


2014

Perceptual Analysis of Prolonged Vowels in Adolescent and Young Adults with Friedreich's Ataxia

Tara Varsallone
University of Central Florida

 Part of the [Communication Sciences and Disorders Commons](#)
Find similar works at: <https://stars.library.ucf.edu/etd>
University of Central Florida Libraries <http://library.ucf.edu>

This Masters Thesis (Open Access) is brought to you for free and open access by STARS. It has been accepted for inclusion in Electronic Theses and Dissertations, 2004-2019 by an authorized administrator of STARS. For more information, please contact STARS@ucf.edu.

STARS Citation

Varsallone, Tara, "Perceptual Analysis of Prolonged Vowels in Adolescent and Young Adults with Friedreich's Ataxia" (2014). *Electronic Theses and Dissertations, 2004-2019*. 4836.
<https://stars.library.ucf.edu/etd/4836>

PERCEPTUAL ANALYSIS OF PROLONGED VOWELS
IN ADOLESCENT AND YOUNG ADULTS
WITH FRIEDREICH'S ATAXIA

by

TARA LISE VARSALLONE
B.A University of Central Florida, 2012

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Arts
in the Department of Communication Sciences and Disorders
in the College of Health and Public Affairs
at the University of Central Florida
Orlando, Florida

Spring Term
2014

ABSTRACT

The purpose of this study was to conduct perceptual analyses, using the initial two-second portions, of prolonged vowels /a/, /i/, and /o/. Two groups of adolescents and young adults were analyzed- one group consisting of 20 individuals with Friedreich's ataxia who were compared to 20 individuals with normal voice (control participants). A trained group of 10 graduate students listened to 132 vowel samples (3 vowels X 40 participants, + 12 samples (10%) for reliability purposes) for a total of 132 perceptual judgments. The students listened to the samples which were randomized onto Dell computers (Optiplex 755) and played through headphones that were set at a comfortable level by the listeners prior to analyzing the voice samples. Listeners used a modified version of the Consensus-Auditory Perceptual Evaluation of Voice (CAPE-VM) to rate the vocal qualities of 'roughness', 'breathiness', and 'strain' in the samples on a 100 millimeter visual analog scale with 0 representing a perception of no roughness, breathiness, or strain, and 100 indicating the most extreme amount of variance from normal voice quality.

Statistical analyses were conducted to determine if perceptual measures were significantly different between the two groups. Values on these analyses were expected to be larger for individuals with Friedreich's ataxia than those with normal voice. Results revealed that all three measures were significantly different between the two groups, with those in the Friedreich's ataxia group reported as having increased rough, breathy, and strained components in their voice quality as compared to normal voiced peers. Findings support perceptual measures as useful indicators for reporting changes in the phonatory system due to Friedreich's ataxia.

ACKNOWLEDGMENTS

Throughout the course of my educational endeavors, I was fortunate enough to be surrounded by family, friends, and professors who held my achievements at a high level of importance. Striving to change others' lives is an integral part of my own life, which is why this career path is so appropriate for me. The past couple of years have flown by, but with new experiences showing themselves daily.

I always knew I had a passion to help others, but in what way I was not sure of until I found the profession of Speech Language Pathology. The different avenues that one can take in the field are so broad that whether it be providing therapy to individuals, teaching at a university, and/or becoming specialized in research, there's never a dull moment.

I would like to thank my thesis advisors, Dr. Cecyle Carson and Dr. Jack Ryalls, for providing me with this wonderful opportunity to acquire more knowledge on voice and its characteristics as well as a new outlook on research itself. I was lucky enough to have had both Dr. Ryalls and Dr. Carson as professors throughout my undergraduate career, as well as teaching labs for Dr. Ryalls' speech science (production and perception) classes when I began the Graduate program. They have both been there for me throughout my undergraduate and graduate career with smiles on their faces. The experience of working with them has been nothing short of wonderful and eye-opening.

I would also like to acknowledge Dr. Bari Hoffman-Ruddy, who is a member of my thesis committee. Dr. Ruddy has been helpful from the very beginning, always willing to incorporate the most up-to-date research and encouraging me to tackle any obstacles that came my way. Not only did she work around her very busy schedule to meet with me whenever

needed, but she also took the time to talk with me over the phone even while she was working at her ENT clinic.

I would like to thank my most close and caring best friend, Kaylea Hardin, who rode this rollercoaster of Undergraduate and Graduate school by my side. I could not have gotten this far without her friendship and words of encouragement. Knowing I was able to work daily with a best friend, peer, co-worker, and wonderful individual made each day a little bit brighter. Thank you for always providing me with positivity and joy.

To the Department of Communication Sciences and Disorders Department, I thank you all for being supportive and willing to work around my schedule. From the undergraduate to the graduate professors that I have had, as well as the clinical educators and supervisors that were always there for positive reinforcement to shape me as the student and clinician that I am today.

Special thanks goes out to Marie Le Normand of France for providing us with the Friedreich's Ataxia voice samples, as well as the individuals who were willing to provide their voice samples for purposes of this research study. The graduate students who participated as listeners also deserve a special thanks, as the hours of rating was definitely appreciated.

Thank you to my entire, wonderful, family who has always been there for me throughout my life. No matter what situations I was in, be it a positive or negative, I knew I was never alone. They have provided me with more smiles and laughs throughout my childhood, adolescence, and still into adulthood than I could have ever wished for. The relationships that I have formed with each member of my family I will hold with me for all of my life. A large thanks to my lovely boyfriend, Gabriel Pruna, who has endured my ups and downs for the past

two years and held my hand every step of the way. Thank you all for believing in me and assisting me to become the more complete woman that I am today.

TABLE OF CONTENTS

| | |
|--|----|
| LIST OF FIGURES | ix |
| LIST OF TABLES | x |
| CHAPTER 1 INTRODUCTION | 1 |
| A Review of the Literature: | 2 |
| Description of FA | 2 |
| Symptoms | 2 |
| Perceptual Measures | 4 |
| Purpose..... | 7 |
| Justification | 8 |
| Hypotheses | 8 |
| CHAPTER 2 METHOD | 10 |
| Study Design..... | 10 |
| Variables | 10 |
| Participants diagnosed with Friedrich’s ataxia | 11 |
| Participants who had normal speech and voice (NV)..... | 11 |
| Listeners | 16 |

| | |
|---|----|
| Institutional Review Board (IRB)..... | 17 |
| Vowel Stimuli | 17 |
| Perceptual Data | 20 |
| Statistical Analysis..... | 21 |
| CHAPTER 3 RESULTS | 23 |
| Group Differences on Voice Attributes | 23 |
| Group Differences on Vowel, Disordered/Normal Voice, and Gender Perception..... | 24 |
| Correlations on CAPE-VM Measures | 27 |
| CHAPTER 4 DISCUSSION..... | 28 |
| Conclusions..... | 31 |
| Limitations | 32 |
| Future Studies | 33 |
| APPENDIX A: INFORMED CONSENT (VOICE SAMPLES) | 34 |
| APPENDIX B: UCF IRB APPROVAL FORM | 38 |
| APPENDIX C: INFORMED CONSENT (LISTENERS)..... | 40 |
| APPENDIX D: DEBRIEFING FORM (LISTENERS)..... | 45 |
| APPENDIX E: LISTENER INFORMATION | 48 |
| APPENDIX F: MODIFIED CAPE-V FORM | 50 |
| APPENDIX G: LISTENER INSTRUCTIONS | 54 |

| | |
|---|-----|
| APPENDIX H: PERCEPTUAL MEASURES RAW DATA..... | 56 |
| REFERENCES | 120 |

LIST OF FIGURES

| | |
|--|----|
| Figure 1: Modified Vowel Quadrilateral depicting tongue placement for the vowel sounds /a/ /i/ and /o/ used in this study..... | 18 |
|--|----|

