PSYCHOMETRIC, ACOUSTIC, AND NEUROCOGNITIVE INVESTIGATION OF IDENTITY AND PHONOTRAUMA

by

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ABSTRACT

The purpose of this research was to explore how social identity orientation might relate with discrete voice changes in individuals with suspected phonotrauma (hereafter "phonotrauma") and two comparison groups, (1) vocally healthy non-performers and (2) vocally healthy performers, in partial replication and expansion of an fMRI study by Brown, Cockett, and Yuan (2019). The current study gathered data via questionnaires, acoustic voice recordings, and fMRI to triangulate potential effects of identity on voice. In response to questions, participants improvised statements using four different identity conditions: self with habitual point of view, resonant voice with habitual point of view, British accent with habitual point of view, and Romeo/Juliet. The phonotrauma group alone had a significant relationship between greater *personal* identity orientation and greater variation in mean CPP (dB), indicating that they had a unique relationship between identity and voice behavior. fMRI analysis of this group also indicated that, more than performers, they activated the precuneus – a cortical region associated with playacting – while they were using their *habitual* (dysphonic) voices. Together, this evidence suggests that the individuals with phonotrauma had a unique and multifaceted relationship between identity and voice production. Clinical implications include potentially tailoring rehabilitation goals to a patient's identity-centric voice needs.

Chapter 1

INTRODUCTION

Identity is at the forefront of contemporary US culture in many arenas. Defined as "the set of characteristics, values, aspirations, and representations that people use to define themselves" (p. 384; Soenens & Vansteenkiste, 2011), individuals may claim a range of identities in domains such as gender, race, politics, etc. A corollary is that behavior is often considered a direct expression of identity [e.g., Goffman's Dramaturgical Theory (Goffman, 1959)]. The link to voice – the interest here – is that behavior is indeed known to be a central causal factor in "phonotraumatic" disorders (Jiang & Titze, 1994; Leonard, 2009; Schneider & Bigenzahn, 2005; Stepp et al., 2011; Stepp et al., 2010a, 2010b), defined as voice disorders that involve damage to the vocal fold mucosa due to how the voice is used (Verdolini, 1998). These disorders are pervasive and widespread (Cohen, 2010; Da Costa et al., 2012; de Medeiros et al., 2012; de Medeiros et al., 2008; Mozzanica et al., 2016; Ohlsson et al., 2012; Preciado-Lopez et al., 2008; Roy et al., 2005; Roy et al., 2004; Sala et al., 2001; Simberg et al., 2004; Simberg et al., 2005). The question can be posed as to whether identity may underlie phonotraumatic behaviors and may be relevant to their treatment in ways that have not yet been elucidated.

In fact, the primary goal of voice therapy for phonotraumatic conditions involves behavior modification (see Van Stan et al., 2015; Van Stan et al., 2021). Some of the data about treatment outcomes are discouraging. In particular, data suggest that therapy non-attendance may range from 29-52% (Gustin et al., 2019;

Pasternak et al., 2020; Portone et al., 2008; Rosow et al., 2019; Vamosi et al., 2020), and failure to complete therapy is reported at 36-74% (Adessa et al., 2018; Ebersole et al., 2018; Hapner et al., 2009; Kavookjian et al., 2018; Portone-Maira et al., 2011; Smith et al., 2010; Starmer et al., 2014). Moreover, even individuals who complete therapy may not have positive therapeutic outcomes (McCrory, 2010; Wingate et al., 2007).

Factors behind these discouraging statistics have been at least partially addressed. Within the voice science literature, male gender (Adessa et al., 2017), low or no occupational voice demand (Ebersole et al., 2018), high occupational voice demand, increased stress, openly expressing thoughts and feelings (Smith et al., 2010), and lack of interest in treatment (Starmer et al., 2012) have all been tied to low adherence—though these findings are inconsistent (Rubino & Verdolini Abbott, in press). Personality has also been suggested to play a role. Specifically, according to the Theory of the Dispositional Bases of Functional Dysphonia and Vocal Nodules (Trait Theory; Roy & Bless, 2000a; Roy & Bless, 2000b), individuals with phonotrauma, specifically vocal fold nodules (VFN), are likely to have high trait Extraversion and Neuroticism. Empirical testing of Trait Theory has found people with vocal fold nodules to have high levels of the superfactor trait Extraversion (Roy, Bless, & Heisey, 2000a), its correlate Positive Emotionality (Clark & Watson, 2021; Roy, Bless, and Heisey, 2000b; Tellegen, 1982), and low levels of Constraint (i.e., high impulsivity) as well as high levels of lower-order traits Social Potency, Stress Reaction, and Aggressiveness (Roy et al., 2000b; Tellegen, 1982). Physiologically, these traits have been linked to upregulation of the Behavioral Activation System, i.e., approach behavior (Gray, 1970). Therefore, these individuals would be likely to approach a group of people whom they would attempt to influence or lead (Social Potency), experience negative emotions (Stress Reaction), and perpetrate antagonistic interactions (Aggressiveness) impulsively (Control) (Roy et al., 2000b; Tellegen, 1982). The implication is that these traits would be manifested behaviorally in ways that are physically damaging to the vocal mechanism.

Trait Theory has been widely accepted in the literature on phonotraumatic voice disorders and has extended to some views affecting clinical practice (El Uali Abeida et al., 2013; Lee et al., 2019; Lee et al., 2021; Mattei et al., 2017; Toles et al., 2021). The discouraging aspect of the theory is that current tradition understands personality—whether the two-factor, three-factor, or five-factor model—in terms of inherited traits that are relatively stable across the lifespan (Clark & Watson, 2021; McCrae et al., 2000; McCrae & Costa Jr, 2008; Roberts & Nickel, 2021). In other words, in this view, affected individuals may have a lifelong susceptibility to phonotrauma due to stable personality traits that may predispose them (Roy, 2011; Roy & Bless, 2000a, 2000b).

Some encouragement is seen in more recent models of personality such as the Personality and Role Identity Structural Model (PRISM; Wood & Roberts, 2006) and the Neo-Socioanalytic Model of Personality (NSM; Roberts & Nickel, 2021; Roberts & Wood, 2006). According to these models, personality is actually *flexible* over time, and germane to this discussion, identity may play a role in that flexibility. The PRISM describes the aggregation of (1) single role experiences into (2) patterns of experiences ultimately coalescing into (3) role identities (how one sees oneself at work versus in romantic relationships, etc.) and eventually (4) general identity (an overall view of oneself). Personality traits, which are positioned at the model's highest hierarchical levels along with role and general identities, may impact structurally lower-level experiences and vice versa. Along similar lines, the NSM describes a reciprocal connection between roles (e.g., one's function in one's family) and identity as well as the bidirectional association of identity and what are called the "personality units of analysis" including personality traits (e.g., extraverted), motives and values (e.g., life goals), abilities (e.g., verbal skills), and narratives (e.g., significant memories). Critical for the present discussion, the current version of the model understands identity as an integral aspect of personality itself. In sum, traditional personality theory—whether the two-factor, three-factor, or five-factor model—views personality as a relatively immutable top-down structure (Clark & Watson, 2021; McCrae et al., 2000; McCrae & Costa Jr, 2008; Roberts & Nickel, 2021), and thus individuals with a personality-driven medical condition such as VFN may be relatively locked into their condition despite temporary ebbs and flows. In contrast, contemporary personality science proposes dynamic structures wherein daily and aggregate life experiences—including behaviors—inform identity, which in turn affects personality and vice versa. In these models, personality-driven, behaviorally-induced medical conditions may undergo greater modulations, even definitive modulations, than traditionally thought.

Given the documented contributions of both vocal behavior and personality to phonotraumatic disorders, these observations point to a possible role of identity in the pathogenesis of VFN and treatment success. However, to date identity has not yet been widely studied as a factor. At the broadest level, the present study addresses this gap. Specifically, the study represents a first step in the examination of a preliminary causal model that starts with the observation that some patients with phonotrauma have poor therapy outcomes, and the corollary assumption that one of the proximal reasons is failure to make therapeutic voice changes in therapy. Such failure in turn is thought to connect in part with some level of resistance to voice changes, driven by the patient's complaints the therapeutic voicing modalities "don't sound like [them]" (see van Leer & Connor, 2010). (Other possible contributing factors were listed earlier.) Extrapolating from Trait Theory's finding of high trait Extraversion in people with phonotrauma (Roy et al., 2000a), resistance to voice changes in this population may be partially related to a characteristically strong orientation to the social self–a social identity in which behavioral expression is tied to dominance and aggressiveness and associated phonotraumatic behaviors. In the end, these patients appear comfortable with (dysphonic) voice "as is," which honors their social identity orientation underlying resistance to therapeutic changes. Therefore, due to a high social identity orientation, the therapy process may be thus thwarted from its inception.

In sum, this study examines factors that may intervene between the development of phonotrauma (not explicitly examined here) and the final outcome of therapy (not examined here), through the lens of social identity. Specifically, the study examines assumptions that (a) individuals with phonotrauma may not readily make voice changes when invited to do so, and such failures in voice change are associated with (b) a tendency towards a social identity orientation and (c) allegiance to voice and acceptance of voice "as is," as "self."

Further theoretical background follows. Note that theoretical considerations introduced here are not examined in the study. Rather, they provide a theoretical context for it.

1.1 Identity and Behavior in Psychology

Behavior and identity have been linked in theoretical models of identity (e.g., Deci & Ryan, 2000; Deci & Ryan, 2012; Goffman, 1959; Swann & Bosson, 2008; Swann, 1999; Turner et al., 1987; Turner & Reynolds, 2012). However, such theories have yet to focus on *vocal* behavior and identity. Three theories in particular motivate questions and methods in the current series: Goffman's Dramaturgical Theory, Tajfel and Turner's Self-Categorization Theory, and Swann and Bosson's Identity Negotiation Theory.

1.1.1 Dramaturgical Theory

Goffman (1959) hypothesized that each permutation of (1) audience, (2) setting, and (3) time affects behavior, or one's presentation of one's identity. Audiences include oneself or others. Settings are the location of the behavior such as at work, at home, etc. The definition of time is self-evident. Of course, one does not become someone else entirely as these variables mutate. However, one's behavior shifts in accordance with how one sees oneself within these varied circumstances. For example, one may use a quiet volume during lunch time (time) with friends (audience) in the breakroom at work (setting); the presented identity may be "thoughtful coworker." However, the same person may use a loud volume during lunch time (time) with friends (audience) at a sports bar (setting); the presented identity may be "one of the guys." Germane to voice disorders, if phonotraumatic voice behavior is routinely used to present identity, and the patient is encouraged to change this behavior, the patient could feel that the "new" behavior does not express the patient's identity, leading to resistance. van Leer and Connor (2010) described a patient many clinicians will recognize, who felt that a therapeutic voicing pattern–in this case so-called “resonant voice”–was incongruent with the patient’s identity. Therapy outcomes were not shared so we have no information about the impact of this factor therapeutically. However, it is difficult to imagine that resistance to a therapeutic voicing pattern would have resulted in good therapy outcomes, short of a wholesale shift in the therapeutic approach.

1.1.2 Self-Categorization Theory

The second psychological theory informing the current study is Self-Categorization Theory (SCT; Turner et al., 1987; Turner & Reynolds, 2012). In SCT, identity is understood at two levels, (1) personal and (2) social. *Personal identity* differentiates individuals within stereotyped social groups (i.e., *social identity*). For example, one may be a *funny* Christian or a *serious* Christian (different personal identities but same social identity). Conversely, one may be a funny *mom* or a funny *dad* (same personal identity but different social identities). Each person may have a stronger or weaker orientation to personal or social identity, and these values are estimated using the Social and Personal Identities Scale (SIPI; Nario-Redmond et al., 2004), discussed in greater detail below and in the Methods section. To illustrate how orientation to personal and social identity impacts behavior, consider a particular group of Christians for whom a low vocal volume is a behavioral marker of group membership. If a funny Christian is more strongly aligned with “funny” than with this type of “Christian,” she may occasionally use a loud voice to tell jokes. The loud voice might be inconsistent with the social group’s typical quiet vocal volume tradition, and the funny Christian’s use of it demonstrates her willingness to break from the group’s normative behavior in favor of “funny,” differentiating her from others in her group. However, if the funny Christian’s social orientation is dominant, she may be more likely to replicate the group's overall quiet vocal volume. These concepts may impact voice therapy through the behaviors that one uses to express personal and social identities—if the expression of one or both is linked to phonotrauma. For example, one's personal identity may be that of a "leader," and one may use an effortful manner of voicing to express leadership to the aforementioned group of vocally quiet Christians. Alternatively, even though one may have a personal identity of "follower" within a given group (and therefore not prone to use the voice to dominate others), the group in question may be musical theatre majors with a group behavioral norm of a heavy vocal load of talking, acting, and singing. In that case, we might expect that individual to also engage in heavy vocal loading.

Grounded in SCT, the SIPI was selected for the current research due to its applicability to the participants and experimental questions as well as its internal validity. The SIPI has been validated in six separate studies (all documented within Nario-Redmond et al., 2004) involving men and women with varied psychosocial backgrounds and ages similar to the anticipated participants. It measures identity across social and personal dimensions, both of which are well-supported by SCT and herein hypothesized to differentiate participant groups. The Aspects of Identity Questionnaire (AIQ; Cheek & Cheek, 2018) is another prominent tool that also measures personal and social identity orientations, which it refers to as "collective" identity rather than "social." However, in one of the SIPI validation studies, its social and personal dimensions were more distinct from each other than the AIQ's personal and collective dimensions (Nario Redmond et al., 2004). Therefore, the SIPI was chosen for this research due to its applicability to the anticipated participant group, strong theoretical basis via the SCT, anticipated ability to differentiate between participant groups, and superior validity in comparison with the AIQ.

1.1.3 Identity Negotiation Theory

Identity Negotiation Theory (INT; Swann & Bosson, 2008) provided the primary motivation for the use of functional magnetic resonance imaging (fMRI) in this study. According to INT, individuals participate in dyads (person to person or person to group) through largely unconscious, continuous processes involving verbal and non-verbal cues (i.e., behaviors) to signal identity, to achieve *relationship goals* (desired end states). With reference to voice, one would use different vocal behaviors in different dyads to signal identity according to the desired end state for that relationship. For example, one may use an authoritative voice with a student to maintain a hierarchical teacher-student relationship. Alternatively, one could use a gentle and warm tone with someone they would like to befriend. However, these behaviors do not necessarily rise to the level of conscious awareness unless the desired end state is not achieved. In that case, a teacher may add more of an edge to an authoritative tone to emphasize teacher-student hierarchy.

Given the proposed inaccessibility of these processes to consciousness, direct assessment approaches requiring introspection would not be useful to identify them. Neural imaging techniques such as fMRI may have the capacity to capture some of the underlying non-conscious processes in such scenarios (by proxy) by examining changes in activation in cortical regions associated with identity. Further discussion of this point is pursued in Section 1.3.

1.2 Identity and Voice Behavior in Voice Science

Voice science has yet to broadly embrace identity theory in any systematic way in our attempts to understand pathogenic and healthy voice. However, interestingly, current and historical practices in gender affirming voice therapy (GAVT) have long centered on relationships between voice and identity and in fact are much of the meat of the matter in those cases; clients work to shape a voice they feel is congruent with their gender identities (Dacakis et al., 2013; Davies & Goldberg, 2006). A handful of voice scientists have followed the thread from identity and GAVT to identity and the greater realm of voice rehabilitation. For example, Helou (2017) centered her first meta-therapy article around GAVT and cited identity as one of many considerations in GAVT. An updated version of Helou's meta-therapy implicitly stepped away from GAVT and proposed identity as one of meta-therapy's five "self-referential goals" (p. 9) of voice rehabilitation (Helou et al., 2021). However, as these authors noted, a limitation of meta-therapy in its current iteration is a lack of operationalization of terms, which stymies empirical testing. Crow et al. (2021) have also made an initial foray into voice and identity through validation of their Vocal Congruence Scale (VCS). Crow et al. defined vocal congruence as the degree to which one feels congruent with one's voice. Crow et al. studied (apparently cis gender) men and women with healthy voices, excluding trained voice users and untrained professional voice users. Findings indicated that individuals with high interoceptive awareness reported greater congruence with their voices than those with low interoceptive awareness. A positive aspect of this study was its focus on self-identification with voice in (presumably) cis gender individuals, thereby helping to establish a foundation for voice identity work in this population. A main limitation was that the concept of vocal congruence was inextricable from interoception. In short, it is unclear whether the VCS measures vocal congruence or interoception more directly. Additionally, there was no comparison group of participants with voice disorders. Comparison between these two groups (and perhaps a trans gender group too) could have further contextualized the VCS and vocal congruence itself within the greater population of potential voice intervention clients. Finally, VCS validation is still limited to a single study. Despite these limitations, the VCS is the only tool available to measure any aspect of identity in the context of voice for cis gender individuals. Therefore, the VCS will be employed in two exploratory aims in this research.

In voice research, acoustic approaches are common, non-invasive manners to quantify vocal behavior. In particular, cepstral peak prominence (CPP) has been meaningful in estimating severity of dysphonia in connected speech (Awan & Roy, 2009; Awan et al., 2009; Eadie & Baylor, 2006; Fraile & Godino-Llorente, 2014; Halberstam, 2004; Heman-Ackah et al., 2002; Maryn et al., 2010; Maryn et al., 2009; Wolfe & Martin, 1997; Wolfe et al., 2000). It is also marked as an emerging measure of voice quality in those with clinically normal voices (S. Awan, personal communication, November 9, 2022; E. van Leer, personal communication, November 13, 2022; Lowell et al., 2011). CPP is derived from the cepstrum, a Fourier transformation of the power spectrum (Baken, 1987) and is the amplitude of the dominant cepstral peak (Hillenbrand et al., 1994). For connected speech, CPP values of 6.11 dB and higher have been tied to a lack of voice disorder (Murton et al., 2020). Spectral mean (SM) is derived from the long-term average spectrum (LTAS), which is a fast Fourier transformation of the power spectrum (Tanner et al., 2005) and is defined as the central tendency of the LTAS (Tanner et al., 2005). SM is a measure of voice quality in individuals with dysphonia in connected speech and has been shown to be significantly lower following voice therapy (Tanner et al., 2005; Tanner et al., 2010). The present research will use these common measures to inform on voice quality in individuals with and without voice disorders during connected speech.

Overall, mean CPP and SM are common manners to evaluate vocal behavior within the uncommonly investigated relationship between vocal behavior and identity, a promising yet still underexplored section of voice science.

1.3 Identity and Voice Behavior in fMRI Research

Functional magnetic resonance imaging (fMRI) is used to quantify changes in blood oxygen level dependent (BOLD) data during different tasks (Glover, 2011). BOLD response in brain regions correlate with increased blood flow and are interpreted to represent the employment of corresponding brain regions and associated processes such as cognition (Glover, 2011) and movement (Biswal et al., 1995).

