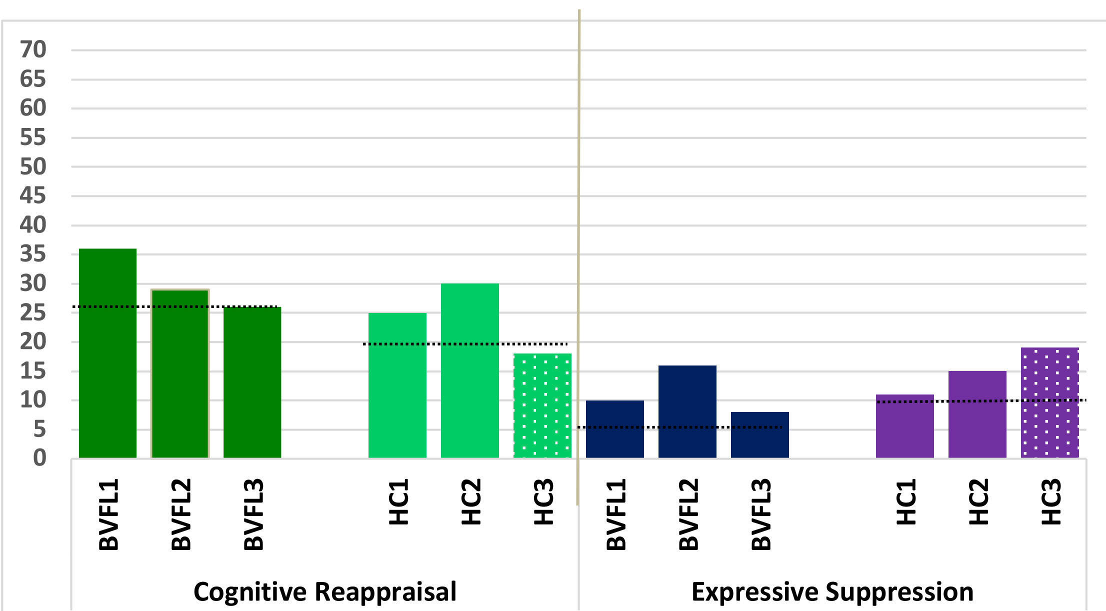

Figure 9. Emotion Regulation Questionnaire scores for each participant. Dark shaded bars denote those with BVFLs and light shaded bars denote healthy controls. Doted bars denotes an atypical healthy control. Doted lines represent group means.