LIST OF TABLES

| | |
|--|----|
| Table 1: Participant Characteristics | 13 |
| Table 2: Statistical Comparisons of Normal Voice Individuals and Friedreich's Ataxia Individuals on Measures of a Modified Consensus Auditory Perceptual Evaluation of Voice (CAPE-VM) in millimeters..... | 24 |
| Table 3: Group Comparison on Measures of Listener Ability to Correctly Identify Vowels, Diagnosis, and Gender. | 26 |

CHAPTER 1

INTRODUCTION

Friedreich's ataxia (FA) is a hereditary, neurodegenerative, rare disease that affects genders equally. It impacts the nervous system which gives rise to movement problems. Neuronal degeneration occurs in individuals with FA, which is why the nervous system is affected. Although the disease itself is rare, it is a fairly common disorder among the ataxias. Ataxia occurs when there's a failure in coordination of the muscles as well as muscular activity irregularity. About 50% of all cases of hereditary ataxia are comprised of Friedreich's ataxia. In regards to prevalence, it is the most prevalent inherited ataxia affecting about 1/50,000 individuals (Cossee et al., 1999). The disease is an autosomal recessive, inherited, degenerative disease. In order for an individual to be affected, it is necessary to receive the gene from both parents making it an autosomal recessive genetic disorder. Incidence of this disease is around 1.5 per 100,000 per year among Europeans and North Americans of European descent. Typically, the onset occurs around puberty, but it can strike as young as 5 years of age (National Institute of Neurological Disorders and Stroke, 2011). The mean age of death is around 32 years. There is also an adult onset form which can occur anytime during adulthood; however, disease progression is faster in the childhood form.

A Review of the Literature:

Description of FA

Frataxin (FXN) is an important mitochondrial protein-located on chromosome 9. FXN helps to move iron and is essentially part of the production of energy. Frataxin is found in prokaryotes and eukaryotes and required for regulation of cellular iron homeostasis (Bencze et al., 2006). In FA, the defective gene, Frataxin, is reduced thus, less energy is available to cells, especially peripheral nerve, spinal cord, brain, and heart muscle cells (National Institute of Neurological Disorders and Stroke, 2011). Specifically, the FXN mutation consists of a homozygous guanine-adenine-adenine (GAA) trinucleotide repeat (Rajeswari, 2012). A normal human karyotype should have around 6 to 36 copies of GAA; whereas, individuals with FA can have between 90 to 1,300 copies on chromosome 9 (Cossee et al., 1999). A positive correlation has been found between the number of GAA copies and disease onset and progression; the more copies present, the earlier the disease will occur and the quicker it will progress (Metz, 2013).

Symptoms

In FA, a gradual loss of strength in the musculature of the arms and legs, stiffness of the muscles, and speech impairments occur. The central and peripheral nervous systems, heart, skeleton, and pancreas are all affected. Physical features of FA are ongoing, usually appearing around puberty. Common initial symptoms are poor balance, slurred speech, and dysphagia

(Pandolfo, 2009). Later characteristics of the disease can include visual impairments, hearing abnormalities, weakness and balance/coordination difficulties involving the arms and legs, scoliosis of the spine, disorders of the heart, and diabetes (Brice, 2004).

FA affects an individual's speech and voice production due to changes in neural control of muscles. Differential subsystem impairment occurs with this disease; thus, all individuals will not portray the same set of symptoms. Disease features depend on which speech subsystems are affected (Folker et al., 2012). For example, scoliosis and decreased respiratory drive of inspiratory muscles can result in reduced inspiratory volume and diminished subglottal air pressure available for speech. A harsh or strained-strangled vocal quality has been noted, likely due to increased muscle tone (spasticity) in phonatory muscles necessary for normal voice production or due to compensatory adjustments at the level of the glottis related to reduced subglottic pressure (Folker et al., 2010). Individual variability reported in the literature is shown in phonetic profiles across subjects with FA (Blaney & Hewlett, 2007). Other perceptual speech and/or voice features reported in FA include hypernasality, variations in pitch and loudness, problems in breath support for speech, stress issues, breathiness, roughness, glottal fry, phonation breaks, tremor, and pitch breaks (Folker et al., 2010; Folker et al., 2012). These characteristics are associated mainly with laryngeal dysfunction, and to a lesser degree with velopharyngeal dysfunction. Furthermore, irregular articulatory breakdowns, prolonged phonemes, distorted vowels, and disturbed oral coordination have been reported (Folker et al., 2010; Hertrich, 1997). Prosody is also affected which results in the perception of monotone speech (Legge, 2010).

A hallmark symptom of FA is dysarthria (e.g., Blaney & Hewlett, 2007a); however, because the cerebellar pathways and/or cranial nerves can be affected, the type of dysarthria present varies from primarily ataxia dysarthria (e.g., coordinative problems) to mixed dysarthria involving combinations of ataxic/spastic/flaccid components with cerebral and cerebellar components. There is evidence to suggest that the signs of the spastic and flaccid components vary across individuals and over time (Blaney & Hewlett, 2007a). Thus, the dysarthria associated with FA has features in common with other forms of cerebellar degenerative diseases, but differs in the added features of variable spastic and flaccid elements. In FA, neuronal degeneration has been found involving the motor cortex and cranial nerves (Botez et al., 1998). According to Blaney and Hewlett (2007a), speech symptoms in FA are not fully understood, but are likely due to the variable effects of the disease on speech subsystems and the progressive nature in which signs may change over the course of the disease (e.g., Folker et al, 2010; Joannette & Dudley, 1980). Not only are perceptual speech dimensions important to support differential diagnosis, disease progression, speech subsystem involvement, and functionality of intervention, but they are useful for clinicians as they can form a common ground for communication.

Perceptual Measures

Acoustic characteristics of speech and voice in FA have received attention as potentially valuable indicators of disease progression, especially through later stages of the disease (Rosen et al., 2012). Considering the “Gold Standard” of clinical measurements related to speech and

voice characteristics is said to be perceptual ratings (Estella & Edwin, -nd), it seems necessary to take these measures into account, in addition to acoustical estimates, when documenting the effects of FA on speech and voice.

Perceptual ratings of vocal features are made from stimuli heard by a listener/observer; however, they are highly subjective, and can be subject to reliability problems (e.g. Kreiman, Gerratt, Kempster, Erman, & Berke, 1993). In response to problems encountered by Speech Language Pathologists (SLPs) in documenting accurately abnormal voice features, members of ASHAs Divison 3, a special interest group of voice professionals/researchers, developed the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) (Kempster, 2007; Kempster, Gerratt, Verdolini Abbott, Barkmeier-Kraemer & Hillman, 2009). The CAPE-V allows SLPs to employ a standardized procedure for a wide variety of voice disorders that contains a small number of clinically meaningful features of voice (Kempster, 2007). Another important criterion in the development and trial of the CAPE-V was that it should be as reliable as possible across clinical professionals and across the vast array of individuals presenting with voice problems. When using the CAPE-V, individuals are required to prolong the vowels /a/ and /i/, read six sentences, and speak briefly about their voice problem. The vowels /a/ and /i/ were selected based on a number of feature differences. For example, /a/ is a lax vowel and /i/ is a tense vowel. The /i/ vowel is commonly used during videostroboscopy and its use during this prolongation task offers an auditory comparison to that produced during a stroboscopic exam (The American Speech-Language-Hearing Association, 2006). Judgments are determined based on overall severity, roughness, breathiness, strain, pitch, and loudness. Overall quality of an individual's voice is also taken into consideration. A visual analog scale is used for marking

perceptual estimates. In terms of reliability, the CAPE-V has been reported to be a reliable and sensitive measure of voice (Karnell et al., 2007).