As noted, a precedent exists for the use of fMRI in identity research, specifically in relation to voice behavior. Brown et al. (2019), whose work provided a general model for the approach in the present study, studied acting students as they covertly answered questions during fMRI scanning in four different conditions: (1) from their own perspectives imagining their habitual voicing patterns, (2) from their own perspectives imagining a British accent, (3) from the perspective of a self-selected, well-known "other" such as a friend, and (4) as Romeo or Juliet. During both the Romeo/Juliet and British accent conditions (in comparison with the "self" condition), participants showed deactivations in the medial prefrontal cortex, which suggested a decentering of habitual self (Brown et al., 2019). While this change was expected during the Romeo/Juliet condition (when participants explicitly played a character), the change was unanticipated for the British accent condition because participants were instructed to answer the questions from their own perspectives, i.e., without consciously changing sense of self. Additionally, during the Romeo/Juliet condition, activation was seen in the precuneus. The suggestion was this area was associated with playacting, or the portrayal of a fictional character.

A small digression is worthwhile to address the distinction of voice and speech, which is more artificial than it is sometimes held to be. The American Speech-Language-Hearing Association (ASHA) defines voice in terms of pitch, loudness, and quality (American Speech-Language-Hearing Association, n.d.-a). However, ASHA defines speech as an integration of articulation, voice, and fluency (American Speech-Language-Hearing Association, n.d.-b). This integration breaks down artificial distinctions between voice and speech. Similarly, from the accent reduction literature, evidence suggests that accent (speech) change involves phonemic, phonological, and *prosodic* alterations, the latter being the domain of voice (Behrman, 2014; Derwing & Munro, 1997; Hahn, 2004). Finally, computer models artificially creating US, Australian, and British accented English have similarly incorporated prosodic (voice) features (Qin et al., 2004; Vaseghi et al., 2009). A longer argument can be made on this point but is not within the scope of this paper. The point is that a change in one's *speech articulation* patterns, as with a British accent, do not necessarily preclude and may even integrate voice changes as well.

Returning to Brown et al.'s results, the finding of deactivation in the medial prefrontal cortex (mPFC) during the British accent condition has implications for voice therapy. To modify accents and specifically phoneme production, individuals alter oropharyngeal gestures. Similarly, in voice therapy, individuals acquire new motor patterns for producing voice (see Van Stan et al., 2015; Van Stan et al., 2021), commonly manipulating oropharyngeal gestures to impact laryngeal function. For example, Lessac-Madsen Resonant Voice Therapy (Verdolini Abbott, 2008) utilizes prolonged voiced continuants to experience and ultimately habituate a sense of easy, "forward vibrations" in phonation, sensations associated with a barely abducted/adducted vocal fold posture (Verdolini et al., 1998). Vocal Function Exercises involve the inverted megaphone posture, achieved via small mouth aperture, fricated vowel production, and dropped jaw; following this program of exercise, users demonstrated improved vocal fold phase symmetry during laryngoscopy (Stemple, 1984; Stemple et al., 1994). Finally, semi-occluded vocal tract exercises, pervasively used in voice training and therapy and actually embedded in the foregoing two therapies, employ vocal tract narrowing to heighten laryngeal reactive inertance (Titze, 2006). Therefore, oropharyngeal motor changes required to produce a British accent may not be all that different from processes in voice therapy, and when accompanied by mPFC deactivation, may imply a relative destabilization of sense of self.

In addition to Brown et al.'s work, two other fMRI studies examined neural activation changes in relation to identity manipulation. Ames et al. (2008) introduced participants (10 women, 4 men) to photographs of two unknown individuals and then asked participants to write for five minutes per photograph about how the individuals might experience a common daily event such as eating lunch with a friend. In the "P1" condition, participants wrote their essays about one of the individuals using the first person perspective ("I") and remarked upon what they, as the P1, saw, felt, etc. during the event. Conversely, in the "P3" condition, participants wrote about the individual using the third person perspective, e.g., “he/she/they,” and commented on what the person might notice or do during the event. Participants were then scanned while using a four-point scale to indicate their own, the P1, and the P3’s preferences for various everyday events or items such as playing videos games. Across the three conditions, participants had the greatest mPFC activation in the self condition, followed by P1, and finally P3. The authors concluded that the activation changes indicated that participants used cognitive processes usually devoted to self-knowledge to answer from the perspective of a fictional other, i.e., during the P1 condition. Additionally, a second, validating study was run with the same participants. The second protocol was designed after a study by Kelley et al. (2002) wherein participants used the same four-point scale to rate the degree to which a given adjective described themselves (in this protocol, “P1”) versus a familiar other (“P3”) whom they did not personally know. Again, mPFC activation was the greatest in the P1 (self as reference) condition. Results from both of these protocols were reported as region of interest (ROI) analyses, and no other changes in activation other than those in the mPFC were included. Overall, this study is informative regarding potential changes in mPFC activation with a change in identity condition.

In a different study, McGettigan et al. (2013) used fMRI to study participants who overtly recited a line from a common nursery rhyme while (1) using their usual voices, (2) impersonating someone, or (3) speaking English using an accent other than their own. Participants were 16 men and 7 women, some with formal training in acting and music, but none had worked professionally as a voice artist. In the results, compared with a rest condition, all three voicing conditions elicited activation in what the authors referred to as a speech production network comprised of bilateral motor and somatosensory cortices, supplementary motor area, superior temporal gyrus (STG), and lobules V and VI of the cerebellum. Conversely, impression and accent conditions (compared to usual voice) were associated with activation of left anterior insula, inferior frontal gyrus (orbital and opercular areas), and right STG. Right STG was more active during impersonation than accent conditions and during normal speech than rest. Finally, impersonations, more than accents, showed increased activation in right mid/anterior superior temporal sulcus (STS), bilateral posterior STS, left angular gyrus (AG), posterior cingulate cortex, and precuneus. The contrast accent > impressions was not significant. Simultaneous acoustic data included speech segment duration, vocal intensity, mean fundamental frequency (f0), minimum f0, maximum f0, standard deviation of f0, spectral center of gravity, and spectral standard deviation. Findings showed that in comparison with habitual speech, during impersonation and accent conditions, significant increases were seen in average duration, intensity, and mean f0. Further, in comparison with the accent condition, during impersonations mean f0 also increased. The conclusion was that during the production of impersonations, the left STS/AG worked with motor and somatosensory areas to provide semantic information about the individuals being impersonated and that the right STS provided acoustic templates to guide articulatory placement in concert with left inferior and middle frontal gyri.

Discrepancies in activation changes across these studies may be explained by the content and modalities of participants' responses. Both Ames et al. and Brown et al. asked the participants to formulate unique impressions or statements while McGettigan et al.'s participants repeated the same line from a nursery rhyme. Therefore, McGettigan et al.'s findings may be more closely aligned with the motor and sensory changes required to produce a novel accent or impression than neurocognitive processes involved in producing a novel accent or inhabiting a character. Because Ames et al. and Brown et al. asked their participants to consider a number of novel stimuli and produce unique answers from a specific point of view (or accent), these results may reflect the aforenoted neurocognitive processes. However, McGettigan et al. uncovered some higher level associative processes, and Brown et al.'s task resulted in motor and somatosensory activations, so it may be wise to conservatively consider all three studies as informing on the greater question of neurological activation changes in association with shifts in voice and identity.

Another major consideration in the study of identity using fMRI is the default mode network (DMN), a series of brain regions understood to be active when one is at rest or engaged in internal or self-oriented tasks and deactivated during externally-oriented tasks (Beaty et al., 2015; Callard & Margulies, 2014; Greicius et al., 2003; Gusnard et al., 2001; Shulman et al., 1997). The regions considered to comprise the DMN vary across authors (Callard & Margulies, 2014), but of greatest relevance to the three fMRI studies currently under consideration, are generally thought to involve medial prefrontal cortex (mPFC) and posterior cingulate cortex/precuneus (PCC/PCu) (Beaty et al., 2015; Cavanna & Trimble, 2006; Shulman et al., 1997; Xu et al., 2016), which are strongly functionally connected (Cavanna & Trimble, 2006). As already noted, both Brown et al. and Ames et al. found significant activation changes in the mPFC across identity conditions. Brown et al. found deactivation in the mPFC during the British accent and Romeo/Juliet conditions, and Ames et al. found activation in this region during self and P1 conditions. Of note, Brown et al. did find deactivation in the ventromedial PFC during their self condition versus fixation. However, this deactivation was stronger in the British and Romeo/Juliet conditions when contrasted with the self condition. Therefore, overall, activation/deactivation in the mPFC was tied to habitual self/non-habitual self, respectively. Posterior cingulate cortex/precuneus (PCC/PCu) activity was connected with impersonations in McGettigan et al.'s study and portrayal of Romeo/Juliet in the study by Brown et al. Therefore, activation in the PCC/PCu was tied with the non-habitual self.

The mPFC and PCC/PCu have also been tied to other functions that could possibly be active in the current experimental tasks. For example, the mPFC has been activated during divergent thinking tasks (Beaty et al., 2015) and theory of mind tasks (Amodio & Frith, 2006; Saxe & Powell, 2006). The PCC, in addition to activating during internally-focused thoughts about the self (Leech et al., 2011), divergent thinking (Beaty et al., 2015), and theory of mind tasks (Saxe & Powell, 2006), may activate to regulate focus of attention when an individual is at rest (Leech et al., 2011; Leech & Sharp, 2014) and deactivate during cognitively-challenging tasks (Singh & Fawcett, 2008). The ventral PCC, in particular, has activated in connection with the hippocampus and parahippocampal cortex in macaque monkeys (Kobayashi & Amaral, 2007). Finally, PCu activation has been implicated in spatial functions supporting motor behavior (Selemon & Goldman-Rakic, 1988) as well as voluntary change of attention and mental imagery (Cavanna & Trimble, 2006). These additional functions will be taken into consideration of the results at a general level. However, full discussion of them is beyond the scope of this project and will be pursued in future research specifically designed to address them.

While the body of identity studies using fMRI in relation to alternative perspective taking is still small, the results, considered against the backdrop of the

DMN, are sufficiently illuminating to formulate initial hypotheses for preliminary work in this area, described next.

1.4 Purpose of the Study

In sum, associations between voice behavior and identity are suggested by psychological theory, voice science, and preliminary fMRI data. The purpose of the present study is to build upon existing knowledge using a three-pronged approach involving psychometric, acoustical, and fMRI imaging data. The approach involves a replication and expansion of work by Brown et al. (2019) and is organized into two different experimental aims, one psychometric and behavioral and the other neurophysiological. Aims and hypotheses as follows.

1. Experimental Aim 1: Psychometric and Behavioral Aims and Hypotheses

(a) Investigate acoustic voice changes in healthy vocal performers ("performers"), healthy non-performers ("controls"), and non-performers with phonotrauma ("phonotrauma") under varying identity conditions (habitual point of view with habitual voice; habitual point of view with resonant voice; habitual point of view with British accent; Romeo/Juliet point of view). Primary and secondary outcome measures are (i) mean CPP (dB; primary) and (ii) SM (Hz; secondary), both of which reflect voice quality (Awan et al., 2009; Awan et al., 2010; Tanner et al., 2005; Tanner et al., 2010). The hypothesis is that for both outcome measures, voice outcomes will vary depending on group. The phonotrauma group will show the least variation and performers may show the greatest variation [both quantified as range of mean CPP (dB)/SM(Hz) across identity conditions], the latter because of their experience and presumable facility with the portrayal of different identities and associated voice characteristics.

(b) Investigate the strength of social (SIPISocial) and personal (SIPIPersonal) identity orientation across the same participant groups. The primary hypothesis is that the phonotrauma group will have the highest social identity orientation scores.

(c) Investigate the possible influence of social or personal identity orientations on voice variations across identity instruction conditions, by group. As for Aim 1a, primary and secondary outcome measures are (i) mean CPP (dB) and (ii) SM (Hz). Hypotheses are that variations in outcome measures across groups and identity conditions will be modulated by SIPISocial scores, potentially differentially across groups.

(d) Exploratory. Investigate the degree of vocal congruence across the participant groups. The hypothesis is that the phonotrauma group will have vocal congruence scores similar to those for the other two participant groups. Stated differently, participants with phonotrauma will report alignment with their dysphonic voices as they are, as control groups report alignment with their healthy voices.

(e) Exploratory. Investigate the possible role of vocal congruence in voice variations across identity conditions, by group. Outcome measures are again (i) mean CPP (dB; primary) and (ii) SM (Hz; secondary). The hypothesis is that a main effect of congruence scores will be shown, possibly differentially across groups.

2. Experimental Aim 2: Neurophysiological Aim and Hypotheses

(a) Investigate neurophysiological activation patterns in fMRI in the same groups, under the same task conditions. The hypothesis is that the phonotrauma group will maintain activation in the medial prefrontal cortex (mPFC) across conditions and will not demonstrate activation in the posterior cingulate cortex (PCC)/precuneus (PCu) under any identity condition, reflecting participants' allegiance to their baseline identity. Performers will deactivate the mPFC and activate the PCC/PCu during the Romeo/Juliet identity condition, contrasted with the self condition, replicating findings by Brown et al. (2019).

Chapter 2

RESEARCH METHODS

2.1 Experimental Design

The study addressed two experimental aims. Dependent and independent variables are listed in Table 2-1. Experimental aim 1(a) investigated acoustic voice changes in healthy vocal performers ("performers"), healthy non-performers ("controls"), and non-performers with phonotrauma ("phonotrauma") under varying identity conditions (habitual point of view with habitual voice; habitual point of view with resonant voice; habitual point of view with British accent; Romeo/Juliet point of view). This aim employed a 3 (participant groups) x 4 (identity conditions) mixed-model, between-subjects randomized design – essentially replicating and extending the design used by Brown et al. (2019). All participants were audio recorded while improvising responses to questions under four different identity conditions: habitual voice as "self," resonant voice as "self," British accent as "self," and as Romeo or Juliet. The primary outcome variable was mean cepstral peak prominence (dB), an acoustic correlate of voice quality reflecting vocal clarity, historically tied to degree of dysphonia (Awan et al., 2009; Awan et al., 2010), but with an emerging application to voice quality in general (S. Awan, personal communication, November 9, 2022; E. van Leer, personal communication, November 13, 2022; Lowell et al., 2011). The secondary outcome variable was spectral mean (Hz), also an acoustic correlate of voice quality, shown to be affected by voice therapy in individuals with so-called functional dysphonia and presbyphonia (Tanner et al., 2005; Tanner et al., 2010).

Experimental aim 1(b) investigated the strength of social (SIPISocial) and personal (SIPIPersonal) identity orientation across the same participant groups, and aim 1(c) investigated the possible influence of social or personal identity orientations on voice variations across identity instruction conditions, by group. This aim used a 3 (participant groups) x 4 (identity conditions) x 2 (identity orientations) mixed-model, between-groups randomized design. Groups and identity conditions were the same as for aim 1(a). Identity orientations were personal and social identity orientation scores from the Social and Personal Identities Scale (SIPI; Nario-Redmond et al., 2004). The SIPI is a validated instrument that estimates identity orientation, i.e., one's feelings of allegiance to both social and personal identity. Social identity refers to one's sense of belonging to stereotyped groups such as football coaches or opera singers, and personal identity refers to one's sense of ways in which one differs one from others in one's stereotyped groups such as a collaborative versus dictatorial football coach or a disciplined versus undisciplined opera singer. The SIPI is grounded in Self-Categorization Theory (Turner et al., 1987; Turner & Reynolds, 2012). The outcome for 1(b) was SIPISocial and SIPIPersonal scores. Primary and secondary outcomes for aim 1(c) were the same as for aim 1(a).

Experimental aim 1(d) investigated the degree of vocal congruence across the same participant groups, and aim 1(e) investigated the possible role of vocal congruence in voice variations across identity conditions, by group. This was a mixed model, between-subjects randomized design with the same participant groups and identity conditions as previously, adding scores on the Vocal Congruence Scale (VCS; Crow et al., 2021) as a covariate. The VCS is an emerging tool for assessing one's sense of alignment with one's voice. The dependent variable for 1(d) was VCS score, and the dependent variables for 1(e) were the same as for aims 1(a) and 1(c).

Experimental aim 2 investigated neurophysiological activation patterns in fMRI in the same groups, under the same task conditions. The independent variables were participant groups and identity conditions previously noted. The outcome variable was fMRI BOLD brain activations or deactivations, quantified as z-scores, across the identity conditions and groups.

Table 2.1: List of Experimental Variables.

<table>
<tr><td colspan="5">Experimental Aim 1(a)</td></tr>
<tr><td>Dependent Variables</td><td>Independent Variable 1: Group</td><td colspan="3">Independent Variable 2: Identity Condition</td></tr>
<tr><td>Variation in mean CPP (dB; primary) & SM (Hz; secondary)</td><td>Performers
Controls
Phonotrauma</td><td colspan="3">Self
Resonant voice as self
British accent as self
Romeo/Juliet</td></tr>
<tr><td colspan="5">Experimental Aim 1(b)</td></tr>
<tr><td>Dependent Variables</td><td colspan="4">Independent Variable 1: Group</td></tr>
<tr><td>SIPISocial score</td><td colspan="4" rowspan="2">Performers
Controls
Phonotrauma</td></tr>
<tr><td>SIPIPersonal score</td></tr>
<tr><td colspan="5">Experimental Aim 1(c)</td></tr>
<tr><td>Dependent Variable</td><td>Independent Variable 1: Group</td><td>Independent Variable 2: Identity condition</td><td>Independent Variable 3: SIPI score</td><td>Interactions</td></tr>
<tr><td>Variation in mean CPP (dB; primary) & SM (Hz; secondary)</td><td>Performers
Controls
Phonotrauma</td><td>Self
Resonant voice as self
British accent as self
Romeo/Juliet</td><td>SIPISocial score
SIPIPersonal score</td><td>All</td></tr>
<tr><td colspan="5">Experimental Aim 1(d)</td></tr>
<tr><td>Dependent Variable</td><td colspan="4">Independent Variable 1: Group</td></tr>
<tr><td rowspan="3">VCS score</td><td colspan="4">Performers</td></tr>
<tr><td colspan="4">Controls</td></tr>
<tr><td colspan="4">Phonotrauma</td></tr>
</table>

Experimental Aim 1(e)				
Dependent Variable	Independent Variable 1: Group	Independent Variable 2: Identity condition	Independent Variable 3: VCS score	Interactions
Variation in mean CPP (dB; primary) & SM (Hz; secondary)	Performers	Self	VCS score	All
	Controls	Resonant voice as self		
	Phonotrauma	British accent as self		
		Romeo/Juliet		

Experimental Aim 2			
Dependent Variable	Independent Variable 1: Group	Independent Variable 2: Identity Condition	Interactions
fMRI BOLD activations/ deactivations (z-scores)	Performers	Self	All
	Controls	Resonant voice as self	
	Phonotrauma	British accent as self	
		Romeo/Juliet	

Note. "CPP" = cepstral peak prominence (dB); "SM" = spectral mean (Hz); "SIPISocial" = social identity orientation score on the Social and Personal Identities Scale (SIPI; Nario Redmond et al., 2004); "SIPIPersonal" = personal identity score on the SIPI; "VCS" = score on the Vocal Congruence Scale (Crow et al., 2021).