A few studies have used perceptual measures in combination with acoustic estimates, to document the effects of FA on speech and voice. Since FA affects multiple speech subsystems to variable degrees (e.g., Folker et al., 2012), studies which included various neuropathologies representing a general form of ataxic dysarthria will not be discussed (e.g., Kent et al., 2000). Studies have varied greatly in terms of number and ages of participants, speech and voice measures collected, qualifications of listeners, rating scales used for perceptual estimates, and use of “normal” peers/controls for comparisons. Some of these variables were dictated by the research questions posed or by language (e.g., Brendel et al., 2013). Participants included in studies of dysarthria in FA have ranged in age from as young as 16 to 71 years of age (Brendel et al., 2013), with most mean ages in the mid- to late 30’s or early 40’s (Blaney & Hewlett, 2007; Brendel et al., 2013; Folker et al., 2010; Folker et al., 2012; Rosen et al., 2012). Number of participants has ranged from 7 (Folker et al., 2012) to 38 (Folker et al., 2010), with a mean of 21 for the seven studies reviewed. Speech samples have included conversational samples (Joanette & Dudley, 1980), reading of the Grandfather Passage (Folker et al., 2010; Folker et al., 2012; Rosen et al., 2012), the Assessment of Intelligibility of Dysarthria Speech (Folker et al., 2010), sustained phonation of the vowel /a/ (Brendel et al., 2013; Folker et al., 2012), and diadochokinetic tasks (Brendel et al., 2013; Singh, Epstein, Myers, Farmer, & Lynch, 2013).

Listeners who have rated the speech samples have varied from untrained undergraduate students who were majoring in “speech and language therapy” (Blaney & Hewlett, 2007) to two SLPs (Folker et al., 2010; Folker et al. 2012; Rosen et al., 2012), or the authors plus a graduate

student (Joanette & Dudley, 1980). It should be noted that the undergraduate students who served as listeners in the Blaney and Hewlett study were only required to determine what word they heard chosen from a list of four, after hearing recorded single-word productions from male participants who had a clinical diagnosis of FA. In terms of perceptual scales used in studies of FA dysarthria, studies by Folker and associates (including Rosen et al., 2012) have used a perceptual rating scale that included 30 different dimensions modeled after Darley, Aronson, and Brown (1975).

Purpose

The purpose of this research study was to determine if a limited array of perceptual features rated by trained listeners from the first 2 seconds of prolonged vowel samples using a modified version of the CAPE-V (CAPE-VM) scaling system could differentiate between 1.) Individuals with FA and 2.) Gender matched and age-equivalent peers who were non-neurologically impaired. A secondary purpose of the study was to determine if trained listeners could determine speaker gender, what vowel was produced, and if the voice sample sounded disordered or non-disordered. Lastly, the study sought to establish if there was a relationship between the three voice attributes measured by CAPE-VM results.

Justification

The CAPE-V serves many purposes, one of which is to describe vocal characteristics that can be easily communicated and understood by clinicians and other professionals. Another purpose of the CAPE-V is to gain information on anatomy and physiology related to voice problems and to evaluate the need for additional testing (American Speech-Language Hearing Association, 2002-2006). Therefore, based on the aforementioned benefits of the CAPE-V, it was used in this study in a somewhat modified form. Listeners were required to rate only three voice parameters on the CAPE-V, namely, roughness, breathiness, and strain. This modified version was labeled CAPE-VM. Three features were used in order to decrease listener fatigue by decreasing the amount of time required to complete the listening task. Further, these vocal characteristics were considered to be likely affected by FA (Folker et al., 2010; Folker et al., 2012).

Hypotheses

It was hypothesized that differences would be found on ratings of roughness, breathiness, and strain between the two groups (NV/FA). Specifically, listeners were expected to rate the FA voices as containing more roughness, breathiness, and/or strain as compared to those who had normal voices (NVs). Further, it was predicted that the listeners would have a more difficult time determining which vowel was heard due to possible effects of FA that could lead to vowel distortion. Listeners were asked to indicate the gender of participants; however, no predictions

were made on the outcome. Further, it was expected that the listeners would be able to determine which vowel samples were disordered or non-disordered when given a forced choice. Lastly, it was predicted that the three voice attributes measured on the CAPE-VM would be highly correlated.

CHAPTER 2 METHOD

Study Design

This study represented a mixed model between a prospective and descriptive design. The study was designed to analyze the differences between two groups, individuals with FA, and normal voiced individuals. Group differences and relationships were determined by analyzing the listeners' rating scores and noting if there were differences between rating scores recorded from the two groups of voice samples: disordered and normal. A specific "comparative" descriptive design was used to measure the behavior of two or more types of subjects at one point in time. Researchers drew conclusions about what the listeners' scores revealed about the two groups.

Variables

In this research study, there was one independent variable (IV) and six dependent variables (DV). The IV was group; whereas, the DVs included CAPE-VM measures of roughness, breathiness, and strain and perceptions of what vowel was heard, gender of speaker, and whether the voice heard represented a disordered or normal voice.

Participants diagnosed with Friedrich's ataxia

Samples of vowel productions from individuals diagnosed with FA were collected by Dr. Marie Le Normand in Paris, France through a Marantz recorder. Medical records were used to confirm the diagnosis of FA. Note that participants in the present study were part of a larger study with patients recruited from all over the country of France and referred by physicians for a possible diagnosis of FA. The larger study was supported by a pharmaceutical company and the equivalent of France's National Institute of Health- Institut National de la Santé Et de la Recherche Medicale with an interest in making sure they were not treating patients who did not have FA. Participants in France were recruited and recorded in accordance with existing policies regarding human subject participation in that country. Participants in the present study included 20 FA individuals, 10 females and 10 males with a mean age of 18.5 years (SD= 3.7; R= 10-25 years old (see Table 1).

Participants who had normal speech and voice (NV)

After approval by the Institutional Review Board (IRB) at the University of Central Florida (UCF), potential participants were recruited by putting flyers in the Communication Sciences and Disorders (CSD) Department on the UCF campus, announcing the need for participants in the CSD classes along with a brief description of the recording task, as well as recruiting through online social networks which explained the study and what was needed from the participants. Twenty young adults, 10 males and 10 females, who were between the ages of

18-25 ($M=20.7$, $SD= 2.2$ years) were selected. Participants met the following criteria: (1) normal speech and voice with no medical history of speech or voice disorders, (2) native English speakers, (3) normal hearing as verified by either an audiometric pure tone screening or self-report of having passed a hearing screening within the past two years, (4) no history of smoking, and (5) overall good health at the time of recording determined by self-report. Gender and age of potential participants was considered when selecting among potential participants in an attempt to assure age equivalency and gender match with participants who were diagnosed with FA. Age was significantly different between the two groups, with those in the FA group being younger than those in the NV group ($t(38) = -2.29$, $p < .05$).

Table 1: Participant Characteristics

Descriptive Information of Participants with Friedreich's Ataxia and Normal Voice, including age and gender.

| Group | Age | Gender |
|--------------|------------|---------------|
| FA03 | 17 | Female |
| FA06 | 17 | Female |
| FA07 | 16 | Male |
| FA08 | 22 | Female |
| FA09 | 13 | Male |
| FA10 | 23 | Female |
| FA11 | 19 | Female |
| FA12 | 25 | Female |
| FA13 | 21 | Female |
| FA17 | 10 | Male |
| FA18 | 20 | Female |
| FA19 | 24 | Female |
| FA20 | 20 | Male |
| FA22 | 19 | Male |
| FA23 | 16 | Male |

| Group | Age | Gender |
|--------------|------------|---------------|
| <hr/> | | |
| FA25 | 16 | Female |
| FA27 | 16 | Male |
| FA29 | 17 | Male |
| FA30 | 18 | Male |
| FA33 | 21 | Male |
| NV01 | 24 | Female |
| NV02 | 21 | Female |
| NV03 | 19 | Female |
| NV04 | 24 | Female |
| NV05 | 22 | Female |
| NV06 | 20 | Female |
| NV07 | 22 | Female |
| NV08 | 25 | Female |
| NV09 | 21 | Male |
| NV10 | 21 | Male |
| NV11 | 20 | Male |
| NV12 | 18 | Female |
| NV13 | 19 | Female |

| Group | Age | Gender |
|--------------|------------|---------------|
| <hr/> | | |
| NV14 | 20 | Male |
| NV15 | 18 | Male |
| NV16 | 21 | Male |
| NV17 | 18 | Male |
| NV18 | 18 | Male |
| NV19 | 19 | Male |
| NV20 | 23 | Male |

Note 1. FA= Friedreich's ataxia; NV= normal voice.

Listeners

After recruiting individuals whose voices were recorded, the researchers then sought 10 individuals who were going to serve as raters of the voice samples. The listener group consisted of 10 trained raters who had the following credentials: they (1) needed to be CSD graduate students at the UCF, (2) have had, or were taking, the graduate course “Voice Disorders” SPA6221, (3) have had their hearing checked within the past two years with no known, ongoing, hearing issues, and (4) were not friends or acquaintances of the researchers. The 10 listeners were all female, ages between 21 and 30. The graduate students were recruited by word of mouth within the department. The 10 selected to be part of the study had a consent form provided to them, with the study explained in depth as well as what was expected of them, specific dates, times, and what benefits they might expect. A one hour training on the CAPE-V was provided to the listening group by Bari Hoffman-Ruddy PhD-CCC-SLP, a professor who specialized in voice disorders at UCF’s CSD program. Dr. Hoffman-Ruddy teaches the graduate level course in voice disorders and maintains an active research agenda and clinical voice practice. She explained the CAPE-V, why it is used, how it is used, and offered feedback for any questions the raters had. The time elapsed between the training and experimental condition was no more than five days.

Institutional Review Board (IRB)

Prior to taking part in the study, each participant (i.e., those who would serve in the NV group and those who were listeners/raters) read the informed consent which was first approved by the IRB at UCF. As per the IRB instructions, the participants were asked to verbally express their consent before proceeding with the study. The participants were told they were able to leave the study at any time without penalty, and that they were not required to partake in the study. Data collection documents, including the CAPE-VM, and a one page questionnaire on which the listeners indicated what vowel they perceived was spoken, whether they felt that the speaker had a distorted or non-distorted voice, and their estimation of the speaker's gender. Those individuals whose voices (n=20) were recorded and the group of listeners (n=10) were provided with separate consent forms explaining their role in the study. The consent forms were provided to explain to the participants the criteria for being included in the study, what was expected of them, specific timelines, privacy aspects, and benefits for participating

Vowel Stimuli

Recorded data collected in France from those in the FA group and used in the present study included production of sustained vowels /a/, /i/, and /o/ using a “normal pitch” recorded into a Marantz at 22.5Khz using an external microphone. This recording order was maintained throughout data collection. For the present study, productions of /a/, /i/, and /o/ were selected from the recordings made in France and used for further analysis and comparisons. These three

vowels were selected because of contrasting tongue heights and advancement. Vowel tongue height may be an indicator of the severity of vocal disorders as a relationship between vowel roughness and vocal tract configuration has been reported. Vowels produced with the tongue placed lower in the oral cavity may result in greater roughness when compared to vowels produced with higher tongue positions (e.g., Sansone & Emanuel 1970). The vowels /a/, /i/, and /o/ have different tongue heights in the oral cavity, as shown by the vowel quadrilateral in Figure 1, with /a/ representing low tongue height.

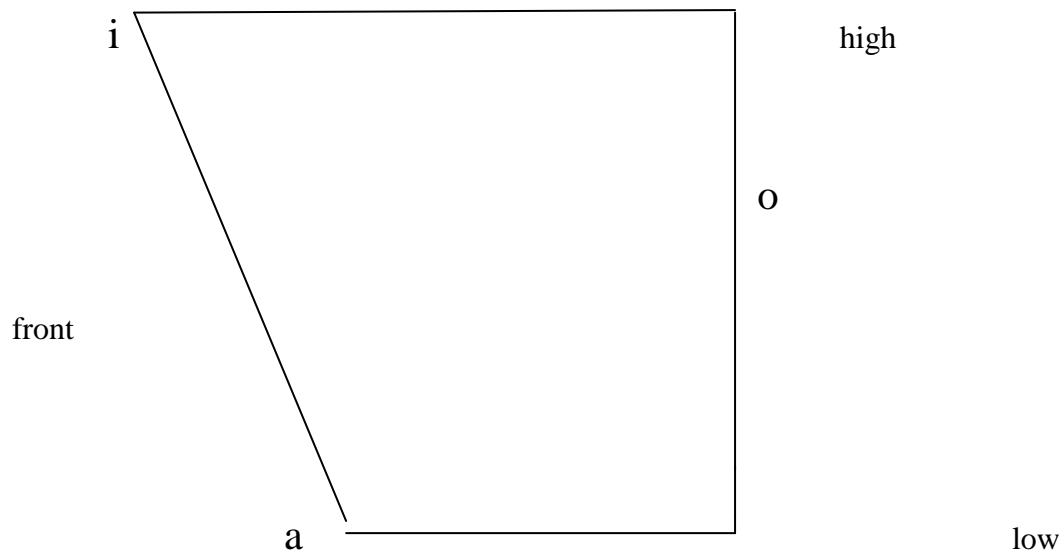


Figure 1: Modified Vowel Quadrilateral depicting tongue placement for the vowel sounds /a/ /i/ and /o/ used in this study.

Methods used to collect data from participants in the NV group were comparable with those used in France. Participants in the NV group were asked to sustain the vowels of /a/, /i/ and /o/ for as long as possible while using a normal pitch. Samples were recorded on a Roland Edirol (R-09HR) through an internal microphone (20-40KHz frequency response) while maintaining a mouth-to-microphone distance of 12 inches and digitized with a sampling rate of 44kHz. Voice samples were recorded in a quiet room located in UCF's College of Health and Public Affairs Department.

The 120 vowel samples (3vowels X 40 speakers) were dubbed onto a Dell (Optiplex 755) laboratory computer in the Speech Science Lab from the Edirol SD card using Brown Laboratory Interactive Speech System, Mertus, 19x (Bliss) software. Samples collected in France were input into Bliss using a sample rate of 22.5KHz (i.e., the rate of sampling when collected in France); whereas, vowel samples recorded from participants in the NV group were input using a 44KHz sample rate (i.e., sample rate of the Edirol). Although the sampling rate between the two groups differed, this did not cause an issue throughout the study. The nyquist sampling theorem states that the sampling frequency should be at least twice the highest frequency contained in the signal, which would make the sampling rates sufficient to capture each peak and trough of the signal (Olshausen, 2000).

Each vowel was time expanded so that the first 2000 milliseconds (ms) from the first recognizable waveform could be selected and copied into a file. Out of the 120 samples, 12 or 10% were randomly selected for reliability purposes. All 132 samples (3 vowels X 40 speakers X 10% reliability samples) were placed in a randomized order and saved. The randomized order was done to eliminate possible listener bias. Each of the 132 samples were saved on separate

files and identified by alphabet letters, beginning with “A”, “AA”, “AAA”, “AAAA”, “B”, etc. Rating of the samples was done in a one-time session. Listeners selected single files shown on the computer screen (Dell Optiplex 755) in the order that was provided and rated those using the CAPE-VM and indicated judgments of gender, vowel perceived, and whether the voice was disordered or non-disordered in the sample. They had the option of listening to each sample up to three times.

The onset portion of the vowel was utilized in this study based on several factors. First, the initial 500 ms of phonation represents an unstable period of vocal fold vibration. It was reasoned that this unstable period might be more unstable in those with FA as compared to NV peers, thus giving the listeners perceptual cues that might not be readily apparent in the mid-portion of a prolonged vowel. Secondly, individuals with FA have a compromised respiratory system which affects their ability to phonate for longer periods of time due to decreased subglottal air pressure (Folker et al., 2010); thus, the vowel prolongation might not be long enough to select a 2-second mid-portion. Lastly, the researchers wanted the listeners to rate the samples on voice quality characteristics while not being influenced by the length in time of each prolongation.