2.2 Participants

A total of n = 29 adults participated in the study. Cis gender women (n = 22) and men (n = 7) were recruited to approximate the participant population in the referent study by Brown et al. (2019). Participants were split into three groups according to vocal health and vocal performance experience: vocally healthy non-performers ("controls," n = 10, 8 women), vocal performers ("performers," n = 8, 4 women), and individuals with suspected phonotrauma ("phonotrauma," n = 11, 10 women). Due to the COVID-19 pandemic, individuals with confirmed diagnoses of phonotrauma were scarce. Inclusion criteria for the phonotrauma group were adjusted accordingly (see 2.2.1, "Inclusion Criteria"). Women predominated in the control and phonotrauma groups. Only the performer group had gender parity, a factor not hypothesized to unduly impact outcomes. The SIPI and the VCS were both validated on men and women; neither one calls for scoring according to sex (Crow et al., 2021; Nario-Redmond et al., 2004). Additionally, the authors of a synthesis of 30 years of fMRI data concluded that there are few sex-related differences between men and women's brains during verbal, spatial, or emotional processing tasks (Eliot, Ahmed, Khan, & Patel, 2021), akin to the tasks of this experiment.

The mean age of the control group was 22.9 years (*SD* = 5.0, range 19-36 years) with the mean age of the performers 23.8 years (*SD* = 5.3, range 19–31 years) and the phonotrauma group 23.3 years (*SD* = 8.3, range 18-47). Participants were recruited from the University of Delaware student body and surrounding communities. All participants satisfied inclusion and exclusion criteria noted next.

2.2.1 Inclusion Criteria

Inclusion criteria for **all participants** were: (1) cis gender female or male 18-50 years of age; (2) native monolingual English speaker; (3) right-handed; and (4) normal or corrected-to-normal vision with contact lenses. Inclusion criteria specific to the **vocal performers, "performers,"** were (5) normal voice on the day of participation based on the author's assessment using the Overall Severity scale of the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) $\leq$ 10; Kempster et al., 2009) and total score on the Voice Handicap Index-10 (VHI-10) $\leq$ 11 (Rosen et al., 2004) and (6) one semester or more of training or experience in acting or singing at the college level or higher. Criteria for the **healthy non-performers, "controls,"** were: (7) CAPE-V Overall Severity $\leq$ 10 on the day of participation, and total VHI-10 score $\leq$ 11. Criteria for **non-performers with suspected phonotrauma, "phonotrauma,"** were (8) otolaryngological diagnosis of phonotrauma of at least one-month duration, within the past month, by history, or participant report of a rough voice that worsens with use for at least a month's duration, within the past month, and (9) currently experiencing symptoms of phonotrauma by participant report or signs by

PI perceptual evaluation (CAPE-V Overall Severity score > 10 on the day of participation; VHI-10 score was noted, but was not exclusionary for participation in this group).

CAPE-V Overall Severity scores were made by the author (MR) and based on the participants' spontaneous connected speech samples. A second, voice specialized, licensed and certified speech-language pathologist (CA) performed post-hoc, blinded CAPE-V Overall Severity scoring of all of participants via recorded samples of participants using their habitual voices. These scores were compared with the authors', and discrepancies were resolved by playing the applicable samples in a blinded fashion for a third, voice specialized, licensed and credentialed speech-language pathologist (KVA). As a result, no participants were excluded, and all remained in the groups initially determined by the PI.

2.2.2 Exclusion Criteria

Exclusion criteria for all participants were: (1) Active upper respiratory or other illness on the day of participation, per subject report and investigator observation; (2) positive report of any flagged items in the University of Delaware Center for Biomedical and Brain Imaging MRI Safety Screening Form including but not limited to fMRI-incompatible metal in the body, pregnancy, or claustrophobia, precluding completion of fMRI scanning; and (3) age-related voice changes (by participant report and perceptual evaluation by the author, a licensed and certified speech-language pathologist specializing in voice disorders). The exclusion criterion specific to the **vocal performers, "performers,"** was (4) history of voice disruption or disorder lasting more than one week. For the **healthy non-performers, "controls,"** the criteria were (5) history of voice disruption or disorder lasting more than one week and (6) history of vocal performance training or experience for one semester or more at the college level or higher. The criterion for **non-performers with suspected phonotrauma, "phonotrauma"** was (7) history of vocal performance training or experience for one semester or more at the college level or higher.

2.3 Measures

2.3.1 Independent Variables

2.3.1.1 The Social and Personal Identities Scale (SIPI; Nario-Redmond et al., 2004)

The SIPI is a 16-question questionnaire with alternating prompts targeting personal and social identity orientations (respectively, perceived value of uniqueness versus group allegiance). Using a nine-point Likert scale, participants rate the perceived importance of each item to their sense of self. Ratings range from one, "not at all important" to nine, "extremely important." The SIPI has been validated for discreteness of personal versus social identity and construct validity via six studies (published in a single paper) of adults with various cultures, races, and ages (Nario-Redmond et al., 2004). It has been used in multiple studies such as Gray and Desmarais's 2014 study regarding activism behavior, self-esteem, and sexual orientation.

2.3.1.2 The Vocal Congruence Scale (VCS; Crow et al., 2021)

The VCS is a 10-question form in which respondents rate the authenticity of their voice on a five-point Likert scale (0 = strongly disagree, 4 = strongly agree) with reference to (1) their voice while reading The Rainbow Passage (Fairbanks, 1960) out loud and (2) their reactions to a recording of themselves reading this passage, which is commonly used in voice therapy and acting. The VCS was validated for vocally healthy adults (Crow et al., 2021).

2.3.1.3 Identity Instruction Condition

Four identity instruction conditions were used: self, self using a therapeutic voicing pattern, "resonant voice," self with British accent, and Romeo/Juliet. The "self" condition involved responding to questions using one's habitual voice and perspective. "Self with resonant voice" involved speaking from one's own perspective using a voice that felt easy, with an attending sensation of vibration in the front of the face (Verdolini Abbott, 2008; Verdolini-Marston, et al., 1995). "Self with British accent" involved responding to questions from one's own point of view while speaking with a British accent. "Romeo/Juliet" involved answering questions from the perspective of Romeo or Juliet depending on participant gender.

2.3.1.4 Participant Groups

Participant groups were healthy vocal performers ("performers"), healthy non-performers ("controls"), and non-performers with suspected phonotrauma ("phonotrauma").

2.3.2 Dependent Variables

2.3.2.1 Acoustic Measures

The primary acoustic outcome variable was mean cepstral peak prominence (CPP; dB), an acoustic correlate of voice quality reflecting dysphonia severity (Awan et al., 2009; Awan et al., 2010) and more generally, vocal clarity. The secondary outcome variable was spectral mean (SM; Hz), an acoustic correlate of voice quality that is sensitive to perceived voice quality and shown to be affected by voice therapy (Tanner et al., 2005; Tanner et al., 2010). A mean CPP of 6.11 dB (Murton et al., 2020) or higher (Awan et al., 2009) has been connected to low perceived dysphonia; male gender (Awan et al., 2009) and loud speech (Awan et al., 2012) have also resulted in high mean CPP scores. Recent clinical findings indicate mean CPP is a general measure of voice quality as well, beyond any continuum of dysphonia (S. Awan, personal communication, November 9, 2022; E. van Leer, personal communication, November 13, 2022; Lowell et al., 2011). SM has been tied to improvements in perceived voice quality following voice therapy (Tanner et al., 2005; Tanner et al., 2010). In other work, higher SM was found for healthy normophonic individuals in comparison to those with hypokinetic dysarthria (Dromey, 2003) and individuals with a variety of voice disorders (Lowell et al., 2011). Mean CPP (dB) is the primary outcome measure in the present study, and SM (Hz) is a tentative secondary measure given that this study did not investigate therapy outcomes.

2.3.2.2 fMRI Outcomes

The primary fMRI outcome variable was BOLD brain activation between identity conditions and between groups. Compared with the self condition, changes in activation during voicing patterns tied to the non-habitual self would be located in the medial prefrontal cortex and the posterior cingulate cortex/precuneus, areas associated with self-directed thought and documented by Ames et al. (2008), McGettigan et al. (2013), and Brown et al. (2019).

2.4 Procedures

2.4.1 Stage 1: Initial Screening and Questionnaires

Participants responded by secure email to a flyer approved by the University of Delaware (UD) Institutional Review Board (IRB) [1781312]. Respondents were screened for inclusion and exclusion criteria via secure email, and those qualifying were provided with a research appointment. Upon arrival, individuals completed a consent form approved by the UD IRB, the Social and Personal Identity Questionnaire (SIPI; Nario-Redmond et al., 2004), the Vocal Congruence Scale (VCS; Crow et al., 2021), and the Voice Handicap Index-10 (Rosen et al., 2004). The author covertly completed the Overall Severity score of the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V; Kempster et al., 2009) based on the participant's spontaneous speech sample during the consenting process. The duration of Stage 1 was approximately 30 minutes.

2.4.2 Stage 2: Identity Instructions

Each participant received five minutes of training by the author in each of the four identity conditions: "self," "self using resonant voice," "self with British accent," and Romeo/Juliet. The order of training was randomized across participants. In each training condition, participants responded to four practice questions (Appendix A) that were similar but not identical to the questions used in the actual experiment (Appendix A). The author is an Equity actor (actor's union) with particular expertise in Shakespeare and a Master of Fine Arts degree as well as licensure and certification in speech-language pathology and trained in Lessac-Madsen Resonant Voice Therapy (LMRVT; Verdolini Abbott, 2008).

Training protocols for each of the identity conditions were as follows. For the "self" condition, the participant was encouraged to use the habitual manner of voicing and habitual point of view to respond to the four practice questions. The "self with resonant voice" condition was trained using four foundational exercises from LMRVT, all after the author's model: humming on /m/, repeating /m/-initial single syllable words, repeating phrases incorporating /m/, and chanting consonant-vowel pairs and short phrases featuring /m/. Practice questions followed this training. In both training and question responses, participants were encouraged to attend to easy anterior oral vibrations, per the perceptual definition of resonant voice (Verdolini Abbott, 2008; Verdolini-Marston et al., 1995). The therapeutic value of this voice type has been documented in rigorous biomechanical and biophysiological studies and clinical trials (e.g., Verdolini Abbott et al., 2012; Verdolini-Marston et al., 1995) and is widely used clinically in voice therapy for phonotrauma and numerous other conditions affecting voice. For the "self with British accent" condition, participants repeated the Rainbow Passage (Fairbanks, 1960), in short sections, following the author's model. Then, participants were prompted to respond to practice questions from their own perspective but using a British accent. The Romeo/Juliet condition was trained in a manner adapted from the referent study by Brown et al. (2019). Participants were oriented to Act 2, Scene 2 of *Romeo and Juliet*, the balcony scene, using the following procedure. The author read a synopsis of the scene to the participants, and then participants read the synopsis to themselves. Next, the author read a brief character biography to the participants (Juliet for women; Romeo for men), and then participants silently read the character biography. Participants then answered four practice questions. In all identity conditions, the participants were instructed to use first person pronouns ("I") and were told that there were no right or wrong answers. This stage lasted approximately 25 minutes.

2.4.3 Stage 3: Behavioral Voice Measures and fMRI Scanning

Behavioral data were collected prior to fMRI scanning so that participants could overtly practice the identity conditions before proceeding to the scanner.

2.4.3.1 Stage 3a: Behavioral Voice Measures

Experimental aims 1(a), (c), and (e) involved behavioral voice measures. Participants were seated in a comfortable chair in front of a microphone (Model SM48-LC; Shure, Inc., Niles, IL) with a mic-to-mouth distance of 10 centimeters, positioned at a 45-degree angle from the mouth (Pentax, Montvale, NJ; Švec & Granqvist, 2010; Winholtz & Titze, 1997). Acoustic data were captured continuously during all experimental utterances, using the Computerized Speech Lab (Model 4500; Pentax, Montvale, NJ).

Identity manipulation procedures adapted those used by Brown et al. (2019) and are shown in Figure 2.1. The order of the four identity conditions (self, self with resonant voice, self with British accent, Romeo/Juliet) was randomized across participants. Participants answered nine different questions in each condition successively (Appendix A; questions used by Brown et al., 2019). Examples included, "Would you tell your parents if you got fired from a job?" "Would you ever stay out all night with your friends?" The order of questions was randomly determined.

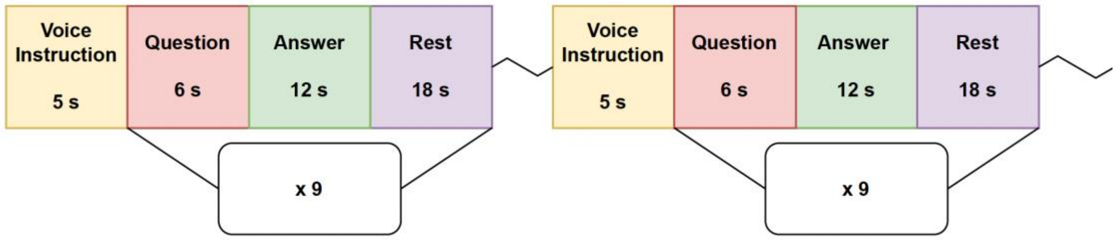

Figure 2.1: Timeline of Acoustic Data Acquisition. Two of the total four identity conditions are depicted. For each identity condition, a total of nine question, answer, and rest cycles occurred prior to progression to the next identity instruction. Jagged lines represent progression to a new identity condition.

The identity conditions were prompted by the following instructions, respectively, "Answer as yourself using your habitual voice," "Answer as yourself using a resonant voice," "Answer as yourself using a British accent," or "Answer as Romeo/Juliet." The questions followed, 8-15 words each, displayed on an Asus laptop computer (Taipei, Taiwan) using EPrime software (Psychology Software Tools, Pittsburgh, PA). The identity instruction lasted five seconds, followed by a question that appeared for six seconds. Participants were instructed to use those six seconds to consider how they might answer the question, but they were to refrain from initiating their answer. Following this period, a dot appeared on the screen, which was their cue to start producing their answer to the question–they were asked to use the entire 12-second interval to respond. A fixation cross replaced the dot, and then participants were given an 18-second rest period. The second question followed the rest period, and the question-answer-rest cycle repeated until a total of nine questions, answers, and rest cycles had been completed for each identity condition. The next identity condition was then prompted, followed by nine question-answer-rest cycles until all four identity conditions were completed. Data collection for each condition lasted approximately 5-

6 minutes. The total duration of this stage was approximately 30 minutes, during which time acoustic data were collected. Following behavioral data collection, the participant proceeded to the UD fMRI suite at the Center for Biomedical and Brain Imaging, approximately 10 minutes from the acoustic suite.

Note that identity instruction conditions in this study were used for the express purpose of assessing participants' responses to them, reflected by acoustic and neurophysiological measures.

2.4.3.2 Stage 3b: fMRI Scanning

Experimental aim 2 involved the acquisition of fMRI data. General procedures replicated those from aims 1(a), (c), and (e) and are shown in Figure 2.2. fMRI scans were completed using a Siemens Magnetom Prisma 3 Tesla MRI machine with a 64-channel head coil. Whole-brain T1-weighted images were collected using a magnetization-prepared rapid gradient echo (MP-RAGE) sequence with the following parameters: TR = 2080 ms, TE = 4.46 ms, flip angle = 9°, FoV = 210 x 210 mm, voxel resolution = 0.9 mm isotropic voxels. Trials of the four identity conditions were presented in a single functional run, and the order of the four conditions was randomized across participants. Functional data were collected using a T-2*-weighted gradient echo-planar imaging (EPI) sequence with the following settings: TR = 1500 ms, TE = 30 ms, flip angle = 76°, FoV = 190 x 190 mm matrix, slice thickness = 2.5 mm, voxel resolution = 2.5 mm isotropic voxels, 60 sagittal slices providing whole-brain coverage, number of volumes = 902, multi-band acceleration factor = 3.

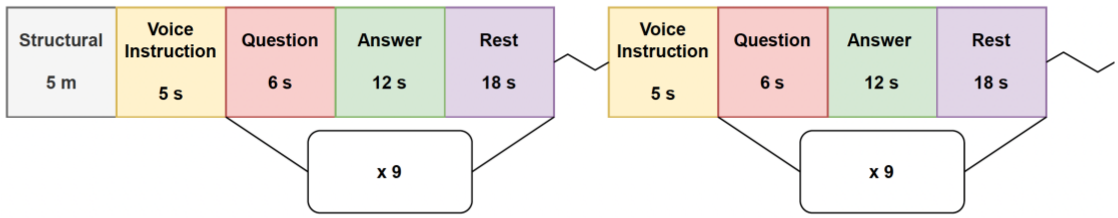

Figure 2.2: Timeline of fMRI Data Acquisition. Structural scan, identity instruction, and two epochs. Four identity instructions total were completed, each with a total of nine repetitions of the question, answer, and rest period cycle prior to progression to the next identity instruction. Jagged lines represent progression to a new identity condition.

This aim used the same EPrime program as in aim 1, including the same identity conditions and questions. However, the orders of the conditions, and the questions within each condition, were randomized. As in the study by Brown et al. (2019), participants answered questions covertly during fMRI scanning. fMRI studies comparing covert and overt productions during language generating tasks have found them to be comparable in activation except for the addition of motor center activations during overt answering (Palmer et al., 2001; Shuster & Lemieux, 2005). However, motor function is not a focus of the current research, so covert answering during fMRI was determined to be a valid approach that also decreased motion artifacts that may have been introduced if using overt production of improvised speech over the course of the full 20-25 minute fMRI scan time. Experimental stimuli were displayed on a screen behind the scanner using EPrime (Psychology Software Tools, Pittsburgh, PA) and viewed via an angled mirror. Following completion of fMRI scans, participants were asked to verbally rate their perceived success producing each voice during the fMRI portion. Ratings were on a 1-10 scale with “1” representing the least successful and “10” the most successful. After this, the participants were thanked for their participation and compensated for their time with a $50 Amazon gift card. The total duration of this stage was approximately 40 minutes. The total duration of the experiment was 2.5 hours or less.

2.5 Data Extraction

2.5.1 Psychometric Data Extraction

Scores from paper forms were transcribed into a Microsoft Excel sheet (Microsoft Corporation, 2018) by a research assistant and verified by the author. There were no discrepancies.

2.5.2 Acoustic Data Extraction

The Computerized Speech Lab (CSL, Model 5109; Pentax Medical, Montvale, NJ) Main Program was used to edit the acoustic samples. Pauses, environmental noises, and non-speech sounds such as laughter were deleted from the sample so that each identity condition (i.e., nine answers to the nine questions) was an uninterrupted stream of speech lasting approximately 100 seconds. The cepstral peak prominence was extracted using the Analysis of Dysphonia in Speech and Voice program (Model 5109; Pentax, Montvale, NJ) in the CSL, and spectral means were calculated using the CSL Main Program. The entire sample was analyzed.

2.5.3 fMRI Data Pre-Processing

Data were converted from DICOM format to NIfTI using MRIcroGL version 2.1.63-0 (Rorden & Brett, 2000). The FMRIB Software Library version 6.0.0 (FSL; Jenkinson et al., 2012) was used for all other processing. Structural scans were skull stripped using the Brain Extraction Tool (Smith, 2002; version 2.1). Using FEAT version 6.00, functional images were pre-processed using FSL's MCFLIRT (rigid-body transformation) for motion correction, FWHM spatial smoothing of 5 mm, and highpass temporal filtering (default setting of 100 seconds). Functional images were registered onto the skull-stripped structural images using FSL's linear, normal search [efficient when structural, functional, and template data are oriented in the same direction; Brain Imaging and Analysis Center (2013)] and FSL's Brain Boundary Registration (BBR) algorithm, which aligns functional and structural images using tissue boundaries. Images were then normalized onto the MNI152 1 mm template using a linear, normal search and 12 degrees of freedom.