Perceptual Data

The listening task involved listeners rating the 132 tokens. Standardized instructions were read to the listeners and questions were answered. The samples of prolonged vowels were presented through Sennheiser (HD 201) stereo headsets, with a loudness level that was self-set at

a comfortable level by the listeners before they started analyzing the voice samples. The samples were played through Dell computers (Optiplex 755) in the CSD Speech Science lab. It should be noted that all lab computers were the same model and had the same A-D cards. The lab was located in a quiet room within the department. As described previously, the rating form included perception of the gender of the speaker, whether the speaker had a non-disordered or disordered voice, what vowel was heard, and an estimation of roughness, breathiness, and strain using the CAPE-VM. The form included a 100 millimeter line for each attribute on which listeners recorded their perception of deviance from normal of the attribute by placing a “tic” mark. General regions were indicated beneath the line and labeled “MI” or “mildly deviant”, “MO”, or “moderately deviant” and “SE” or “severely deviant”. Data collected from the CAPE-VM consisted of measuring the length in millimeters from the start of the line to the “tic”.

Data on perceptions of gender, vowel produced, and diagnosis (whether the speaker had a disordered or non-disordered voice) were coded with “1” for a judgment that was correct and “0” for estimates that were incorrect.

Statistical Analysis

Descriptive statistics including mean and standard deviations were calculated to describe voice attributes and listener perceptions of gender, vowel, and diagnosis (disordered/non-disordered voice). Differences on the measures of roughness, breathiness, and strain recorded from CAPE-VM results were determined using one-way analysis of variance (ANOVA) tests. When variances were significantly different using Levine’s test for homogeneity of variance (2-

tailed), *t*-tests for unequal variances were conducted. Pearson correlations were performed to ascertain the relationships among the voice attributes. A probability level of $p < .05$ was established for all statistical tests.

Inter-rater reliability (Chronbach's Alpha) was calculated using the 12 reliability samples using the three CAPE-VM measures. A reliability score of .88 was reported which indicated internal consistency just below excellent (.90) (Mason, Lind & Marchal, 1983).

CHAPTER 3 RESULTS

Group Differences on Voice Attributes

Table 2 depicts the group means and standard deviations recorded on the CAPE-VM for measures of roughness, breathiness, and strain. An ANOVA and two t-tests for unequal variances were performed on the three voice attributes by group. Results revealed significantly larger values for those who had FA as compared to NV peers. Listeners perceived those in the FA group as having greater amounts of roughness, breathiness, and strain in their production of vowels than those in the NV group. All of the listeners' individual perceptual measures for these variables can be found in Appendix H.

Table 2: Statistical Comparisons of Normal Voice Individuals and Friedreich's Ataxia Individuals on Measures of a Modified Consensus Auditory Perceptual Evaluation of Voice (CAPE-VM) in millimeters.

| <u>CAPE-VM</u> Measures | NV | FA | df | <i>F</i> value | <i>t</i> value |
|----------------------------|--------------|--------------|-------|----------------|----------------|
| Roughness | 10.12 (8.00) | 18.29 (5.26) | 1,38 | 14.58** | |
| Breathiness | 6.32 (3.51) | 15.66 (8.45) | 25.38 | | 4.57** |
| Strain | 9.02 (5.73) | 22.74 (9.60) | 31.02 | | 5.49** |

Note 1. NV= normal voice; FA= Friedreich's ataxia; df= degrees of freedom. Values are expressed as means and (standard deviations) in millimeters.

Note 2. Higher scores on all measures indicate a greater amount of the specific voice feature perceived.

Note 3. ** $p \leq .001$, 2-tailed.

Group Differences on Vowel, Disordered/Normal Voice, and Gender Perception

Descriptive statistics were used to determine how well listeners correctly identified vowels that were produced, gender, and diagnosis (i.e., disordered versus non-disordered voice) between participants in the NV and FA groups. Measures can be found in Table 3.

Overall, listeners were mostly accurate in identifying which vowel was produced and gender of the speaker in both groups. In contrast, distinguishing if a speaker had a normal (non-

disordered) or disordered voice was a more difficult task as indicated by the lower means and higher standard deviations as contrasted to the perceptions of vowel heard and gender. Their estimates were more accurate for those who had normal voices on all vowels as compared to those in the FA group. Generally, listeners had the most agreement and least amount of variation in their judgments on perceiving gender for those who were in the NV group.

Table 3: Group Comparison on Measures of Listener Ability to Correctly Identify Vowels, Diagnosis, and Gender.

| Measures | NV | FA |
|------------------|-------------|-------------|
| Vowel | | |
| /a/ | 9.85 (.36) | 9.25 (.85) |
| /i/ | 9.25 (-.55) | 9.30 (.47) |
| /o/ | 8.20 (2.71) | 8.90 (1.07) |
| Diagnosis | | |
| /a/ | 6.90 (2.49) | 6.05 (2.26) |
| /i/ | 7.70 (1.78) | 5.50 (2.59) |
| /o/ | 6.95 (2.42) | 6.50 (2.12) |
| Gender | | |
| /a/ | 9.75 (.41) | 8.70 (2.87) |
| /i/ | 9.95 (.22) | 8.45 (2.84) |
| /o/ | 9.60 (.60) | 8.60 (2.85) |

Note 1. NV= normal voice; FA= Friedreich's ataxia; Values are expressed as means (standard deviations) out of a mean of 10 possible.

Note 2. Lower scores on all measures indicate poorer ability to correctly identify the percept of interest.

Correlations on CAPE-VM Measures

Correlations between the three measures on the CAPE-VM were conducted using Pearson Correlations (2-tailed). All measures were positively and significantly correlated at the 0.01 level. Breathiness correlated with roughness ($r=.66$), strain correlated with roughness ($r=.78$) and strain correlated with breathiness ($r=.75$). Results indicated a moderate positive linear relationship between breathiness and roughness, and strong or high positive linear relationships between strain and roughness as well as strain and breathiness (Mason, Wong, & Entwisle, 1993).

CHAPTER 4

DISCUSSION

The purpose of this study was to investigate the perceptual voice differences between 20 individuals (10 males, 10 females) who had normal voice and 20 individuals (10 males, 10 females) with Friedreich's ataxia. The stimuli consisted of the first 2000 ms of the vowels /a/, /i/, and /o/. Trained listeners were asked to rate vocal quality on three characteristics of voice, roughness, breathiness, and strain using a modified version of the CAPE-V, as well as indicate the gender, vowel heard, and whether the voice was disordered or non-disordered.

Measures of vocal quality (roughness, breathiness, and strain) while sustaining the vowels /a/, /i/, and /o/ were found to be higher for individuals with Friedreich's ataxia than for individuals with normal voice. Therefore, as hypothesized, listeners rated the Friedreich's ataxia voice samples more negatively on the CAPE-VM measures than the normal voice samples. This finding supports previous work by Folker et al. (2010) who found that listeners rated speakers with FA as having more strain and stress in their voices when reading "The Grandfather Passage" as compared to speakers with normal voices.

Further, our results provide preliminary support for the use of the perceptual attributes of roughness, breathiness, and strain to distinguish adolescents and young adults with FA from young adult peers who are non-neurologically involved. It was interesting to note that although the listeners perceived higher levels of the three attributes in those who had FA, they were only moderately accurate in estimating if the speaker had a voice that was disordered or non-disordered. The overall rating of diagnosis seemed to be a more difficult percept than estimating

singular voicing characteristics as shown by the mean and standard deviation of accuracy rates, and might have been expected given that those in the FA group were perceived as having, on average, ratings on the CAPE-VM in the mild to moderately deviant range (i.e., @ 16-23 mm, Table 2).

Further, it would seem logical that the voices of adolescents and young adults with FA might be only mildly affected, since dysarthria usually develops late in the disease (Eigentler et al., 2011).

In one of the few longitudinal studies on changes that occur during FA disease progression, Rosen et al. (2012) assessed participants once per year over a four year period. Results revealed three acoustic measures that depicted subtle changes in the acoustic signal when comparing between two consecutive year intervals. The authors felt that acoustic measures were more sensitive than perceptual measures to subtle changes that occurred due to disease progression to those with FA in their study, stating that listeners may not be able to detect slight alterations in the acoustic signal that were identified by acoustic measures. It should be noted, however, that listeners in the Rosen et al. study were asked to rate overall severity using Direct Magnitude Estimation. It could be that perceptual evidence was available within each comparison 2-year period, but was not realized due to the use of an overall severity rating, rather than having listeners estimate specific voice characteristics. As stated previously, listeners in this study weren't very accurate when given the forced choice of indicating whether the voice sample was disordered or non-disordered, a rating somewhat similar to overall severity, even though subtle differences between groups on the three voicing attributes were noted by our

listeners using the CAPE-VM. Thus, more research is indicated to determine if specific perceptual attributes can contribute to charting disease progression and treatment outcomes.