2.6 Statistical Analysis

2.6.1 Experimental Aim 1

Minitab® version 21.2 (Minitab, LLC., 2021) was used for statistical analysis. Descriptive statistics were first computed for all variables. Inferential statistics used different approaches depending on the experimental question. For all aims, a mixed-models approach with repeated measures was used to assess 1(a) a group x identity condition interaction for mean CPP (dB) and SM (Hz)outcomes; 1(b) the relationship between the groups and SIPISocial and SIPIPersonal scores; 1(c) the interaction of SIPISocial–and separately SIPIPersonal–scores with identity condition and group on mean CPP (dB) and SM (Hz) outcomes; 1(d) the relationship between the groups and VCS scores; and 1(e) the interaction of VCS score with identity condition and group on mean CPP (dB) and SM (Hz) outcomes. In models 1(a), 1(c), and 1(e), the independent variables (participant group and identity condition) were set as fixed effects, and participant was a random effect. For aims 1(b) and (d), means, standard deviations, and one-way ANOVAs were used to describe group differences in social and personal subscale scores on the SIPI and separately, group differences in vocal congruence scores. Statistical significance was set at $p < 0.05$ for all tests. No attempt was made to adjust for multiple testing.

The primary outcomes of theoretical interest were: Aim 1(a): The group x identity condition interaction for mean CPP (dB) and SM (Hz); Aim 1(b): Group differences in social and personal SIPI scores; Aim 1(c): Interaction of group, identity condition, and SIPI scores for mean CPP (dB) and SM (Hz); Aim 1(d): Group differences in vocal congruence scores; and 1(e): Interaction of group, identity condition, and vocal congruence scores for mean CPP (dB) and SM (Hz).

2.6.2 Experimental Aim 2

The FMRIB Software Library (FSL 6.0.0; Jenkinson et al., 2012) was used for the subject-level analysis. The general linear model was comprised of the following elements. The explanatory variables were the four identity conditions (Self, Resonant, British, Romeo/Juliet). Custom three-column timing files were generated for each participant per identity condition. FSL's Double Gamma HRF was used to convolute the data. It is a preset function comprised of two Gamma functions, "a standard, positive function at a normal lag, and a small, delayed, inverted Gamma, which attempts to model the late undershoot" (Jenkinson et al., 2012, p. 1). Both a temporal derivative (a fraction of the original waveform) and temporal filtering were added to improve the fit of the model to the data. Standard motion parameters were applied as was FSL's FILM prewhitening, which is recommended for "normal first-level time series analysis" to "make the statistics valid and maximally efficient" (Jenkinson et al., 2012, p. 1). Cluster correction was used to correct for multiple comparisons. An initial threshold of $z = 3.1$ was used to determine contiguous clusters. Next, the estimated significance level of each cluster from Gaussian random field theory was compared with the cluster *p* threshold ($p = 0.05$) with only significant clusters used to create resulting images. Contrasts between the identity conditions were set as in Table 2.2. FSLeyes, the imaging program within FSL, only displays a one-sided test result. Therefore, to facilitate visualization of both activations and deactivations, both so-called "positive" and "negative" contrasts were run. For example, Resonant > Self would be considered a positive contrast, and Self > Resonant was a negative contrast. Additionally, due to the exploratory nature of this investigation, all of the identity conditions were contrasted with each other (not just with Self). Negative contrasts were generated for all positive contrasts for a total of 12 inter-condition contrasts.

Table 2.2: Identity Condition Contrasts. Subject-level contrasts.

Contrast Number	**Contrast Description**
1	Resonant > Self
2	Self > Resonant
3	British > Self
4	Self > British
5	RJ > Self
6	Self > RJ
7	British > RJ
8	RJ > British
9	Resonant > British
10	British > Resonant
11	Resonant > RJ
12	RJ > Resonant

Note. "Self" = answering as self using habitual manner of voicing. "Resonant" = answering as self using resonant voice. "British" = answering as self using British accent. "RJ" = answering as Romeo/Juliet.

Group level analysis was conducted using FSL. All 12 subject-level identity condition contrasts (Table 2.2) were included from all 29 participants, and the three participant groups were entered as an explanatory variable. Mixed effects FLAME 1 +

2 was used due to its appropriateness for small sample sizes (Jenkinson et al., 2012). For each subject-level identity condition contrast (Table 2.2), nine group-level analyses, including group means and group contrasts were conducted, as seen in Table 2.3. Thresholding was according to cluster, with z = 3.1 and p = 0.05, corrected. To determine the location of a cluster, anatomical probabilities were based on the Harvard-Oxford Cortical Structural Atlas (Desikan et al., 2006; Frazier et al., 2005; Goldstein et al., 2007; Makris et al., 2006) due to its coverage of all of the brain areas of interest in this research. Due to the whole-brain approach, a cerebellar atlas was used. Because the standard brain template was MNI, the Cerebellar Atlas in MNI152 Space after Normalization with FNIRT (Diedrichsen et al., 2009) was selected.

Table 2.3: Higher-Level Contrasts.

Contrast Number	**Contrast Description**
1	Control Mean
2	Performer Mean
3	Phonotrauma Mean
4	Performers > Control
5	Control > Performers
6	Phonotrauma > Control
7	Control > Phonotrauma
8	Performers > Phonotrauma
9	Phonotrauma > Performers

Chapter 3

RESULTS

Results are organized according to the experimental aims. For psychometric and behavioral aims (1a-e), descriptive outcomes are reported first followed by inferential outcomes. Experimental aims and hypotheses are restated prior to the results that address them. Only significant results will be reported; exceptions will be non-significant outcomes that pertain to hypotheses.

3.1 Experimental Aim 1: Psychometric and Behavioral Aims and Hypotheses

3.1.1 Experimental Aim 1(a)

Experimental aim 1(a) investigated acoustic voice changes in healthy vocal performers ("performers"), healthy non-performers ("controls"), and non-performers with phonotrauma ("phonotrauma") under varying identity conditions (habitual point of view with habitual voice; habitual point of view with resonant voice; habitual point of view with British accent; Romeo/Juliet point of view). Primary and secondary outcome measures are (i) mean CPP (dB; primary) and (ii) SM (Hz; secondary), both of which reflect voice quality (Awan et al., 2009; Awan et al., 2010; Tanner et al., 2005; Tanner et al., 2010). The hypothesis was that for both outcome measures, voice outcomes would vary depending on group. The phonotrauma group would show the least variation and performers might show the greatest variation [both quantified as range of mean CPP (dB)/SM(Hz) across identity conditions], the latter because of their experience and presumable facility with the portrayal of different identities and associated voice characteristics.

3.1.1.1 Mean Cepstral Peak Prominence Results

Mean CPP results are shown in Table 3.1. Descriptively, inconsistent with expectations, the phonotrauma group had the widest mean CPP range across identity conditions (6.23–7.02 dB) while the other two groups showed less change and were similar to each other (controls = 6.10–6.73 dB, performers = 6.70–7.34 dB). Inferentially, the main effects of identity condition (F = 9.36, p = 0.00) and group (F = 4.49, p = 0.02) were significant. Follow up testing for each group separately showed that the performer (F = 3.39, p = 0.04) and phonotrauma groups (F = 4.88, p = 0.01) had a significant relationship between identity condition and mean CPP. Controls showed a weak trend toward a relationship (F = 2.39, p = 0.09). Overall, the outcome was that identity conditions were clearly associated with mean CPP variations in performer and phonotrauma groups in particular, implying that these conditions were effective in examining hypotheses around participants' behavioral responses to implicitly invited voice changes. Because the identity conditions are categorical variables, the direction of this relationship is not interpretable.

Relevant to the suspected voice disorder of the phonotrauma group, their mean CPP in the self condition (6.71 dB) was the lowest overall but was still greater than a published cutoff value for dysphonia in connected speech (mean CPP = 6.11 dB; Murton et al., 2020), numerically suggesting that this group was not dysphonic. However, perceptual and acoustic indicators of dysphonia (specifically mean CPP) have been shown to diverge somewhat, with perceptual impressions of dysphonia more severe than those suggested by mean CPP (Awan et al., 2009) and standardization of acoustic cutoff values for dysphonia still in flux (Awan et al., 2016). Further, perceptual measures remain the gold standard for clinical determination of dysphonia (Kreiman et al., 1993; Madill et al., 2021), despite the accepted specificity and sensitivity of mean CPP to changes in the voice (Awan et al., 2016; Madill et al., 2021; Maryn et al., 2009; Maryn & Weenink, 2015). Finally, the assignment of individuals to phonotrauma versus non-phonotrauma groups in the current study was dependent on perceptual ratings via the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V; Kempster et al., 2009) and validated via two blinded, post-hoc perceptual raters. Therefore, the conclusion is that the phonotrauma group did demonstrate some severity of dysphonia despite an objectively "normal" voice measured via mean CPP.

Table 3.1: Descriptive and Inferential Results of Mean Cepstral Peak Prominence (dB) across Performers, Controls, and Individuals with Phonotrauma during Self, Resonant Voice, British, and Romeo/Juliet Conditions.

Performers (n = 8)				Controls (n = 10)				Phonotrauma (n = 11)			
Descriptive Results											
Var.	*Con.*	*M*	*SD*	*Var.*	*Con.*	*M*	*SD*	*Var.*	*Con.*	*M*	*SD*
Mean CPP (dB)	Self	7.21	0.44	Mean CPP (dB)	Self	6.73	0.73	Mean CPP (dB)	Self	6.71	0.82
	Res.	7.34	0.71		Res.	6.61	1.41		Res.	7.02	0.88
	Brit.	6.70	0.58		Brit.	6.10	0.78		Brit.	6.23	1.08
	RJ	6.88	0.65		RJ	6.33	0.93		RJ	6.74	0.87
Inferential Results											
Term				*F*-value				*p*-value			
Identity Condition				9.36				0.00			
Group				4.49				0.02			
Performers: Identity Condition				3.39				0.04			
Phonotrauma: Identity Condition				4.88				0.01			
Controls: Identity Condition				2.39				0.09			

Note. Var. = variable; Con. = identity condition; M = mean; SD = standard deviation; CPP = cepstral peak prominence; Res. = resonant; Brit. = British; RJ = Romeo/Juliet. The colon in cells such as "Performers: Identity Condition" is intended to denote that the statistics to the right of the cell are the main effect of identity condition for the performer group and so forth.

3.1.1.2 Spectral Mean Results

SM results are shown in Table 3.2. Consistent with expectations, the phonotrauma group had the smallest range of SM across the voice conditions (949–1105 Hz) while the performers had the greatest (891–1369 Hz). Neither of the main effects were significant for SM nor was the group x identity condition interaction.

Table 3.2: Descriptive and Inferential Results of Spectral Mean (Hz) across Performers, Controls, and Individuals with Phonotrauma during Self, Resonant Voice, British, and Romeo/Juliet Conditions.

Performers (n = 8)				Controls (n = 10)				Phonotrauma (n = 11)			
Descriptive Results											
Var.	*Con.*	*M*	*SD*	*Var.*	*Con.*	*M*	*SD*	*Var.*	*Con.*	*M*	*SD*
SM (Hz)	Self	891	404	SM (Hz)	Self	1040	455	SM (Hz)	Self	955	393
	Res.	1043	486		Res.	992	733		Res.	949	405
	Brit.	1369	848		Brit.	869	390		Brit.	1105	574
	RJ	1101	491		RJ	1099	448		RJ	1011	357
Note. Var. = variable; Con. = voice condition; M = mean; SD = standard deviation; SM = spectral mean; Res. = resonant; Brit. = British; RJ = Romeo/Juliet.											

3.1.2 Experimental Aims 1(b) and 1(c)

Experimental aim 1(b) investigated the strength of social and personal identity across the same participant groups, and aim 1(c) addressed the possible influence of social or personal identity orientation on voice variations across identity instruction conditions, by group. For experimental aim 1(b), the primary hypothesis was that the phonotrauma group would have the highest social identity orientation scores. For experimental aim 1(c), the hypothesis was that variations in outcome measures across groups and identity conditions would be modulated by SIPISocial scores, SIPIPersonal scores, or both, differentially across groups.

3.1.2.1 Experimental Aim 1(b) Results

Outcomes from the Social and Personal Identities Scale (Nario-Redmond et al., 2004) are displayed in Table 3.3. Descriptively, the phonotrauma group's SIPI social orientation scores were intermediate relative to the other groups (M = 5.42, SD = 1.15). The phonotrauma group's mean personal identity orientation score was the highest, although in the general range for the other groups' personal scores (M = 6.43, SD = 1.38). Parenthetically, all three groups' SIPIPersonal scores were within one standard deviation of the average of 930 undergraduates (M = 5.71, SD = 1.32) from a SIPI validating study (Nario-Redmond et al., 2004), implying these scores were generally normal. Compared with the SIPISocial scores from the same validating study (M = 4.80, SD = 1.47), the SIPISocial scores were also generally normal. Inferentially, the SIPISocial and SIPIPersonal scores did not significantly differ across groups.

3.1.2.2 Experimental Aim 1(c) Results

3.1.2.2.1 Cepstral Peak Prominence Results

Results for this question are shown in Table 3.1, Table 3.3 and Figure 3.1. Descriptive results were discussed in sections 3.1.1.1 and 3.1.2.1. The interaction of SIPIPersonal x group (F = 3.92, p = 0.03) was significant. Follow-up testing revealed that only the phonotrauma group had a significant relationship between SIPIPersonal and mean CPP (F = 10.35, p = 0.01), which was indirect (and a main effect without respect to identity condition). Visual inspection of Figure 3.1 suggests that for the phonotrauma group, higher SIPIPersonal scores were related to wider mean CPP range than lower SIPIPersonal scores. The main effect of SIPISocial was non-significant.

3.1.2.2.2 Spectral Mean Results

The interaction of SIPIPersonal and group approximated significance (p = 0.07; Table 3.3). The model was then rerun for each of the groups separately with no significant results. SIPISocial showed no significant results.

Table 3.3: Descriptive and Inferential Results from Social and Personal Identities Scale (Nario-Redmond et al., 2004).

Performers (n = 8)			Controls (n = 10)			Phonotrauma (n = 11)		
Variable	M	SD	Variable	M	SD	Variable	M	SD
SIPIPers.	5.59	1.23	SIPIPers.	5.55	1.16	SIPIPers.	6.43	1.38
SIPISoc.	4.41	0.77	SIPISoc.	5.83	1.01	SIPISoc.	5.42	1.15
Inferential Results								
Term			*F*-value			*p*-value		
(Mean CPP) SIPIPersonal x Group			3.92			0.03		
(Mean CPP) Phonotrauma: SIPIPersonal			10.35			0.01		
(SM) Group x SIPIPersonal			3.07			0.07		
Note. M = mean; SD = standard deviation; CPP = Cepstral Peak Prominence; SIPIPers. = SIPI Personal Identity Orientation score; SIPISoc. = SIPI Social Identity Orientation Score; ___ x ___ denotes an interaction.; SM = Spectral Mean. The colon in the cell "(Mean CPP) Phonotrauma: SIPIPersonal" is intended to denote that the statistics to the right of the cell pertain to the phonotrauma group.								

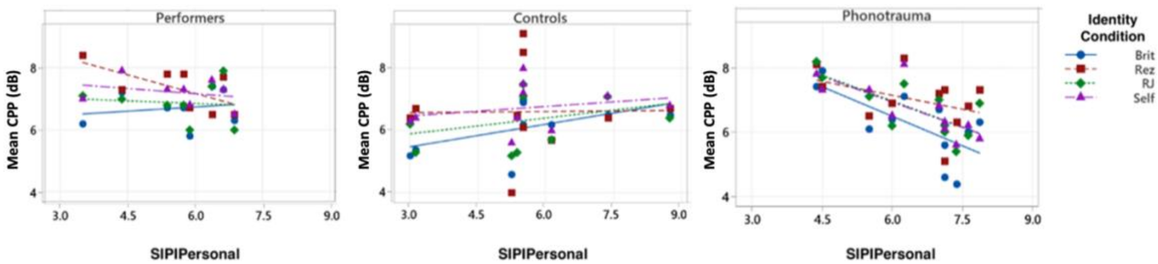

Figure 3.1: Scatterplot of Group, Identity Condition, Personal Identity Orientation from the Social and Personal Identities Scale (“SIPIPersonal”), and Mean Cepstral Peak Prominence (“CPP”; dB). “Brit” = British accent, “Rez” = resonant voice, and “RJ” = Romeo/Juliet.

3.1.3 Experimental Aims 1(d) and 1(e)

Experimental aim 1(d) investigated the degree of vocal congruence across the participant groups. Experimental aim 1(e) investigated the possible role of vocal congruence in voice variations (mean CPP and SM) across identity conditions, by group. The hypothesis for aim 1(d) was that the phonotrauma group would have vocal congruence scores similar to those for the other two participant groups. Stated differently, participants with phonotrauma would report alignment with their dysphonic voices. For aim 1(e), the hypothesis was that a main effect of congruence scores for mean CPP and SM would be shown, differentially across groups.

3.1.3.1 Experimental Aim 1(d) and 1(e) Results

Consistent with predictions, the phonotrauma group’s mean vocal congruence score (Table 3.4; *M* = 32.91, *SD* = 5.89) was within one standard deviation of the other two groups. However, numerically the phonotrauma group’s mean was the lowest of the three groups. Performers had the highest mean congruence (*M* = 35.13, *SD* = 2.75), and control group scores were intermediate (*M* = 33.70, *SD* = 4.57). Incidentally, the three groups’ median scores were similar (performers = 35, controls =

34, phonotrauma = 35), and range scores revealed a single outlier in both the control and phonotrauma groups (24 and 17, respectively). With these outliers excluded, the median scores of all three groups were 35, and the means more closely approximated that of the performers (controls = 34.78; phonotrauma = 34.50). However, inferentially, VCS scores did not differ significantly between the groups.

There were no significant relationships between VCS score and mean CPP (dB) nor between VCS score and spectral mean (Hz).

Table 3.4: Descriptive Results from the Vocal Congruence Scale (Crow et al., 2021).

Performers (n = 8)				Controls (n = 10)				Phonotrauma (n = 11)			
Descriptive Results											
M	SD	Mdn	R	M	SD	Mdn	R	M	SD	Mdn	R
35.13	2.75	35	32-39	33.70	4.57	34	24-40	32.91	5.89	35	17-39
Note. M = mean; SD = standard deviation; Mdn = median; R = range.											

3.2 Experimental Aim 2: Neurophysiological Aim and Hypotheses

Experimental aim 2 investigated changes in neurophysiological activation patterns in fMRI in the same groups, under the same task conditions. The hypothesis was that the phonotrauma group would maintain activation in the medial prefrontal cortex (mPFC) across conditions and would not demonstrate activation in the posterior cingulate cortex (PCC)/precuneus (PCu) under any identity condition, reflecting participants' allegiance to their baseline identity. Performers would deactivate the mPFC and activate the PCC/PCu during the Romeo/Juliet identity condition, contrasted with the self condition, replicating findings by Brown et al. (2019).