Findings from categorical listening tasks revealed that listeners had varying levels of accuracy when asked to indicate what vowel they perceived, if the voice was disordered or non-disordered, and gender of the speaker. It was hypothesized that listeners would also have a more difficult time determining which vowel was perceived when listening to FA individuals in comparison to NV individuals, but this was not the case. For the vowel /a/, listeners perceived, on average, which vowel was heard in the NV samples more correctly than in the FA voice samples. For the vowels /i/ and /o/, the opposite was true; listeners perceived which vowel was heard more accurately in the FA voice samples. Thus, it would appear that spectral features leading to vowel identification were available in the 2000 ms samples.

It was hypothesized that listeners would be able to determine which voice samples were recorded from voices that were disordered versus non-disordered, yet this was the category with the least number of matches with actual information out of the three categorical perceptual tasks. Listeners were slightly more accurate in identifying speakers who were neurologically normal than those in the FA group, which suggests that overall judgments of severity might have been more difficult because the task involves a summation of perception, rather than focusing on one or more distinct vocal attributes. Further, perhaps those in the FA group had voices that were relatively unaffected as of yet by the disease process.

Out of the three categorical tasks, listeners were most accurate in identifying correct gender. Results slightly favored more accurate gender identification in the normal voice samples as compared to the FA voice samples. This finding could be related to the younger overall age

of those in the FA group who might have had fundamental frequencies within an ambiguous range, somewhere between adult male and female averages.

Lastly, the three voice features of roughness, breathiness, and strain were all significantly correlated. Thus, as one attribute was perceived as increasing in level, the others were also found to increase.

Conclusions

The requirements of individuals to prolong vowels demand breath support, neural control of muscles, and a quality of voice that does not interfere with listener identification. Individuals with Friedreich's ataxia, whose breath support, neural control, and quality of voice (among other characteristics) are affected, are a unique population to study. The present study was designed in an attempt to determine if perceptual analyses were useful in comparing those with Friedreich ataxia voices to individuals who had normal voices (i.e., neurologically normal).

As expected, during perceptual analysis with a modified CAPE-V form (CAPE-VM), listeners rated the Friedreich's ataxia voice samples as more deviant from the norm when compared to normal voice samples on the three voice attributes studied: roughness, breathiness, and strain. Based on a review of the literature, the use of the CAPE-V in modified form was the first time it has been used for perceptual ratings in studies of those with FA. On the form, percepts were recorded on a 100 millimeter line on which listeners placed a mark on the line to indicate their rating of deviance from normal. This visual analog scaling afforded advantages over Liekert-like perceptual scaling methods in that slight gradations in deviance could be noted,

rather than forcing decisions into discrete points (e.g., 1-7 scale) or categories (e.g., disordered or non-disordered). It would appear that the CAPE-VM scaling system was sensitive to the subtle differences in voice attributes between the groups; whereas, the more holistic categorical choice of disordered versus non-disordered was not as sensitive to the mild voicing differences. Based on our findings, the CAPE-VM is suggested as a perceptual tool that may be of benefit in monitoring changes over time in the speech/voice systems of those who have FA. More research is necessary to determine the applicability of the CAPE-V, CAPE-VM or other modifications thereof, in longitudinal studies that incorporate acoustic and perceptual analyses. The ability of tools/assessments to detect minimal deterioration in speech and/or voice motor performance over time in progressive diseases is critical to validation of treatments.

Limitations

This study would have benefited from a more exact age matching of the individuals in the FA and NV groups. In addition, the listeners who analyzed the voice samples should have each listened to a different randomized order, rather than all ten listeners listening to the voice samples in one randomized order in order to rule out listener fatigue. While listening to the voice samples from France, an echo was sometimes heard, whereas the voice samples from UCF did not contain the echo. Although the nyquist theory states that different sampling rates used throughout this study between the two groups (NV/FA) should not have caused any issues, this could be considered a limitation. Future studies would benefit from voice or speech recordings collected in a sound treated environment/booth.

Future Studies

Findings from the current study provide important information that may lead to further investigation of perceptual characteristics of individuals with FA. To determine if an individual's voice deviates from the norm, more extensive research should be conducted on age-matched individuals with FA, as well as normal controls, with use of listener groups. The FA and NV individuals should produce sentences as well as prolong vowels, for perceptual analysis, to verify if one measurement is more reliable than the other. With use of prolonged vowels as well as production of sentences, clinicians are able to analyze speech rate. Clinicians are more sensitive to slowness of speech than to any other feature of spoken language during dysarthria evaluation (Brendel, 2013). Each listener should be analyzing the voice samples in a randomized order, with listeners having their own randomized order to analyze. Acoustic analysis, with use of perceptual analysis, should also be conducted in order to correlate the findings. Training clinicians to use the CAPE-V as one source of differential diagnosis would be of benefit to the clinician, and to clients with voice disorders. Perceptual measures are a useful aid in the therapy process, from baseline to follow-up. When used appropriately, perceptual measures can assist in determining if an individual's voice is deviant, how the deviant quality of voice affects the client's life, determining what treatment conditions should be applied, as well as documenting therapy progress.

APPENDIX A: INFORMED CONSENT (VOICE SAMPLES)



Acoustic Analysis in Normal, Young, College Students Informed Consent

Principal Investigator(s): Tara Varsallone

Sub-Investigator(s): Kaylea Hardin

Faculty Supervisor: Jack Ryalls, PhD

Investigational Site(s): University of Central Florida, Department of Communication Sciences and Disorders
University of Central Florida, Communication Disorders Clinic

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about 20 people at UCF. You have been asked to take part in this research study because you are a normal speaking UCF speaking. You must be 18 years of age or older to be included in the research study.

The person doing this research is Tara Varsallone, Masters Student in the Communication Sciences & Disorders graduate program. Because the researcher is a graduate student, she is being guided by Dr. Jack Ryalls, a UCF faculty supervisor in Communication Sciences & Disorders. Kaylea Hardin is a Graduate UCF student, who is also participating in this study as part of the research team.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.

- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to establish normative voice measures of speech from young, college students at UCF. Multidimensional Voice Profile (MDVP) quickly and easily provides a revealing snapshot of voice quality. Since its introduction, MDVP has garnered numerous references in peer-reviewed professional journals establishing its reliability, value of multiple parameters, and efficacy. There is an extensive database of normal adult speakers available for the MDVP provided by Kay Elemetrics, but this data is not broken down by age of speaker. We would like to obtain a database and voice parameters for young, normal, healthy, college age students.

What you will be asked to do in the study: Participants will be asked to say various vowel sounds into a microphone on a digital recorder. Speakers will be recorded in a quiet environment.

Location: University of Central Florida, Department of Communication Sciences & Disorders and University of Central Florida, Communication Disorders Clinic.

Time required: We expect that you will be in this research study for 1 session of no more than 15 minutes.

Audio or video taping: You will be audio taped during this study. If you do not want to be audio taped, you will not be able to participate in the study. Discuss this with the researcher or a research team member. If you are audio taped, the tape will be kept in a locked, safe place. The tape will be erased or destroyed after completion of the study.

Risks: There are no reasonably foreseeable risks or discomforts involved in taking part in this study.

Benefits: There are no expected benefits to you for taking part in this study.

Compensation or payment: There is no compensation or other payment to you for taking part in this study.

Confidentiality: We will limit your personal data collected in this study to people who have a need to review this information. We cannot promise complete secrecy.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, talk to Tara Varsallone, Graduate Student, Communication Sciences &

Disorders Program, College of Health and Public Affairs, (407) 823-4798 or Dr. Jack Ryalls, Faculty Supervisor, Department of Communication Sciences & Disorders at (407) 823-4798 or by email at ryalls@ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.

Your signature below indicates your permission to take part in this research.

DO NOT SIGN THIS FORM AFTER THE IRB EXPIRATION DATE BELOW

Name of participant

Signature of participant

Date

Signature of person obtaining consent

Date

Printed name of person obtaining consent

APPENDIX B: UCF IRB APPROVAL FORM



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1
FWA00000351, IRB00001138**

To: **Tara L. Varsallone and Co-PI: Kaylea D. Hardin**

Date: **June 07, 2013**

Dear Researcher:

On 6/7/2013 the IRB approved the following human participant research until 6/6/2014 inclusive:

| | |
|-----------------|--|
| Type of Review: | Submission Correction for UCF Initial Review Submission Form Expedited Review |
| Project Title: | Perceptual Analysis in Normal, Young, College Students |
| Investigator: | Tara L. Varsallone |
| IRB Number: | SBE-13-09168 |
| Funding Agency: | |
| Grant Title: | |
| Research ID: | N/A |

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at <https://iris.research.ucf.edu>.

If continuing review approval is not granted before the expiration date of 6/6/2014, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Patria Davis on 06/07/2013 03:35:20 PM EDT

IRB Coordinator

APPENDIX C: INFORMED CONSENT (LISTENERS)



Perceptual Analysis in Normal, Young, College Students

Informed Consent

Principal Investigator(s): Tara Varsallone

Co-Investigator(s): Kaylea Hardin

Research Associate(s): Bari Hoffman Ruddy, PhD

Faculty Supervisor: John Ryalls, PhD

Investigational Site(s): University of Central Florida, Department of Communication Sciences & Disorders
University of Central Florida Communication Sciences and Disorders Clinic

Introduction: Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include one group of about 10 people at UCF. You have been asked to take part in this research study because you are a normal hearing UCF student who has taken Voice Disorders at the Graduate level. You must be 18 years of age or older to be included in the research study.

The person doing this research is Tara Varsallone, Masters Student in the Communication Sciences & Disorders graduate program. Because the researcher is a graduate student, she is being guided by Dr. John Ryalls, a UCF faculty supervisor in Communication Sciences & Disorders. Kaylea Hardin is a Graduate UCF student, who is also participating in this study as part of the research team.

What you should know about a research study:

- Someone will explain this research study to you.
- A research study is something you volunteer for.
- Whether or not you take part is up to you.
- You should take part in this study only because you want to.
- You can choose not to take part in the research study.
- You can agree to take part now and later change your mind.
- Whatever you decide it will not be held against you.
- Feel free to ask all the questions you want before you decide.

Purpose of the research study: The purpose of this study is to establish normative voice measures of speech from young, college students at UCF. Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) provides a perceptual rating of voice quality. Since its introduction, CAPE-V has garnered numerous references in peer-reviewed professional journals establishing its reliability, value of multiple ratings, and parameters. Perceptual ratings are the Golden Standard in the field of Communication Sciences and Disorders. The CAPE-V provides a structured rating scale for these measures to be analyzed. We would like to obtain a data base and voice ratings for young, normal, healthy college-aged students.

What you will be asked to do in the study: Participants will be asked to listen to voices and answer a specific question questions created by the researchers in regards to voice samples.

Location: University of Central Florida, Department of Communication Sciences & Disorders and University of Central Florida, Communication Disorders Clinic.

Time required: We expect that you will be in this research study for 1 session for approximately an hour.

Risks: There are no reasonably foreseeable risks or discomforts involved in taking part in this study

Benefits: Participants will be provided with pizza for their time.

Compensation or payment: There is no compensation or other payment to you for taking part in this study.

Confidentiality: We will limit your personal data collected in this study to people who have a need to review this information. We cannot promise complete secrecy.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints, talk to Tara Varsallone, Graduate student, Communication Sciences & Disorders Program, College of Health and Public Affairs, (407) 823- 4798 or Dr. John Ryalls, Faculty Supervisor, Department of Communication Sciences & Disorders at (407) 823- 4798 or by E-Mail at Ryalls@ucf.edu.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

Withdrawing from the study:

- If you decide to leave the research, you will not be penalized but can't take credit for participation (e.g. on a resume, application, etc.) If you decide to leave the study, contact the investigator so that the investigator can recruit another participant as soon as possible. The person in charge of the research study or the sponsor can remove you from the research study without your approval. Possible reasons for removal include failure to follow instructions of the research staff, not attending training session(s) (if applicable), if a hearing loss is acquired before participation, and/or if the person in charge decides that the research study is no longer in your best interest. The sponsor can also end the research study early. We will tell you about any new information that may affect your health, welfare or choice to stay in the research.

APPENDIX D: DEBRIEFING FORM (LISTENERS)



Debriefing Statement

For the study entitled:

"Perceptual Analysis in Normal, Young, College Students"

Dear Participant;

During this study, you were asked to listen to voice samples and rating voice quality using a modified CAPE-V and/or answering questions created by the researchers. You were told that the purpose of the study was to collect data on the characteristics of normal and disorder voices. The actual purpose of the study was to collect data on these characteristics, but information was withheld about the language of the participants which included English and French speakers.

We did not tell you everything about the purpose of the study because we wanted to minimize bias when identifying if the voice was normal or disordered. The disordered voices were collected from French speakers.

You are reminded that your original consent document included the following information: Participants will be asked to attend a training session for one hour on the CAPE-V with Dr. Bari Hoffman Ruddy. During the training session, Dr. Ruddy will provide a tutorial on the CAPE-V, and show voice samples to practice how to use the protocol. On another day, the same participants who have been trained will be asked to listen to the various recorded voice samples and answer specific questions on a modified CAPE-V and questions created by the researchers about the voice samples.

You have the right to withdraw from this study at any time with no penalty. If you have any concerns about your participation or the data you provided in light of this disclosure, please discuss this with us. We will be happy to provide any information we can to help answer questions you have about this study.

The responses in this study are de-identified and cannot be linked to you.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints or think the research has hurt you: Tara Varsallone or Kaylea Hardin, Graduate Student, Communication Sciences and Disorders, College of Health Public Affairs, (407) 823-4798 or Dr. Jack Ryalls, Faculty Supervisor, Department of Communication Sciences and Disorders at (407) 823-4798.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

If you have experienced distress as a result of your participation in this study, a referral list of mental health providers is attached to this document for your use.⁶ (Please remember that any cost in seeking medical assistance is at your own expense.)

Please again accept our appreciation for your participation in this study.

APPENDIX E: LISTENER INFORMATION

| Listener | Age | Gender |
|-------------|-----|--------|
| Listener 1 | 30 | Female |
| Listener 2 | 23 | Female |
| Listener 3 | 22 | Female |
| Listener 4 | 22 | Female |
| Listener 5 | 23 | Female |
| Listener 6 | 22 | Female |
| Listener 7 | 22 | Female |
| Listener 8 | 23 | Female |
| Listener 9 | 23 | Female |
| Listener 10 | 22 | Female |

APPENDIX F: MODIFIED CAPE-V FORM



Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)-Modified

Voice Sample #: _____

Date: _____

The following parameter of voice quality will be rated upon completion of the following tasks:

- Sustained vowels, /a/ /i/ /o/ for 2 seconds duration each.