Analyses of each identity condition in isolation (self, self with resonant voice, self with British accent, Romeo/Juliet) were performed as a sanity check. Compared to rest (fixation), activations in the default mode network (superior frontal gyrus), motor regions (supplementary motor area, basal ganglia, cerebellum), left hemisphere language regions, and occipital lobe were common across all four conditions and considered to be reasonable given the demands of the experimental tasks.

Intergroup and inter-condition contrasts revealed a number of significant activations. FSL calculates only activation and not deactivation. Therefore, both “positive” and “negative” group (e.g., Performer > Phonotrauma, Phonotrauma > Performer) and identity condition (e.g., Resonant > Self, Self > Resonant) contrasts were run so that both activations and deactivations could be captured.

All significant clusters are listed in Table 3.5. One of these clusters pertained to the experimental aim and will be described here. In the contrast comparing (1) people with phonotrauma to (2) performers, there was a significant interaction in the (1) self versus (2) resonant voice contrast (Figure 3.2) wherein the group with phonotrauma activated the right PCu while responding covertly with habitual voice, comparatively more than when they covertly responded with the novel voicing pattern, resonant voice ($z = 4.60$, $p = 0.01$). The bilateral PCu is the brain region that Brown et al. (2019) associated with acting.

Table 3.5: Significant Clusters of BOLD Activations from Intergroup Analysis of Identity Condition Contrasts.

Groups	**x**	**y**	**z**	**Anatomical Probability**	**Voxels**	***z***	***p***
Phonotrauma > Performers							
Self > Resonant	10	-52	43	72% R Precuneus 3% R PCC	1574	4.60	0.01
Romeo/Juliet > British	35	40	-19	50% R Frontal Pole 3% R Frontal Orbital Cortex	3209	5.1	0.00
	-32	35	-23	10% L Frontal Pole 6% L Frontal Orbital Cortex	1916	5.5	0.001

Romeo/Juliet > Resonant	50	-82	-2	39% R Inferior LOC	990	5.41	0.04
No significant results for Resonant > Self, British > Self, Self > British, Romeo/Juliet > Self, Self > Romeo/Juliet, British > Romeo/Juliet, Resonant > British, British > Resonant, Resonant > Romeo/Juliet.							
Performers > Controls							
Resonant > Romeo/Juliet	-20	37	47	39% L SFG 29% L Frontal Pole 5% L MFG	3533	5.42	0.00
	-30	-23	6	3% L Insular Cortex	1347	4.83	0.01
	-34	19	49	50% L MFG 2% L SFG	1179	4.62	0.02
	36	46	-17	74% R Frontal Pole	1094	4.71	0.03
	52	-82	-2	10% R Inferior LOC	984	5.24	0.04
No significant results for Resonant > Self, Self > Resonant, British > Self, Self > British, Romeo/Juliet > Self, Self > Romeo/Juliet, British > Romeo/Juliet, Romeo/Juliet > British, Resonant > British, British > Resonant, Romeo/Juliet > Resonant.							
Controls > Performers							
Romeo/Juliet > British	-11	-89	-31	91% L Crus II 3% L Crus I	1279	4.81	0.01
	38	-75	-54	23% R Crus II 18% R VIIB	1274	4.39	0.01
No significant results for Resonant > Self, Self > Resonant, British > Self, Self > British, Romeo/Juliet > Self, Self > Romeo/Juliet, British > Romeo/Juliet, Resonant > British, British > Resonant, Resonant > Romeo/Juliet, Romeo/Juliet > Resonant.							
Performers > Phonotrauma							
No significant results							
Phonotrauma > Controls							
No significant results							
Controls > Phonotrauma							
No significant results							
Note. Coordinates are in MNI space. Anatomical probabilities based on the Harvard-Oxford Cortical Structural Atlas (Desikan et al., 2006; Frazier et al., 2005; Goldstein et al., 2007; Makris et al., 2006) and the Cerebellar Atlas in MNI152 Space after Normalization with FNIRT (Diedrichsen et al., 2009). "R" = right, "L" = left, "PCC" = posterior cingulate cortex, "SPL" = superior parietal lobule, "SFG" = superior frontal gyrus, "MFG" = middle frontal gyrus, "LOC" = lateral occipital cortex.							

Group means of each identity condition comparison were calculated to facilitate the interpretation of the intergroup analysis (Table 3.6). Regarding the Phonotrauma > Performers, Self > Resonant interaction above, the Self > Resonant phonotrauma group mean suggested BOLD activation in the PCC/PCu (z = 6.12, p = 0.00) and the PCu (z = 4.76, p = 0.00). However, the performer group mean for Resonant > Self did not include significant BOLD activation changes in the PCC/PCu.

Table 3.6: Significant Clusters of BOLD Activations from Group Mean Analysis of Identity Condition Contrasts.

Control Group Mean							
Self > Resonant	2	42	42	49% R Paracingulate Gyrus 34% R Anterior Cingulate Gyrus	2381	5.2	0.00
Romeo/Juliet > Self	-28	61	2	86% L Frontal Pole	3084	5.0	0.00
	2	-69	44	77% R Precuneus	1802	4.7	0.00
Romeo/Juliet > British	25	-89	-37	68% R Crus II	8140	6.58	0.00
	-17	-93	-24	10% L Occipital Fusiform Gyrus 8% L Occipital Pole	6054	5.82	0.00
	5	-46	20	65% R PCC 3% R Precuneus	1282	4.95	0.01
	2	-39	67	47% R Postcentral Gyrus 10% R Precuneus 5% R Precentral Gyrus	1198	4.47	0.02
Resonant > Romeo/Juliet	-41	-38	42	31% L Anterior Supramarginal Gyrus 17% L Superior Parietal Lobule 17% L Postcentral Gyrus 10% L Supramarginal Gyrus	2242	5.92	0.00
Romeo/Juliet > Resonant	5	45	38	73% R SFG	9618	6.24	0.00
	1	-57	38	73% R Precuneus 2% R PCC	4904	5.69	0.00
	-36	20	51	73% L MFG	2256	5.50	0.00
	-52	-60	28	45% L Angular Gyrus 31% L Superior LOC 7% L Posterior Supramarginal Gyrus	2161	5.53	0.00
	-3	-57	-37	74% L Vermis IX 8% L Vermis VIIIb 4% L IX	2019	4.97	0.00
	-55	21	-26	Outside of brain	1413	4.61	0.01
	-64	3	-20	5% L Temporal Pole 4% L Anterior MTG	1076	4.75	0.03
No significant results for Resonant > Self, British > Self, Self > British, Self > Romeo/Juliet, British > Romeo/Juliet, Resonant > British, British > Resonant.							
Performer Group Mean							

Resonant > Self	-51	-21	29	22% L Postcentral Gyrus 13% L Anterior Supramarginal Gyrus	3903	5.92	0.00
	-45	8	32	28% L MFG 26% L Precentral Gyrus 19% L IFG, Pars Opercularis	3564	5.59	0.00
	-42	48	10	89% L Frontal Pole	3387	5.99	0.00
Self > British	-57	-8	-23	40% L Anterior MTG 25% L Posterior MTG	991	4.37	0.05
Resonant > British	-1	-30	62	46% L Precentral Gyrus 9% L Postcentral Gyrus	2126	4.71	0.00
	-38	7	29	31% L Precentral Gyrus 21% L MFG 12% L IFG, Pars Opercularis	1656	5.78	0.01
	-49	-34	40	38% L Anterior Supramarginal Gyrus 5% L Posterior Supramarginal Gyrus	1483	5.03	0.01
	-36	-16	18	48% L Insular Cortex 18% L Central Opercular Cortex 5% L Parietal Operculum Cortex	1453	4.96	0.01
	39	-31	64	51% R Postcentral Gyrus	1363	4.58	0.02
	-51	-20	32	37% L Postcentral Gyrus 9% L Supramarginal Gyrus	1159	4.48	0.04
Resonant > Romeo/Juliet	-60	-19	18	42% L Central Opercular Gyrus 26% L Postcentral Gyrus 5% L Parietal Operculum	6123	5.47	0.00
	-49	10	30	29% L IFG, Pars Opercularis	4870	6.43	0.00
	44	33	18	44% R MFG 18% R IFG, Pars Triangularis 18% R Frontal Pole	2264	5.24	0.00
	-53	35	26	4% L MFG 3% L Frontal Pole	1544	5.18	0.01

	-3	-29	43	79% L PCC 9% L Precuneus 5% L Precentral Gyrus	950	4.10	0.05
No significant results for Self > Resonant, British > Self, Romeo/Juliet > Self, Self > Romeo/Juliet, British > Romeo/Juliet, Romeo/Juliet > British, British > Resonant, Romeo/Juliet > Resonant.							
Phonotrauma Group Mean							
Resonant > Self	-38	39	20	40% L Frontal Pole 20% L MFG	3698	7.11	0.00
Self > Resonant	36	-81	32	71% R Superior LOC	6494	6.81	0.00
	11	-51	6	36% R Precuneus 29% R PCC 13% R Lingual Gyrus	2082	6.12	0.00
	5	55	28	64% R SFG 23% R Frontal Pole	1999	6.07	0.00
	8	-56	44	70% R Precuneus	1932	4.76	0.00
	4	-59	-48	97% R IX	1342	5.05	0.03
	53	-51	25	76% R Angular Gyrus 4% R Posterior Supramarginal Gyrus	1188	4.94	0.04
	-6	39	56	30% L SFG 24% L Frontal Pole	1171	5.31	0.04
Self > British	21	-67	59	61% R Superior LOC	2218	4.78	0.00
	39	-80	24	65% R Superior LOC	2191	4.5	0.00
	49	-71	-13	73% R Inferior LOC 7% R Occipital Fusiform Gyrus	2089	4.94	0.00
	-21	-92	-37	23% L Crus II	1563	4.95	0.01
Romeo/Juliet > British	41	33	-31	Outside of brain	3511	5.7	0.00
	30	-92	-27	3% R Inferior LOC	3456	4.76	0.00
	-28	-91	-30	29% L Crus II	3170	5.23	0.00
	-34	35	-23	7% L Frontal Pole 6% L Frontal Orbital Cortex	2248	5.74	0.00
	1	45	-18	95% R Frontal Medial Cortex	1791	5.99	0.00
	7	-48	32	73% R PCC 9% R Precuneus	1322	5.15	0.01
	-6	-62	-43	47% L Vermis VIIIb 31% L IX 12% L VIIIb 6% L Vermis IX	1114	4.22	0.03
Resonant > British	-45	-47	56	35% L Posterior Supramarginal Gyrus 24% L Superior Parietal Lobule 6% L Angular Gyrus	3491	5.71	0.00
	-40	42	28	77% L Frontal Pole	2592	6.36	0.00

				13% L MFG			
	42	45	28	81% R Frontal Pole	1420	5.26	0.02
Resonant > Romeo/Juliet	-55	-4	38	80% L Precentral Gyrus	2642	6.25	0.00
	-58	-41	39	78% L Precentral Gyrus 10% L Postcentral Gyrus	2285	6.36	0.00
	-39	40	20	54% L Frontal Pole 17% L MFG	1730	6.13	0.00
	41	44	27	86% R Frontal Pole	1205	5.31	0.02
	-64	-24	19	32% L Anterior Supramarginal Gyrus 32% L Postcentral Gyrus 10% L Planum Temporale 8% L Parietal Operculum Cortex	1046	4.65	0.03
Romeo/Juliet > Resonant	-2	-61	37	97% L Precuneus	13174	6.35	0.00
	6	-58	-44	93% R IX	6374	6.43	0.00
	4	57	31	45% R SFG 38% R Frontal Pole	5545	7.23	0.00
	-19	-93	-32	20% L Crus II	4597	5.20	0.00
	35	-84	-31	93% R Crus I 5% R Crus II	3625	5.75	0.00
	1	-72	-11	49% R Vermis VI 14% R Lingual Gyrus	2100	4.77	0.00
	-44	30	-18	54% L Frontal Orbital Cortex 11% L Frontal Pole	1616	6.33	0.00
	49	-55	24	48% R Angular Gyrus 6% R Superior LOC	1232	5.66	0.02
No significant results for British > Self, Romeo/Juliet > Self, Self > Romeo/Juliet, British > Romeo/Juliet, British > Resonant.							
Note. Coordinates are in MNI space. Anatomical probabilities based on the Harvard-Oxford Cortical Structural Atlas (Desikan et al., 2006; Frazier et al., 2005; Goldstein et al., 2007; Makris et al., 2006) and the Cerebellar Atlas in MNI152 Space after Normalization with FNIRT (Diedrichsen et al., 2009). "R" = right, "L" = left, "PCC" = posterior cingulate cortex, "MTG" = medial temporal gyrus, "IFG" = inferior frontal gyrus, "SFG" = superior frontal gyrus, "MFG" = middle frontal gyrus, "LOC" = lateral occipital cortex.							

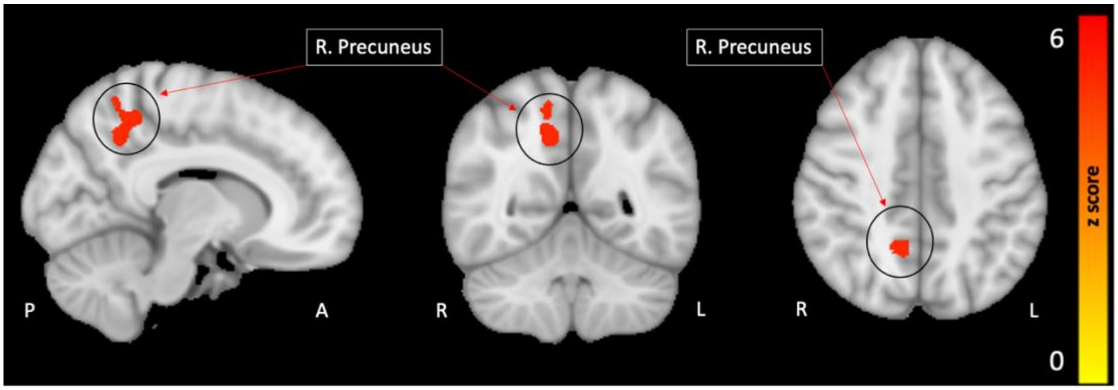

Figure 3.2: Group-Level Contrast using Cluster Analysis of Identity Conditions Self (Habitual Point of View and Voice) > Resonant (Habitual Point of View and Resonant Voice) and Participant Groups Phonotrauma > Performer.

3.3 Success Ratings

Due to procedural issues, only 20 participants rated their perceived success with all four of the identity conditions during fMRI scanning. Of the remaining participants, eight rated resonant, British, and Romeo/Juliet conditions but not the self condition. Finally, one participant did not rate any voices despite repeated follow-up attempts. Of those who rated their perceived success with the self condition, they rated this condition the most successful (performers, M = 9.33, controls, M = 9.63, phonotrauma, M = 10). Regarding the other three identity conditions, both the performers (M = 7.13) and the phonotrauma group (M = 7.10) ranked British following self, while controls had Romeo/Juliet in this position (M = 6.40). British was third for the controls (M = 6.25), resonant voice was third for performers, (M = 6.63), and the Romeo/Juliet condition was third for the phonotrauma group (M = 6.05). Controls (M = 5.70) and the phonotrauma group (M = 4.70) rated resonant voice as least successful, whereas the least successful rating for performers was Romeo/Juliet (M = 5.75). On visual inspection of success ratings in concert with fMRI activations, it appears that the conditions that participants thought were the least successful (resonant and Romeo/Juliet) yielded the greatest number of significant activations in the noted contrasts.

3.4 Summary of Results

Overall, the phonotrauma group demonstrated distinctions from the other two groups psychometrically, acoustically, and neurologically. Comparing across all three domains, those with phonotrauma had the highest personal identity orientation, lowest mean vocal congruence, greatest variation in mean cepstral peak prominence (CPP) across the identity instruction conditions, least variation in spectral mean (SM) across the conditions, a significant relationship between identity condition and mean CPP [i.e., participant changes in identity condition (a combination of voice and point of view) significantly corresponded with voice measured using mean CPP], a significant, indirect relationship between SIPIPersonal and mean CPP (i.e., as personal identity orientation increased, mean CPP decreased), and activation of the precuneus (PCu), an area associated with acting (Brown et al., 2019), when responding as themselves (in comparison with resonant voice and performers).

To a lesser extent, performers also distinguished themselves from the other two groups. They had the greatest variation in SM across the identity conditions. Like the phonotrauma group, they had a significant relationship between identity condition and mean CPP, but they had the lowest SIPISocial score.

Chapter 4

DISCUSSION

This study was motivated by anecdotal reports, corroborated by clinical experience and empirical evidence, that many patients with phonotraumatic disorders of voice such as vocal fold nodules do not complete voice therapy, and in the therapy in which they do engage may often express resistance to therapeutic voicing patterns [e.g., “That voice (e.g., “resonant voice”) doesn’t sound like me”; (see van Leer & Connor, 2010)]

The study investigated this troublesome phenomenon at a preliminary level through the lens of identity. The overarching hypothesis inspired by empirical data and theory was that many individuals with phonotrauma do not engage in therapeutic voice adaptations, i.e., do not demonstrate changes in voicing pattern when invited to do so, due to a strong allegiance to a stable social identity (typified by socially-oriented behaviors consistent with Extraversion) and to voice “as is” (vocal congruence). The study assessed voice changes across imposed identity conditions using acoustical measures of voice quality in the target group of interest–adults with presumed phonotrauma–and in healthy performer and non-performer control groups. Strength of social (versus personal) identity orientation was assessed using a validated psychometric questionnaire. Vocal congruence was similarly measured using a published psychometric tool, and resistance was obliquely implied by its corollary, neurophysiological evidence of sense of “self” versus “other” in imagined voice production in fMRI scanning. The notion was that if a therapeutic voicing pattern–or any voicing pattern different from the habitual one–might be associated with resistance, this might be implied by neurophysiological data showing an association with activity associated with impersonation, rather than habitual self. Sub-hypotheses addressed across experimental aims were that (1) participants with phonotrauma would not show voice changes across identity manipulation conditions, or would show less change compared to healthy performer and non-performer controls (behavioral data), and that (2) for those participants in particular, voice change failure would be associated with a strong sense of social identity and concomitantly a sense of congruence with (dysphonic) voice "as is," "as self" (psychometric and neurophysiological data).

Results turned these hypotheses on their head at every step. First, participants with phonotrauma tended to show *more* voice changes than healthy performer and non-performer controls across identity manipulation conditions, using the more sensitive of the two acoustical measures of voice quality [mean cepstral peak prominence (CPP); the secondary measure, spectral mean was entirely insensitive in the present context]. Second, these participants did *not* have stronger social identity than other participants, but rather tended to show stronger *personal* identity in general, at least numerically. Moreover, strength of personal identity actually predicted greater voice changes across identity conditions compared to weaker personal identity for this group (but interestingly, for this group alone). Third, these participants did *not* report congruence with (dysphonic) voice "as is" but rather, more than other groups they reported diminished mean congruence with (dysphonic) voice in daily life. Moreover, vocal congruence scores did not predict variations in voice quality for any of the groups. Fourth, and consistent with findings of diminished congruence for the phonotrauma group, neurophysiological data indicated the participants in this group may have experienced their habitual, dysphonic voices not as accepted “self” “as is,” but rather as foreign “other.”

Discussion that follows examines each of these findings in turn, in relation to existing theory and empirical data. An important preliminary point is that *all* of the initial experimental sub-hypotheses were turned around 180 degrees by findings. An isolated turnaround could be discounted as spurious. But consistent turnarounds across sub-hypotheses and different data types (psychometric, behavioral, and neurophysiological) seem to point to a reality different than often assumed in clinical practice and reported in the scientific literature. Moreover, as highlighted in the discussion that follows, the combined findings appear to point to a cohesive picture that challenges some of our assumptions about patients with phonotrauma in particular, and our therapy models in general.

Discussion focuses on findings for participants with presumed phonotrauma in comparison to a healthy control group known to have facility with voice change in character portrayal, vocal performers, and a second healthy control group of non-performers who would be similar to the phonotrauma group on most dimensions except suspected phonotrauma. Findings for the other groups are incidental to the experimental hypotheses and will be discussed secondarily only as relevant.

4.1 Findings in Relation to the Proposed Causal Model

Participants with phonotrauma showed more voice changes across identity manipulation conditions than control groups. This finding showed that despite a presumably impaired mechanism, these participants were physically able to make voice changes, as reflected by mean CPP. A low mean CPP indicates relatively diminished amplitude of lower-harmonic energy in a sample and relatively increased amplitude of the higher harmonics as well as increased aperiodicity in the sample, i.e., diminished voice quality (Awan et al., 2010). Therefore, acoustically, these participants modulated their voice qualities according to the identity condition after only a brief period of voice training. (As noted, spectral mean was insensitive in the present study. Although this measure has been shown to reflect gross voice changes pre-to post-therapy, it may be insufficiently nuanced to capture more subtle changes in voice quality across identity instruction conditions tested here and will not be further discussed.) Further, these participants actually made greater changes in voice across conditions than participants in other groups. Two questions emerge. First, why would these participants have made *more* changes than healthy participants? By way of speculation, perhaps participants' tendency towards personal identity orientation that distinguishes themselves from others in a social group (discussed shortly), coupled with their social reward seeking and Social Potency described elsewhere in the literature for this population (Roy et al., 2000b), gave these participants a propensity for and experience with vocal manipulations to "work the room," so to speak, via a superior ability to alter the amplitudes of their low versus high harmonics. This speculation can be pursued in future studies designed specifically to address it.

Second, how can these results be reconciled with anecdotal (yet widespread) comments by clinicians that patients with phonotrauma often seem to resist therapeutic voicing patterns such as resonant voice? Clinical experience suggests that in fact, when patients express resistance towards therapeutic voicing patterns complaining they "do not sound like me," this resistance has little to do with the patterns themselves. Rather, resistance may have to do with the way voice is trained in therapy.

Specifically, often therapeutic voice patterns are initially trained in a chant-type modality, followed by "sing-song" prosody that seems to facilitate the technical production of the patterns (McCabe & Titze, 2002). However, if patients come to associate the therapeutic voicing modality with this sing-song prosody, the result will indeed seem artificial rather than authentic. In other words, perhaps the resistance often encountered clinically is not seated in patients but rather in the way clinicians train them. This issue is dealt with explicitly in one of the primary contemporary models of voice therapy, Lessac-Madsen Resonant Voice Therapy (LMRVT; Verdolini Abbott, 2008). In that program, patients are exposed early on to the therapeutic voicing modality, resonant voice, in a chant format. However, over the course of a few minutes, as opposed to the whole arc of therapy, the chant aspect of voice is purposefully removed while patients retain the therapeutic voice quality with authentic prosody and communicative intent. This therapy program has the longest-term follow up data to date for patients with phonotrauma, showing excellent functional results at one-year follow up (Verdolini Abbott et al., manuscripts in preparation). Anecdotally, complaints that "this voice doesn't sound like me" are exceedingly rare in this approach (K. Verdolini Abbott, personal communication, December 6, 2022; J. Glasner, personal communication, December 8, 2022; D. Orbelo, personal communication, December 8, 2022; I. Pozzali, personal communication, December 8, 2022; S. Radionoff, personal communication, December 8, 2022; A. Trovarelli, personal communication, December 8, 2022; T. Walter, personal communication, December 8, 2022).

Stated differently, perhaps the present findings suggest alternative approaches to common therapeutic voice training, whereby traditional approaches inadvertently associate a therapeutic voicing pattern with artificial prosody giving problematic rise to sensations of inauthenticity and by extension, resistance. In other words, the problems shown by patient comments that a therapeutic modality "doesn't sound like me," may not lie so much with patients as it does with faulty clinical models in treatment.

Moving to the next point, participants with phonotrauma reported greater *personal* (not social) identity than participants in other groups, and greater sense of personal identity was actually associated with a wider range of voice changes than weaker personal identity for this group (alone). Although this finding might seem at odds with predictions based on Trait Theory alone, it falls into place when contextualized along with Dramaturgical Theory (Goffman, 1959), Self-Categorization Theory (via the SIPI; Nario-Redmond et al., 2004; Turner et al., 1987; Turner & Reynolds, 2012), and Identity Negotiation Theory (Swann & Bosson, 2008). First, results showing the highest SIPIPersonal scores in the phonotrauma group may seem a contradiction of Trait Theory per Roy et al.'s (2000a) report that people with vocal fold nodules (VFN) tend to be extraverted, or strongly oriented to social reward (Roy et al., 2000b). Because they are oriented to others, one may predict that their social identity orientation (and not personal identity orientation) would be high. However, people with VFN have been found to be high in Social Potency, a lower-order trait that describes a leader who is persuasive and strong, one who enjoys visibility, dominance, and being in charge (Patrick et al., 2002; Roy et al., 2000b; Tellegen, 1982). Coupled with the SIPI's foundation in Self-Categorization Theory (Turner & Reynolds, 2012) specifying that personal identity orientation is what sets one apart from others in a group (Nario-Redmond et al., 2004), people with phonotrauma may be drawn to interact with other people but to use their voices to stand out from others as a "*strong* teacher" rather than a "*permissive* teacher" or a "*dominant* mother" rather than a "*submissive* mother." So, people with phonotrauma may be less motivated to *join* a group than to be *visible* within that group. Relating this idea to Dramaturgical Theory (Goffman, 1959), individuals with phonotrauma may be likely to identify as leaders and therefore portray this (personal) identity through voice use that eventually causes phonotrauma. Moreover, Identity Negotiation Theory (Swann & Bosson, 2008) states that individuals will shift their behavior until the person with whom they are interacting reflects back the originator's intended identity. One may imagine an individual experimenting (probably unconsciously) with different vocal behaviors (quantifiable via mean CPP) until one group of behaviors leads an interaction partner to treat the originator as a leader. Therefore, participants with phonotrauma who had the greatest SIPIPersonal scores (and potentially the greatest need to be treated as leaders within a group) may have the greatest skill with producing a range of voice behaviors to suit a variety of situations. Speculatively, once phonotrauma and dysphonia are established, these individuals may now experience low vocal congruence because their full range of preferred vocal behaviors are no longer available to them due to dysphonia. A further speculation is that it is possible that they may eschew maintenance of voice change during voice treatment because the new voice they are encouraged to habituate during voice therapy feels "sing-song" and therefore inauthentic to their identities.

A question does arise as to why a relationship between strength of personal identity orientation and voice changes was shown for the phonotrauma group but not the control or performer groups. For the moment, pending further research to unpack it, this finding remains enigmatic.

Turning to the question of vocal congruence, participants with phonotrauma reported *less congruence* with their habitual voice "as is" in real life than participants in other groups, and neurophysiological data corroborated the impression they experienced their dysphonic voice as "other," as if "playacting," in difference to other participants. These findings patently challenge notions that patients with phonotrauma accept their dysphonic voices "as they are" in real life, as "self." As a corollary, it does not seem that acceptance of current voice "as is," or as "self," is likely to underlie presumed resistance to voice changes in voice therapy. Moreover, vocal congruence scores did not have any relation to voice changes reflected by mean CPP in any of the groups.

Neurophysiological data were consistent with findings for vocal congruence scores in the phonotrauma group in particular. In both intergroup and group mean analyses, individuals in this group activated the PCu when answering questions in the self condition (i.e., their habitual voices) versus the resonant voice condition (which required a novel vocal motor production pattern). This finding suggests that this group connects their own habitual voices with portraying a character more than they associate a new motor pattern with the portrayal of someone other than themselves. Stated differently, the neurophysiological data suggest these individuals may think of their own voices as character voices, belonging not to them but to a foreign persona. This interpretation may be supported by the phonotrauma group mean analyses wherein the phonotrauma group activated the PCu during the Romeo/Juliet > Resonant contrast, suggesting that they used similar cognitive processes to generate statements while in character as Romeo/Juliet (contrasted with Resonant) as they did while using their habitual voices (contrasted with Resonant), given that this study is tying PCu activation with acting (Brown et al., 2019). As already noted, this evidence supports the conclusion that people with phonotrauma feel relatively low congruence with their habitual (dysphonic) voices shown by self-report data.

Alternative interpretations for PCu BOLD activation in the phonotrauma group could be (1) they felt unnatural producing their habitual voices covertly and in the fMRI environment, leading to BOLD activations consistent with perceived alienation with habitual voice. Additionally, consistent with other PCu functions, during habitual voice, (2) the participants may have been executing spatial functions supporting motor behavior (Selemon & Goldman-Rakic, 1988) or (3) voluntary change of attention and mental imagery (Cavanna & Trimble, 2006). Yet, these alternative arguments become less likely when one considers the conditions during which PCu activation occurred. Resonant voice is a novel voicing method and therefore seemingly more likely than habitual voice to trigger perceived (1) alienation. Additionally, resonant voice calls for feeling vibrations at the front of the face (Verdolini, 2008), which is a (2) spatial function. (3) Voluntary change of attention and mental imagery could have been more active during the Romeo/Juliet condition than the resonant voice condition if participants were imagining themselves as Romeo/Juliet. However, these cognitive processes should be less active during habitual voicing from one's own point of view than during novel resonant voicing. Overall, the initial interpretation of these data seems better supported by the confluence of intergroup and group mean analysis as well as the phonotrauma group's relatively low mean vocal congruence.

4.2 Associated Findings

Although the study design used by Brown et al. (2019) was a general guideline for the present work, the purpose was not necessarily to compare findings from that study to the present one. However, some comments can be made about a comparison. In the previous study, actors demonstrated deactivations in the dorsomedial and ventromedial prefrontal cortices and activation in the precuneus (PCu) during imagined vocalization playing Romeo/Juliet (in comparison to their first-person selves), a change in activity that, the authors concluded, suggested the association of the PCu with playacting. That finding was not replicated in performers in the current study with the Romeo/Juliet > Self contrast, possibly because participants in the current study self-identified as, variously, actors and singers, and Brown et al.'s participants were actors who trained within the same theatre program. Additionally, Brown et al.'s participants took part in a more extensive Romeo/Juliet training session than in the current study. The extended session could be necessary to differentiate the self from Romeo/Juliet and therefore trigger the corresponding cognitive changes and associated BOLD deactivations and activations.

For further comparison, the group means in the current study indicated that the performers exhibited BOLD activation of the posterior cingulate cortex (PCC) during the Resonant > Romeo/Juliet contrast. The PCC was associated with non-habitual voicing in McGettigan et al. (2013). Therefore, resonant voicing could have been more non-habitual for performers than Romeo/Juliet in the current study than in the article by Brown et al. Again, one may attribute this to Brown et al.'s comparatively more extended training of Romeo/Juliet as well as their participants' approach to acting. Brown et al.'s participants used the Stanislavski method of acting, wherein one essentially "becomes" the character that they are inhabiting, experiencing the world through the character's point of view (Stanislavski, 1936; 1949). Brown et al. found that the PCu was activated in the Romeo/Juliet > Self contrast in response to this "becoming." Therefore, in the current study, perhaps the performers did not receive enough training to "become" Romeo/Juliet and therefore experience them cognitively as a true "other." However, the performers in this study may not have replicated Brown et al.'s findings even if the performers had received the same training as Brown et al.'s participants because the performers were a mix of singers and actors, and approach to acting was not a controlled variable.

Overall, even though the present study did not replicate the findings from Brown et al., it offers additional preliminary evidence for the likelihood of shifts in sense of identity during voicing changes and may support further use of fMRI to study associations between mechanical changes in voicing and shifts of activation in brain regions associated with identity and their impacts on voice therapy outcomes.

4.3 Novel Picture that Emerges

Across findings, a novel picture emerges about patients with phonotrauma that may alter our assumptions about them in therapy and may challenge some of our voice therapy models more generally. Participants in this study with presumed phonotrauma seemed uncomfortable with their dysphonic voices and perhaps experienced them as "other than self." (A subgroup of people with phonotrauma who feel congruent with their voices may exist and cannot be ruled out statistically due to the small number of participants.) Perhaps this notion can be highlighted by clinicians in voice therapy with this population, to support patients' motivation to engage in therapy–to regain a healthy voice that expresses "self." Perhaps therapeutic voicing modalities such as resonant voice can be trained emphasizing greater authenticity, as occurs for example currently in LMRVT, emphasizing to patients their ability to craft a functional and authentic voice. Patient-centered approaches emphasizing treatment approaches tailored to a patient's specific voice needs are hardly new (American Speech-Language-Hearing Association, 2004). However, *contextualizing these needs in terms of a patient's deeply-seated identity is both novel and supported by evidence for the first time in this study.*

4.4 Limitations

The study was underpowered, as seems to frequently be the nature of research using fMRI due to financial and time costs. The study design and data analyses also contributed to this problem due to multiple conditions and contrasts. However, these limitations were thought to be acceptable given the exploratory nature of this research. Additionally, lack of a medical diagnosis of phonotrauma may reduce internal validity of the phonotrauma group. However, clinical perceptual impressions of phonotrauma and patient report of voice quality that worsens with use have been accepted and used in other much larger studies, a shift in inclusion criteria brought about by the necessities of conducting research during the COVID-19 pandemic (e.g., Verdolini Abbott et al., R01 DC017923; University of Delaware IRB 1384233). Statistical analysis of the CPP data did not control for variables found to impact CPP including loudness (Awan et al., 2012) and male gender (Awan et al., 2009). However, again, the size of participant groups and number of variables of interest precluded addition of variables beyond those of primary interest.

4.5 Future Directions

Future research should attempt to replicate current findings with an expanded participant number and perhaps refinement of experimental measures. As important, future work should assess initial and endpoints of the proposed causal model–not studied here–to explore the role of identity in pathogenesis and therapy outcomes. Longitudinal study designs will be required for full responses to these questions. Personality assessments may help to contextualize results via the Trait Theory. Finally, patient interviews such as those used in micro-phenomenological interviews may serve to deepen evidence surrounding a connection between voice and identity (Depraz, 2022; Petitmengin et al., 2017; Petitmengin et al., 2019).

4.6 Conclusions

Although nascent, the study of identity in the context of voice therapy is promising. Hypothetically, awareness of potential contributions of identity orientation to rehabilitation success for people with phonotrauma might lead to more positive outcomes. In this light, even now clinicians can be encouraged to reframe their current patient-centered approaches to incorporate identity-centered voice needs. Further empirical evidence will help to shape this line of inquiry.

REFERENCES

Adessa, M., Stadelman-Cohen, T., Zipse, L., Guarino, A. J., & Heaton, J. T. (2018). Factors affecting voice therapy completion in singers. *Journal of Voice*, *32*(5), 564-571. https://doi.org/10.1016/j.jvoice.2017.06.021

American Speech-Language-Hearing-Association. (2004). Preferred Practice Patterns for the Profession of Speech-Language Pathology [Preferred Practice Patterns].

American Speech-Language-Hearing-Association. (n.d.-a). *Voice Disorders (Practice Portal)*. Retrieved 09/07 from www.asha.org/Practice-Portal/Clinical-Topics/Voice-Disorders/

American Speech-Language-Hearing-Association. (n.d.-b). *What is Speech? What is Language?* Retrieved 09/07 from https://www.asha.org/public/speech/development/speech-and-language/

Ames, D. L., Jenkins, A. C., Banaji, M. R., & Mitchell, J. P. (2008). Taking another person's perspective increases self-referential neural processing. *Psychological Science*, *19*(7), 642-644. https://doi.org/10.1111/j.1467-9280.2008.02135.x

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: The medial frontal cortex and social cognition. *Nature Reviews Neuroscience*, *7*(4), 268-277. https://doi.org/10.1038/nrn1884

Awan, S. N., Giovinco, A., & Owens, J. (2012). Effects of vocal intensity and vowel type on cepstral analysis of voice. *Journal of Voice*, *26*(5), 670.e615-620. https://doi.org/10.1016/j.jvoice.2011.12.001

Awan, S. N., & Roy, N. (2009). Outcomes measurement in voice disorders: Application of an acoustic index of dysphonia severity. *Journal of Speech, Language, and Hearing Research*, *52*(2), 482-499. https://doi.org/10.1044/1092-4388(2009/08-0034)

Awan, S. N., Roy, N., & Dromey, C. (2009). Estimating dysphonia severity in continuous speech: Application of a multi-parameter spectral/cepstral model. *Clinical Linguistics & Phonetics*, *23*(11), 825-841. https://doi.org/10.3109/02699200903242988

Awan, S. N., Roy, N., Jetté, M. E., Meltzner, G. S., & Hillman, R. E. (2010). Quantifying dysphonia severity using a spectral/cepstral-based acoustic index: Comparisons with auditory-perceptual judgements from the CAPE-V. *Clinical Linguistics & Phonetics*, *24*(9), 742-758. https://doi.org/10.3109/02699206.2010.492446

Awan, S. N., Roy, N., Zhang, D., & Cohen, S. M. (2016). Validation of the Cepstral Spectral Index of Dysphonia (CSID) as a screening tool for voice disorders: Development of clinical cutoff scores. *Journal of Voice*, *30*(2), 130-144. https://doi.org/10.1016/j.jvoice.2015.04.009

Baken, R. J. (1987). *Clinical measurement of speech and voice*. College-Hill Press.

Beaty, R. E., Benedek, M., Barry Kaufman, S., & Silvia, P. J. (2015). Default and executive network coupling supports creative idea production. *Scientific Reports, 5*(1), 10964. https://doi.org/10.1038/srep10964

Behrman, A. (2014). Segmental and prosodic approaches to accent management. *American Journal of Speech-Language Pathology*, *23*(4), 546-561. https://doi.org/doi:10.1044/2014_AJSLP-13-0074

Biswal, B., Yetkin, F. Z., Haughton, V. M., & Hyde, J. S. (1995). Functional connectivity in the motor cortex of resting human brain using echo-planar MRI. *Magnetic Resonance in Medicine, 34*(4), 537-541.

Brain Imaging and Analysis Center. (2013, January 7). *FSL tutorial.* Retrieved January 31, 2023, from https://wiki.biac.duke.edu/lib/exe/fetch.php?media=biac:fslcourse.pdf.

Brown, S., Cockett, P., & Yuan, Y. (2019). The neuroscience of Romeo and Juliet: An fMRI study of acting. *Royal Society Open Science*, *6*(3), 181908-181908. https://doi.org/10.1098/rsos.181908

Callard, F., & Margulies, D. S. (2014). What we talk about when we talk about the default mode network. *Frontiers in Human Neuroscience*, *8*, 619. https://doi.org/10.3389/fnhum.2014.00619

Cavanna, A. E., & Trimble, M. R. (2006). The precuneus: A review of its functional anatomy and behavioural correlates. *Brain*, *129*(3), 564-583. https://doi.org/10.1093/brain/awl004

Cheek, N. N., & Cheek, J. M. (2018). Aspects of identity: From the inner-outer metaphor to a tetrapartite model of the self. *Self and Identity, 17*(4), 467-482.

Clark, L. A., & Watson, D. (2021). *Temperament: Theory and research* (4th ed.). The Guilford Press.

Cohen, S. M. (2010). Self-reported impact of dysphonia in a primary care population: An epidemiological study. *The Laryngoscope*, *120*(10), 2022-2032. https://doi.org/https://doi.org/10.1002/lary.21058

Crow, K. M., van Mersbergen, M., & Payne, A. E. (2021). Vocal congruence: The voice and the self measured by interoceptive awareness. *Journal of Voice*, *35*(2), 324.e315-324.e328. https://doi.org/10.1016/j.jvoice.2019.08.027

Da Costa, V., Prada, E., Roberts, A., & Cohen, S. (2012). Voice disorders in primary school teachers and barriers to care. *Journal of Voice*, *26*(1), 69-76. https://doi.org/10.1016/j.jvoice.2010.09.001

Dacakis, G., Davies, S., Oates, J. M., Douglas, J. M., & Johnston, J. R. (2013). Development and preliminary evaluation of the Transsexual Voice Questionnaire for Male-to-Female Transsexuals. *Journal of Voice*, *27*(3), 312-320. https://doi.org/10.1016/j.jvoice.2012.11.005

Davies, S., & Goldberg, J. M. (2006). Clinical aspects of transgender speech feminization and masculinization. *International Journal of Transgenderism*, *9*(3-4), 167-196. https://doi.org/10.1300/J485v09n03_08

de Medeiros, A. M., Assuncao, A. A., & Barreto, S. M. (2012). Absenteeism due to voice disorders in female teachers: A public health problem. *International Archives of Occupational and Environmental Health*, *85*(8), 853-864. https://doi.org/10.1007/s00420-011-0729-1

de Medeiros, A. M., Barreto, S. M., & Assuncao, A. A. (2008). Voice disorders (dysphonia) in public school female teachers working in Belo Horizonte: prevalence and associated factors. *Journal of Voice, 22*(6), 676-687. https://doi.org/10.1016/j.jvoice.2007.03.008

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. In E. T. Higgins, A. W. Kruglanski, & P. van Lange (Eds.), *Handbook of theories of social psychology* (Vol. 1, pp. 416-436). Sage Publications Ltd. https://doi.org/10.4135/9781446249215.n21

Depraz, N. (2022). Micro-phenomenological explicitation interviews and biographical narrative interviews: A combined perspective in light of the experiential analysis of chronic diseases. *Phenomenology and the Cognitive Sciences*, *21*(1), 97-106. https://doi.org/10.1007/s11097-021-09740-3

Derwing, T. M., & Munro, M. J. (1997). Accent, intelligibility, and comprehensibility: Evidence from four L1s. *Studies in Second Language Acquisition*, *19*(1), 1-16. https://doi.org/10.1017/S0272263197001010

Desikan, R. S., Ségonne, F., Fischl, B., Quinn, B. T., Dickerson, B. C., Blacker, D., Buckner, R. L., Dale, A. M., Maguire, R. P., Hyman, B. T., Albert, M. S., & Killiany, R. J. (2006). An automated labeling system for subdividing the human cerebral cortex on MRI scans into gyral based regions of interest. *Neuroimage*, *31*(3), 968-980. https://doi.org/10.1016/j.neuroimage.2006.01.021

Diedrichsen, J., Balsters, J. H., Flavell, J., Cussans, E., & Ramnani, N. (2009). A probabilistic MR atlas of the human cerebellum. *Neuroimage*, *46*(1), 39-46. https://doi.org/10.1016/j.neuroimage.2009.01.045

Dromey, C. (2003). Spectral measures and perceptual ratings of hypokinetic dysarthria. *Journal of Medical Speech-Language Pathology*, *11*, 85-94.

Eadie, T. L., & Baylor, C. R. (2006). The effect of perceptual training on inexperienced listeners' judgments of dysphonic voice. *Journal of Voice*, *20*(4), 527-544. https://doi.org/10.1016/j.jvoice.2005.08.007

Ebersole, B., Soni, R. S., Moran, K., Lango, M., Devarajan, K., & Jamal, N. (2018). The role of occupational voice demand and patient-rated impairment in predicting voice therapy adherence. *Journal of Voice*, *32*(3), 325-331. https://doi.org/10.1016/j.jvoice.2017.06.002

Eliot, L., Ahmed, A., Khan, H., & Patel, J. (2021). Dump the “dimorphism”: Comprehensive synthesis of human brain studies reveals few male-female differences beyond size. *Neuroscience & Biobehavioral Reviews, 125*. 667-697.

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. *Journal of Voice*, *27*(1), 129.e115-129.e120. https://doi.org/10.1016/j.jvoice.2011.08.012

Fairbanks, G. (1960). *Voice and articulation drillbook* (2nd ed.). Harper & Row.

Fraile, R., & Godino-Llorente, J. I. (2014). Cepstral peak prominence: A comprehensive analysis. *Biomedical Signal Processing and Control*, *14*, 42-54. https://doi.org/https://doi.org/10.1016/j.bspc.2014.07.001

Frazier, J. A., Chiu, S., Breeze, J. L., Makris, N., Lange, N., Kennedy, D. N., Herbert, M. R., Bent, E. K., Koneru, V. K., Dieterich, M. E., Hodge, S. M., Rauch, S. L., Grant, P. E., Cohen, B. M., Seidman, L. J., Caviness, V. S., & Biederman, J. (2005). Structural brain magnetic resonance imaging of limbic and thalamic volumes in pediatric bipolar disorder. *American Journal of Psychiatry*, *162*(7), 1256-1265. https://doi.org/10.1176/appi.ajp.162.7.1256

Geuter, S., Qi, G., Welsh, R. C., Wager, T. D., & Lindquist, M. A. (2018). Effect size and power in fMRI group analysis. *bioRxiv*, 295048. https://doi.org/10.1101/295048

Glover, G. H. (2011). Overview of functional magnetic resonance imaging. *Neurosurgery Clinics of North America*, *22*(2), 133-139, vii. https://doi.org/10.1016/j.nec.2010.11.001

Goffman, E. (1959). *The presentation of self in everyday life*. Anchor Books.

Goldstein, J. M., Seidman, L. J., Makris, N., Ahern, T., O'Brien, L. M., Caviness, V. S., Jr., Kennedy, D. N., Faraone, S. V., & Tsuang, M. T. (2007). Hypothalamic abnormalities in schizophrenia: Sex effects and genetic vulnerability. *Biological Psychiatry*, *61*(8), 935-945. https://doi.org/10.1016/j.biopsych.2006.06.027

Gray, J. A. (1970). The psychophysiological basis of introversion-extraversion. *Behavior Research and Therapy*, *8*(3), 249-266.

Greicius, M. D., Krasnow, B., Reiss, A. L., & Menon, V. (2003). Functional connectivity in the resting brain: A network analysis of the default mode hypothesis. *Proceedings of the National Academy of Sciences of the United States of America*, *100*(1), 253-258. https://doi.org/10.1073/pnas.0135058100

Gusnard, D. A., Akbudak, E., Shulman, G. L., & Raichle, M. E. (2001). Medial prefrontal cortex and self-referential mental activity: relation to a default mode of brain function. *Proceedings of the National Academy of Sciences of the United States of America*, *98*(7), 4259-4264. https://doi.org/10.1073/pnas.071043098

Gustin, R. L., Pielage, K. C., Howell, R., Khosla, S., & Giliberto, J. P. (2019). Increased interval from initial evaluation to initial voice therapy session is associated with missed voice therapy appointments. *Journal of Voice*. https://doi.org/10.1016/j.jvoice.2019.05.007

Hahn, L. D. (2004). Primary stress and intelligibility: Research to motivate the teaching of suprasegmentals. *TESOL Quarterly*, *38*(2), 201-223. https://doi.org/10.2307/3588378

Halberstam, B. (2004). Acoustic and perceptual parameters relating to connected speech are more reliable measures of hoarseness than parameters relating to sustained vowels. *ORL: Journal for Otorhinolaryngology and its Related Specialties*, *66*(2), 70-73. https://doi.org/10.1159/000077798

Hapner, E., Portone-Maira, C., & Johns III, M. M. (2009). A study of voice therapy dropout. *Journal of Voice*, *23*(3), 337-340. https://doi.org/10.1016/j.jvoice.2007.10.009

Helou, L. (2017). Crafting the dialogue: Meta-therapy in transgender voice and communication training. *Perspectives of the ASHA Special Interest Groups*, *2*(10), 83-91. https://doi.org/doi:10.1044/persp2.SIG10.83

Helou, L., Gartner-Schmidt, J. L., Hapner, E. R., Schneider, S. L., & Van Stan, J. H. (2021). Mapping meta-therapy in voice interventions onto the rehabilitation treatment specification system. *Seminars in Speech and Language*, *42*(1), 5-18. https://doi.org/10.1055/s-0040-1722756

Heman-Ackah, Y. D., Michael, D. D., & Goding, G. S., Jr. (2002). The relationship between cepstral peak prominence and selected parameters of dysphonia. *Journal of Voice*, *16*(1), 20-27. https://doi.org/10.1016/s0892-1997(02)00067-x

Hillenbrand, J., Cleveland, R. A., & Erickson, R. L. (1994). Acoustic correlates of breathy vocal quality. *Journal of Speech Hearing Research*, *37*(4), 769-778. https://doi.org/10.1044/jshr.3704.769

Jenkinson, M., Beckmann, C. F., Behrens, T. E. J., Woolrich, M. W., & Smith, S. M. (2012). FSL. *Neuroimage*, *62*(2), 782-790. https://doi.org/10.1016/j.neuroimage.2011.09.015

Jiang, J. J., & Titze, I. R. (1994). Measurement of vocal fold intraglottal pressure and impact stress. *Journal of Voice*, *8*(2), 132-144. https://doi.org/10.1016/s0892-1997(05)80305-4

Kavookjian, H., Holcomb, A., Garnett, J. D., & Kraft, S. (2018). The role of quality-of-life instruments in predicting voice therapy dropout. *Laryngoscope*, *128*(12), 2832-2837. https://doi.org/10.1002/lary.27269

Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self? An event-related fMRI study. *Journal of Cognitive Neuroscience*, *14*(5), 785-794. https://doi.org/10.1162/08989290260138672

Kempster, G. B., Gerratt, B. R., Verdolini Abbott, K., Barkmeier-Kraemer, J., & Hillman, R. E. (2009). Consensus auditory-perceptual evaluation of voice: development of a standardized clinical protocol. *American Journal of Speech Language Pathology*, *18*(2), 124-132. https://doi.org/10.1044/1058-0360(2008/08-0017)

Kobayashi, Y., & Amaral, D. G. (2007). Macaque monkey retrosplenial cortex: III. Cortical efferents. *Journal of Comparative Neurology*, *502*(5), 810-833. https://doi.org/10.1002/cne.21346

Kreiman, J., Gerratt, B. R., Kempster, G. B., Erman, A., & Berke, G. S. (1993). Perceptual evaluation of voice quality: review, tutorial, and a framework for future research. *Journal of Speech Hearing Research*, *36*(1), 21-40. https://doi.org/10.1044/jshr.3601.21

Lee, J. M., Roy, N., & Dietrich, M. (2019). Personality, psychological factors, and behavioral tendencies in children with vocal nodules: A systematic review. *Journal of Voice*, *33*(6), 945.e941-945.e918. https://doi.org/10.1016/j.jvoice.2018.07.016

Lee, J. M., Roy, N., Park, A., Muntz, H., Meier, J., Skirko, J., & Smith, M. (2021). Personality in children with vocal fold nodules: A multitrait analysis. *Journal of Speech, Language, and Hearing Research*, *64*(10), 3742-3758. https://doi.org/10.1044/2021_jslhr-21-00144

Leech, R., Kamourieh, S., Beckmann, C. F., & Sharp, D. J. (2011). Fractionating the default mode network: Distinct contributions of the ventral and dorsal posterior cingulate cortex to cognitive control. *Journal of Neuroscience*, *31*(9), 3217-3224. https://doi.org/10.1523/jneurosci.5626-10.2011

Leech, R., & Sharp, D. J. (2014). The role of the posterior cingulate cortex in cognition and disease. *Brain*, *137*(1), 12-32. https://doi.org/10.1093/brain/awt162

Leonard, R. (2009). Voice therapy and vocal nodules in adults. *Current Opinion in Otolaryngology & Head and Neck Surgery*, *17*(6). https://journals.lww.com/co-otolaryngology/Fulltext/2009/12000/Voice_therapy_and_vocal_nodules_in_adults.11.aspx

Lowell, S. Y., Colton, R. H., Kelley, R. T., & Hahn, Y. C. (2011). Spectral- and cepstral-based measures during continuous speech: Capacity to distinguish dysphonia and consistency within a speaker. *Journal of Voice*, *25*(5), e223-e232. https://doi.org/https://doi.org/10.1016/j.jvoice.2010.06.007

Madill, C., Chacon, A., Kirby, E., Novakovic, D., & Nguyen, D. D. (2021). Active ingredients of voice therapy for muscle tension voice disorders: A retrospective data audit. *Journal of Clinical Medicine*, *10*(18). https://doi.org/10.3390/jcm10184135

Makris, N., Goldstein, J. M., Kennedy, D., Hodge, S. M., Caviness, V. S., Faraone, S. V., Tsuang, M. T., & Seidman, L. J. (2006). Decreased volume of left and total anterior insular lobule in schizophrenia. *Schizophrenia Research*, *83*(2-3), 155-171. https://doi.org/10.1016/j.schres.2005.11.020

Maryn, Y., Corthals, P., Van Cauwenberge, P., Roy, N., & De Bodt, M. (2010). Toward improved ecological validity in the acoustic measurement of overall voice quality: Combining continuous speech and sustained vowels. *Journal of Voice*, *24*(5), 540-555. https://doi.org/10.1016/j.jvoice.2008.12.014

Maryn, Y., Roy, N., De Bodt, M., Van Cauwenberge, P., & Corthals, P. (2009). Acoustic measurement of overall voice quality: A meta-analysis. *Journal of the Acoustical Society of America*, *126*(5), 2619-2634. https://doi.org/10.1121/1.3224706

Maryn, Y., & Weenink, D. (2015). Objective dysphonia measures in the program Praat: Smoothed cepstral peak prominence and acoustic voice quality index. *Journal of Voice*, *29*(1), 35-43. https://doi.org/10.1016/j.jvoice.2014.06.015

Mattei, A., Revis, J., & Giovanni, A. (2017). Personality traits inventory in patients with vocal nodules. *European Archives of Oto-Rhino-Laryngology*, *274*(4), 1911-1917. https://doi.org/10.1007/s00405-016-4421-7

McCabe, D., & Titze, I. (2002). Chant therapy for treating vocal fatigue among public school teachers: A preliminary study. *American Journal of Speech-Language Pathology*, *11*, 356-369.

McCrae, R., Costa, P. T., Ostendorf, F., Angleitner, A., Hřebíčková, M., Avia, M. D., Sanz, J., Sanchez-Bernardos, M. L., Kuşdil, M. E., Woodfield, R., Saunders, P. R., & Smith, P. B. (2000). Nature over nurture: Temperament, personality, and life span development. *Journal of Personality and Social Psychology*, *78*(1), 173-186.

McCrae, R. R., & Costa Jr, P. T. (2008). The five-factor theory of personality. In *Handbook of personality: Theory and research,* (3rd ed.). (pp. 159-181). The Guilford Press.

McCrory, E. (2010). Voice therapy outcomes in vocal fold nodules: A retrospective audit. *International Journal of Language & Communication Disorders*, *36*(S1), 19-24. https://doi.org/10.3109/13682820109177852

McGettigan, C., Eisner, F., Agnew, Z. K., Manly, T., Wisbey, D., & Scott, S. K. (2013). T'ain't what you say, it's the way that you say it--left insula and inferior frontal cortex work in interaction with superior temporal regions to control the performance of vocal impersonations. *Journal of Cognitive Neuroscience*, *25*(11), 1875-1886. https://doi.org/10.1162/jocn_a_00427

Minitab, LLC. (2021). *Minitab.* Retrieved from https://www.minitab.com.

Mozzanica, F., Ginocchio, D., Barillari, R., Barozzi, S., Maruzzi, P., Ottaviani, F., & Schindler, A. (2016). Prevalence and voice characteristics of laryngeal pathology in an Italian voice therapy-seeking population. *Journal of Voice*, *30*(6), 774.e713-774.e721. https://doi.org/10.1016/j.jvoice.2015.11.018

Murton, O., Hillman, R., & Mehta, D. (2020). Cepstral peak prominence values for clinical voice evaluation. *American Journal of Speech-Language Pathology*, *29*(3), 1596-1607. https://doi.org/doi:10.1044/2020_AJSLP-20-00001

Nario-Redmond, M. R., Biernat, M., Eidelman, S., & Palenske, D. J. (2004). The Social and Personal Identities Scale: A measure of the differential importance ascribed to social and personal self-categorizations. *Self and Identity*, *3*(2), 143-175. https://doi.org/10.1080/13576500342000103

Ohlsson, A. C., Andersson, E. M., Sodersten, M., Simberg, S., & Barregard, L. (2012). Prevalence of voice symptoms and risk factors in teacher students. *Journal of Voice*, *26*(5), 629-634. https://doi.org/10.1016/j.jvoice.2011.11.002

Palmer, E. D., Rosen, H. J., Ojemann, J. G., Buckner, R. L., Kelley, W. M., & Petersen, S. E. (2001). An event-related fMRI study of overt and covert word stem completion. *Neuroimage*, *14*(1), 182-193. https://doi.org/https://doi.org/10.1006/nimg.2001.0779

Pasternak, K., Diaz, J., & Thibeault, S. L. (2020). Predictors of voice therapy initiation: A cross-sectional cohort study. *Journal of Voice*. https://doi.org/10.1016/j.jvoice.2020.05.003

Patrick, C. J., Curtin, J. J., & Tellegen, A. (2002). Development and validation of a brief form of the Multidimensional Personality Questionnaire. *Psychological Assessment*, *14*(2), 150-163. https://doi.org/10.1037/1040-3590.14.2.150

Petitmengin, C., van Beek, M., Bitbol, M., Nissou, J., & Roepstorff, A. (2017). What is it like to meditate? Methods and issues of a micro-phenomenological description of meditative experience. *Journal of Consciousness Studies*, *24*(5-6), 170-198.

Petitmengin, C., van Beek, M., Bitbol, M., Nissou, J., & Roepstorff, A. (2019). Studying the experience of meditation through micro-phenomenology. *Current Opinion in Psychology*, *28*, 54-59.

Portone, C., Johns, M. A., & Hapner, E. R. (2008). A review of patient adherence to the recommendation for voice therapy. *Journal of Voice*, *22*(2), 192-196. https://doi.org/10.1016/j.jvoice.2006.09.009

Portone-Maira, C., Wise, J. C., Johns III, M. M., & Hapner, E. R. (2011). Differences in temporal variables between voice therapy completers and dropouts. *Journal of Voice*, *25*(1), 62-66. https://doi.org/10.1016/j.jvoice.2009.07.007

Preciado-Lopez, J., Perez-Fernandez, C., Calzada-Uriondo, M., & Preciado-Ruiz, P. (2008). Epidemiological study of voice disorders among teaching professionals of La Rioja, Spain. *Journal of Voice*, *22*(4), 489-508. https://doi.org/10.1016/j.jvoice.2006.11.008

Qin, Y., Vaseghi, S., Rentzos, D., & Ching-Hsiang, H. (2004, May 17-21). *Analysis by synthesis of acoustic correlates of British, Australian and American accents* [Paper presentation]. 2004 IEEE International Conference on Acoustics, Speech, and Signal Processing, Montreal, QC, Canada.

Roberts, B. W., & Nickel, L. B. (2021). Personality development across the life course: A neo-socioanalytic perspective. In O. P. John & R. W. Robins (Eds.), *Handbook of personality: Theory and research* (4th ed., pp. 259-283). The Guildford Press.

Roberts, B. W., & Wood, D. (2006). Personality development in the context of neo-socioanalytic theory. In D. Mroczek & T. D. Little (Eds.), *Handbook of personality development* (pp. 11-39). Erlbaum.

Rorden, C., & Brett, M. (2000). Stereotaxic display of brain lesions. *Behavioural Neurology*, *12*(4), 191-200. https://doi.org/10.1155/2000/421719

Rosen, C. A., Lee, A. S., Osborne, J., Zullo, T., & Murry, T. (2004). Development and validation of the Voice Handicap Index-10. *Laryngoscope*, *114*(9), 1549-1556. https://doi.org/10.1097/00005537-200409000-00009

Rosow, D. E., Diaz, J., Pan, D. R., & Lloyd, A. T. (2021). Hispanic ethnicity as a predictor of voice therapy adherence. *Journal of Voice, 35*(2). https://doi.org/10.1016/j.jvoice.2019.09.011

Roy, N. (2011). Personality and voice disorders. *Perspectives on Voice and Voice Disorders*, *21*(1), 1-38.

Roy, N., & Bless, D. M. (2000a). Personality traits and psychological factors in voice pathology. *Journal of Speech, Language, and Hearing Research*, *43*(3), 737-748. https://doi.org/doi:10.1044/jslhr.4303.737

Roy, N., & Bless, D. M. (2000b). Toward a theory of the dispositional bases of functional dysphonia and vocal nodules: Exploring the role of personality and emotional adjustment. In R.D. Kent & M.J. Ball, (Eds.), *Voice quality measurement* (pp. 461-480). Singular Publishing Group.

Roy, N., Bless, D. M., & Heisey, D. (2000a). Personality and voice disorders: A multitrait-multidisorder analysis. *Journal of Voice*, *14*(4), 521-548.

Roy, N., Bless, D. M., Heisey, D. (2000b). Personality and voice disorders: A superfactor trait analysis. *Journal of Speech, Language, and Hearing Research*, *43*, 749-768.

Roy, N., Merrill, R. M., Gray, S. D., & Smith, E. M. (2005). Voice disorders in the general population: prevalence, risk factors, and occupational impact. *Laryngoscope*, *115*(11), 1988-1995. https://doi.org/10.1097/01.mlg.0000179174.32345.41

Roy, N., Merrill, R. M., Thibeault, S., Parsa, R. A., Gray, S. D., & Smith, E. M. (2004). Prevalence of voice disorders in teachers and the general population. *Journal of Speech*, *Language, and Hearing Research*, *47*(2), 281-293. https://doi.org/doi:10.1044/1092-4388(2004/023)

Rubino, M., & Verdolini Abbott, K. (in press). Scoping review of voice therapy adherence. *Journal of Voice.*

Sala, E., Laine, A., Simberg, S., Pentti, J., & Suonpää, J. (2001). The prevalence of voice disorders among day care center teachers compared with nurses. *Journal of Voice*, *15*(3), 413-423. https://doi.org/10.1016/s0892-1997(01)00042-x

Saxe, R., & Powell, L. J. (2006). It's the thought that counts: Specific brain regions for one component of theory of mind. *Psychological Science*, *17*(8), 692-699. https://doi.org/10.1111/j.1467-9280.2006.01768.x

Schneider, B., & Bigenzahn, W. (2005). Vocal risk factors for occupational voice disorders in female teaching students. *European Archives of Oto-Rhino-Laryngology*, *262*(4), 272-276. https://doi.org/10.1007/s00405-004-0768-2

Selemon, L. D., & Goldman-Rakic, P. S. (1988). Common cortical and subcortical targets of the dorsolateral prefrontal and posterior parietal cortices in the rhesus monkey: Evidence for a distributed neural network subserving spatially guided behavior. *Journal of Neuroscience*, *8*(11), 4049-4068. https://doi.org/10.1523/jneurosci.08-11-04049.1988

Shulman, G. L., Fiez, J. A., Corbetta, M., Buckner, R. L., Miezin, F. M., Raichle, M. E., & Petersen, S. E. (1997). Common blood flow changes across visual tasks: II. Decreases in cerebral cortex. *Journal of Cognitive Neuroscience*, *9*(5), 648-663. https://doi.org/10.1162/jocn.1997.9.5.648

Shuster, L. I., & Lemieux, S. K. (2005). An fMRI investigation of covertly and overtly produced mono- and multisyllabic words. *Brain and Language*, *93*(1), 20-31. https://doi.org/https://doi.org/10.1016/j.bandl.2004.07.007

Simberg, S., Sala, E., & Ronnemaa, A. M. (2004). A comparison of the prevalence of vocal symptoms among teacher students and other university students. *Journal of Voice*, *18*(3), 363-368. https://doi.org/10.1016/j.jvoice.2003.12.005

Simberg, S., Sala, E., Vehmas, K., & Laine, A. (2005). Changes in the prevalence of vocal symptoms among teachers during a twelve-year period. *Journal of Voice*, *19*(1), 95-102. https://doi.org/10.1016/j.jvoice.2004.02.009

Singh, K. D., & Fawcett, I. P. (2008). Transient and linearly graded deactivation of the human default-mode network by a visual detection task. *Neuroimage*, *41*(1), 100-112. https://doi.org/10.1016/j.neuroimage.2008.01.051

Smith, S. M. (2002). Fast robust automated brain extraction. *Human Brain Mapping*, *17*(3), 143-155.

Smith, B. E., Kempster, G. B., & Sims, H. S. (2010). Patient factors related to voice therapy attendance and outcomes. *Journal of Voice, 24*(6), 694-701. https://doi.org/10.1016/j.jvoice.2009.03.004

Soenens, B., & Vansteenkiste, M. (2011). When is identity congruent with the self? A self-determination theory perspective. In *Handbook of identity theory and research, Vols. 1 and 2* (pp. 381-401). Springer Science + Business Media. https://doi.org/10.1007/978-1-4419-7988-9_17

Stanislavski, K. (1936). *An actor prepares*. Routledge.

Stanislavski, K. (1949). *Building a character*. Routledge.

Starmer, H. M., Liu, Z., Akst, L. M., & Gourin, C. (2014). Attendance in voice therapy: Can an interdisciplinary care model have an impact. *Annals of Otology, Rhinology and Laryngology*, *123*(2), 117-123. https://doi.org/10.1177/0003489414523708

Stemple, J. (1984). *Clinical voice pathology: Theory and management*. Merrill.

Stemple, J. C., Lee, L., D'Amico, B., & Pickup, B. (1994). Efficacy of vocal function exercises as a method of improving voice production. *Journal of Voice*, *8*(3), 271-278. https://doi.org/https://doi.org/10.1016/S0892-1997(05)80299-1

Stepp, C. E., Heaton, J. T., Stadelman-Cohen, T. K., Braden, M. N., Jette, M. E., & Hillman, R. E. (2011). Characteristics of phonatory function in singers and nonsingers with vocal fold nodules. *J Voice*, *25*(6), 714-724. https://doi.org/10.1016/j.jvoice.2010.06.003

Stepp, C. E., Hillman, R. E., & Heaton, J. T. (2010a). Use of neck strap muscle intermuscular coherence as an indicator of vocal hyperfunction. *IEEE Trans Neural Syst Rehabil Eng*, *18*(3), 329-335. https://doi.org/10.1109/TNSRE.2009.2039605

Stepp, C. E., Hillman, R. E., & Heaton, J. T. (2010b). A virtual trajectory model predicts differences in vocal fold kinematics in individuals with vocal hyperfunction. *J Acoust Soc Am*, *127*(5), 3166-3176. https://doi.org/10.1121/1.3365257

Swann, W. B., & Bosson, J. K. (2008). *Identity negotiation: A theory of self and social interaction*. The Guilford Press.

Swann, W. J. (1999). *Resilient identities: Self, relationships, and the construction of social reality*. Basic Books.

Tanner, K., Roy, N., Ash, A., & Buder, E. H. (2005). Spectral Moments of the Long-term Average Spectrum: Sensitive Indices of Voice Change After Therapy? *Journal of Voice*, *19*(2), 211-222. https://doi.org/https://doi.org/10.1016/j.jvoice.2004.02.005

Tanner, K., Sauder, C., Thibeault, S. L., Dromey, C., & Smith, M. E. (2010). Vocal fold bowing in elderly male monozygotic twins: A case study. *Journal of Voice*, *24*(4), 470-476. https://doi.org/10.1016/j.jvoice.2008.10.010

Tellegen, A. (1982). *Brief manual for the Multidimensional Personality Questionnaire*. Unpublished manuscript.

Titze, I. R. (2006). Voice training and therapy with a semi-occluded vocal tract: rationale and scientific underpinnings. *J Speech Lang Hear Res*, *49*(2), 448-459. https://doi.org/10.1044/1092-4388(2006/035)

Toles, L. E., Ortiz, A. J., Marks, K. L., Burns, J. A., Hron, T., Stan, J. H. V., Mehta, D. D., & Hillman, R. E. (2021). Differences Between Female Singers With Phonotrauma and Vocally Healthy Matched Controls in Singing and Speaking Voice Use During 1 Week of Ambulatory Monitoring. *American Journal of Speech-Language Pathology*, *30*(1), 199-209. https://doi.org/doi:10.1044/2020_AJSLP-20-00227

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherall, M. (1987). *Rediscovering the social group: A self-categorization theory*. Basil Blackwell.

Turner, J. C., & Reynolds, K. J. (2012). Self-categorization theory. In P. A. M. Van Lange, A. W. Kruglanski, & E. T. Higgins (Eds.), *Handbook of theories of social psychology (Vol. 2)* (pp. 399-417). Sage Publications Ltd, Thousand Oaks, CA. https://doi.org/http://dx.doi.org/10.4135/9781446249222.n46

Vamosi, B. E., Mikhail, L., Gustin, R. L., Pielage, K. C., Reid, K., Tabangin, M. E., Altaye, M., Collar, R. M., Khosla, S. M., Giliberto, J. P., & Howell, R. J. (2020). Predicting no show in voice therapy: Avoiding the missed appointment cycle. *Journal of Voice*. https://doi.org/10.1016/j.jvoice.2020.01.003

van Leer, E., & Connor, N. P. (2010). Patient perceptions of voice therapy adherence. *Journal of Voice*, *24*(4), 458-469. https://doi.org/10.1016/j.jvoice.2008.12.009

Van Stan, J. H., Roy, N., Awan, S., Stemple, J., & Hillman, R. E. (2015). A taxonomy of voice therapy. *Am J Speech Lang Pathol*, *24*(2), 101-125. https://doi.org/10.1044/2015_AJSLP-14-0030

Van Stan, J. H., Whyte, J., Duffy, J. R., Barkmeier-Kraemer, J., Doyle, P., Gherson, S., Kelchner, L., Muise, J., Petty, B., Roy, N., Stemple, J., Thibeault, S., & Tolejano, C. J. (2021). Voice therapy according to the Rehabilitation Treatment Specification System: Expert consensus ingredients and targets. *Am J Speech Lang Pathol*, *30*(5), 2169-2201. https://doi.org/10.1044/2021_ajslp-21-00076

Vaseghi, S., Yan, Q., & Ghorshi, A. (2009). Speech Accent Profiles: Modeling and Synthesis [Applications Corner]. *IEEE Signal Processing Magazine*, *26*(3), 69-74. https://doi.org/10.1109/MSP.2009.932161

Verdolini Abbott, K. (2008). *Lessac-Madsen Resonant Voice Therapy*. Plural Publishing.

Verdolini, K., Druker, D. G., Palmer, P. M., & Samawi, H. (1998). Laryngeal adduction in resonant voice. *J Voice*, *12*(3), 315-327. https://doi.org/10.1016/s0892-1997(98)80021-0

Verdolini-Marston, K., Burke, M., Lessac, A., Glaze, L., & Caldwell, E. (1995). Preliminary study of two methods of treatment for laryngeal nodules. *Journal of Voice*, *9*(1), 74-85. https://doi.org/10.1016/S0892-1997(05)80225-5

Wingate, J. M., Brown, W. S., Shrivastav, R., Davenport, P., & Sapienza, C. M. (2007). Treatment outcomes for professional voice users. *J Voice*, *21*(4), 433-449. https://doi.org/10.1016/j.jvoice.2006.01.001

Wolfe, V., & Martin, D. (1997). Acoustic correlates of dysphonia: Type and severity. *Journal of Communication Disorders*, *30*(5), 403-415; quiz 415-406. https://doi.org/10.1016/s0021-9924(96)00112-8

Wolfe, V. I., Martin, D. P., & Palmer, C. I. (2000). Perception of dysphonic voice quality by naive listeners. *Journal of Speech Language Hearing Research*, *43*(3), 697-705. https://doi.org/10.1044/jslhr.4303.697

Wood, D., & Roberts, B. W. (2006). Cross-sectional and longitudinal tests of the Personality and Role Identity Structural Model (PRISM). *Journal of Personality*, *74*(3), 779-809.

Xu, X., Yuan, H., & Lei, X. (2016). Activation and Connectivity within the Default Mode Network Contribute Independently to Future-Oriented Thought. *Scientific Reports*, *6*(1), 21001. https://doi.org/10.1038/srep21001

Appendix A

LIST OF QUESTIONS

Self: Acoustic and Scanner

1. Would you tell your parents / if you got fired from a job?

2. Would you be friends with a person / who often gets into trouble?

3. Would you call in sick to work / if the weather were especially nice?

4. Would you marry someone / who your parents didn't approve of?

5. Would you ever watch / a religious TV program?

6. Would you fight in a war / if asked to by the government?

7. Would you have a personal conversation / with a waiter in a restaurant?

8. Would you shout at someone / who got in your way?

9. Would you attend the funeral / of someone you didn't like?

Self: Practice

1. Would you ever stay out all night / with your friends?

2. Would you expect your family to support you financially / if you were out of work?

3. Would you ever get into an argument / with a store clerk?

4. Would you run a red light if you were in a rush?

Self with resonant voice: Acoustic and Scanner

1. Would you obey your parents / even if you disagreed with them?

2. Would you re-connect with a childhood friend / after many years of no contact?

3. Would you hire a nanny / to help take care of your children?

4. Would you write a poem to express / your feelings for your romantic partner?

5. Would you pray before / an important job interview?

6. Would you lie to a police officer / to protect a close friend?

7. Would you tell your parents / if a friend were in trouble?

8. Would you fight someone who / confronted you in a public place?

9. Would you miss the funeral of a family member / if it conflicted with work?

Self with resonant voice: Practice

1. Would you become angry / if you had to wait in a long line?

2. Would you ever go out to a dance club with your friends?

3. Would you challenge an employer's opinion if you believed it was wrong?

4. Would you cry at the funeral of a family member?

Self with British accent: Acoustic and Scanner

1. If your parents offered you money, / would you accept it?

2. Would you act rowdy in public / if your friends were doing so?

3. Would you date someone of / a lower economic class than yourself?

4. Would you move to another city / to be with your romantic partner?

5. Would you change your lifestyle / if a religious advisor suggested you do so?

6. Would you miss work / if a friend asked you for a ride to the airport?

7. Would you take towels from a hotel / if you thought nobody would notice?

8. Would you stand up for / a close friend if they were insulted?

9. Would you give a eulogy at a funeral / if asked to?

Self with British accent: Practice

1. Would you be upset if a friend made fun of you?

2. Would you go on a vacation with your parents?

3. Would you discuss your personal problems with a religious figure?

4. Would you go to a party where you didn't know any of the people?

Romeo/Juliet: Acoustic and Scanner

1. Would you go to your parents / to discuss your woes?

2. Would you ever keep secrets / from your closest friends?

3. Would you ask your servant / for their opinion on a personal matter?

4. Would you do anything that / your lover requested of you?

5. Would you ever tell a lie / to a religious figure?

6. Would you accept an order / from an authority figure without question?

7. Would you go to a party / that you were not invited to?

8. Would you use violence / in order to right a wrong?

9. Would you mourn the death of an enemy?

Romeo/Juliet: Practice

1. Would you be angry with a friend who betrayed you?

2. Would you be concerned about the well-being of a servant?

3. Would you go to a church during a difficult time?

4. Would you tell your parents / if you met someone who you liked?

Appendix B

IRB CONTINUING REVIEW/PROGRESS REPORT LETTER

UNIVERSITY OF DELAWARE

Institutional Review Board
210H Hullihen Hall
Newark, DE 19716
Phone: 302-831-2137
Fax: 302-831-2828

DATE:	September 1, 2022
TO:	Marianna Rubino, MFA, MS, PhD Student
FROM:	University of Delaware IRB
STUDY TITLE:	[1781312-5] Neurobehavioral Activity During Voice-Centric Identity Challenge
SUBMISSION TYPE:	Continuing Review/Progress Report
ACTION:	APPROVED
EFFECTIVE DATE:	September 1, 2022
NEXT REPORT DUE:	August 17, 2023
REVIEW TYPE:	Administrative Review
REVIEW CATEGORY:	Expedited review category # *(4,6)*

Thank you for your Continuing Review/Progress Report submission to the University of Delaware Institutional Review Board (UD IRB). The UD IRB has reviewed and APPROVED the proposed research and submitted documents via Administrative Review in compliance with the pertinent federal regulations.

As the Principal Investigator for this study, you are responsible for, and agree that:

- All research must be conducted in accordance with the protocol and all other study forms as approved in this submission. Any revisions to the approved study procedures or documents must be reviewed and approved by the IRB prior to their implementation. Please use the UD amendment form to request the review of any changes to approved study procedures or documents.
- Informed consent is a process that must allow prospective participants sufficient opportunity to discuss and consider whether to participate. IRB-approved and stamped consent documents must be used when enrolling participants and a written copy shall be given to the person signing the informed consent form.
- Unanticipated problems, serious adverse events involving risk to participants, and all non-compliance issues must be reported to this office in a timely fashion according with the UD requirements for reportable events. All sponsor reporting requirements must also be followed.

The UD IRB REQUIRES the submission of a PROGRESS REPORT DUE ON August 17, 2023. A continuing review/progress report form must be submitted to the UD IRB at least 45 days prior to the due date to allow for the review of that report.

If you have any questions, please contact the UD IRB Office at (302) 831-2137 or via email at hsrb-research@udel.edu. Please include the study title and reference number in all correspondence with this office.

INSTITUTIONAL REVIEW BOARD

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