Legend: C = Consistent I = Intermittent

MI = Mildly Deviant

MO = Moderately Deviant

SE = Severely Deviant

SCORE

Roughness _____ C I ____/100

MI

MO

SE

Breathiness _____ C I ____/100

MI

MO

SE

Strain _____ C I ____/100
MI MO SE

COMMENTS ABOUT RESONANCE: NORMAL OTHER (Provide description): _____

ADDITIONAL FEATURES (for example, diplophonia, fry, falsetto, asthenia, aphonia, pitch instability, tremor, wet/gurgly, or other relevant terms):

Student Code: _____

Sample Code: _____

Perceived Vowel: _____

Circle one of the following:

Disordered or Non-disordered

Male or Female

APPENDIX G: LISTENER INSTRUCTIONS

1. Sit down at lab computer
2. Put on the headphones
3. Play a Youtube video and adjust the volume to what is most comfortable to you
4. You may not adjust the volume once you start listening to the voice samples
5. Start with the first voice sample and listen to them in the order provided to you
6. You may listen to each voice sample up to three times each
7. Put your responses on the Modified Cape-V form
8. If you have any questions, raise your hand and we will come to help

APPENDIX H: PERCEPTUAL MEASURES RAW DATA

Listener 1

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|------------|---------------------|--------------------|--------|
| fa07arM | 25 | 13 | 1 | n/a | a | Non | male |
| nv15orM | 34 | 0 | 0 | n/a | u | Non | male |
| fa20irM | 0 | 0 | 0 | n/a | i | Non | male |
| nv08arF | 0 | 0 | 0 | n/a | a | Non | female |
| fa25irF | 12 | 0 | 2 | hypernasal | i | Disordered | male |
| fa27irM | 0 | 0 | 0 | n/a | i | Non | male |
| fa13arF | 2 | 0 | 11 | n/a | a | Disordered | female |
| fa07orM2 | 17 | 0 | 0 | n/a | o | Disordered | male |
| fa23arM | 0 | 36 | 35 | n/a | ^ | Disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | Non | female |
| fa29arM | 0 | 0 | 0 | n/a | a | Non | male |
| fa06irF | 0 | 21 | 12 | n/a | i | Disordered | female |
| fa33arM | 4 | 0 | 0 | n/a | a | Non | male |
| fa33irM2 | 4 | 0 | 0 | n/a | i | Non | male |
| fa33irM | 0 | 0 | 0 | n/a | i | Non | male |
| nv04orF | 0 | 0 | 12 | n/a | a | Disordered | male |
| fa29irM | 26 | 4 | 0 | n/a | i | Non | male |
| nv12arF | 0 | 0 | 2 | n/a | a | Non | female |
| nv05irF2 | 1 | 1 | 1 | n/a | i | Non | female |
| nv03irF | 0 | 0 | 0 | n/a | i | Non | female |
| nv03orF | 0 | 0 | 0 | n/a | o | Non | female |
| fa30arM | 0 | 0 | 37 | n/a | a | Disordered | male |
| nv07irF | 0 | 0 | 5 | n/a | i | Disordered | female |
| nv20irM | 0 | 0 | 1 | n/a | i | non | male |
| nv05irF | 0 | 0 | 3 | n/a | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv02arF | 18 | 0 | 11 | n/a | a | disordered | Male |
| fa30irM | 33 | 24 | 2 | n/a | i | disordered | Male |
| fa27arM | 25 | 1 | 1 | n/a | a | disordered | Male |
| nv18irM | 1 | 1 | 1 | n/a | i | non | Male |
| nv09arM | 1 | 0 | 3 | n/a | a | non | Male |
| fa30orM | 62 | 0 | 0 | n/a | o | disordered | Male |
| nv01orF | 19 | 1 | 34 | n/a | o | disordered | Female |
| fa11irF | 4 | 0 | 20 | n/a | i | non | Male |
| nv16arM | 3 | 4 | 0 | n/a | a | non | Male |
| nv10irM | 26 | 4 | 11 | n/a | i | non | Male |
| fa29orM | 0 | 0 | 0 | n/a | u | non | Male |
| nv02irF | 0 | 15 | 26 | n/a | i | disordered | Female |
| fa19irF | 0 | 5 | 1 | n/a | i | non | Female |
| nv14arM | 1 | 1 | 12 | n/a | a | non | Male |
| nv13arF | 0 | 0 | 14 | n/a | a | non | Female |
| fa27orM | 47 | 0 | 35 | n/a | u | disordered | Male |
| nv03arF | 3 | 0 | 0 | n/a | a | non | Female |
| nv10orM | 11 | 0 | 3 | n/a | o | non | Male |
| nv11irM | 4 | 0 | 12 | n/a | i | non | Male |
| nv14irM | 24 | 0 | 12 | n/a | i | non | Male |
| fa23irM | 3 | 61 | 51 | n/a | i | disordered | Male |
| nv04arF | 3 | 37 | 53 | n/a | a | disordered | Female |
| nv05orF | 0 | 24 | 4 | n/a | a | disordered | Female |
| nv08orF | 0 | 17 | 2 | n/a | ^ | non | Female |
| nv17irM | 2 | 22 | 15 | n/a | i | non | Male |
| fa22arM | 0 | 13 | 34 | n/a | a | non | Male |
| nv04irF | 0 | 0 | 3 | n/a | i | non | Female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv17arM | 15 | 4 | 39 | n/a | a | disordered | Male |
| nv05arF | 0 | 0 | 2 | n/a | a | non | Female |
| nv20orM | 4 | 0 | 3 | n/a | o | non | Male |
| fa18orF | 0 | 18 | 50 | n/a | o | disordered | male |
| nv06arF | 3 | 0 | 18 | n/a | a | non | female |
| nv13irF | 17 | 0 | 39 | n/a | i | non | female |
| nv02orF | 1 | 20 | 0 | n/a | o | non | female |
| nv08orF2 | 2 | 5 | 0 | n/a | ^ | non | female |
| fa17arM | 11 | 55 | 67 | n/a | a | disordered | male |
| nv06orF | 1 | 4 | 0 | n/a | o | non | female |
| nv08irF | 3 | 0 | 15 | n/a | i | non | female |
| fa33orM | 16 | 0 | 44 | n/a | o | disordered | male |
| fa29arM2 | 0 | 4 | 25 | n/a | a | non | male |
| fa12irF | 36 | 0 | 65 | n/a | i | disordered | female |
| nv07orF | 35 | 18 | 0 | n/a | o | non | female |
| nv01irF | 14 | 0 | 21 | n/a | i | non | female |
| fa25orF | 86 | 1 | 35 | n/a | o | disordered | female |
| fa20orM2 | 75 | 25 | 37 | n/a | ^ | disordered | male |
| fa11arF | 15 | 1 | 37 | n/a | a | non | female |
| nv09orM | 4 | 66 | 53 | n/a | o | disordered | male |
| fa22irM | 67 | 11 | 52 | n/a | i | disordered | male |
| fa20arM | 0 | 64 | 0 | n/a | a | non | male |
| nv11orM2 | 82 | 77 | 82 | n/a | ^ | disordered | male |
| fa09arM | 58 | 50 | 79 | n/a | a | disordered | female |
| nv12orF | 0 | 0 | 0 | n/a | o | non | female |
| fa17irM | 41 | 91 | 98 | n/a | i | disordered | male |
| fa13orF | 100 | 0 | 66 | n/a | o | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv15orM2 | 59 | 15 | 77 | n/a | u | disordered | male |
| fa08irF | 13 | 0 | 21 | n/a | i | disordered | female |
| nv14orM | 0 | 0 | 0 | n/a | o | non | female |
| fa10orF | 4 | 76 | 0 | n/a | o | disordered | female |
| fa09irM | 44 | 20 | 97 | n/a | i | disordered | male |
| nv20arM | 0 | 0 | 0 | n/a | a | non | male |
| fa07orM | 0 | 23 | 13 | n/a | o | disordered | male |
| nv15irM | 0 | 0 | 0 | n/a | i | non | male |
| fa03irF | 0 | 23 | 11 | n/a | i | non | female |
| fa06orF | 0 | 0 | 17 | n/a | o | disordered | female |
| nv19arM | 45 | 83 | 68 | n/a | a | disordered | male |
| fa08orF | 0 | 12 | 34 | n/a | u | disordered | female |
| nv16orM | 41 | 46 | 38 | n/a | o | non | male |
| fa07irM | 4 | 0 | 0 | n/a | i | non | male |
| fa03orF | 23 | 3 | 0 | n/a | o | non | female |
| nv17orM | 69 | 0 | 23 | n/a | o | disordered | male |
| fa10irF | 58 | 39 | 58 | n/a | i | non | male |
| nv18arM | 0 | 0 | 0 | n/a | a | non | male |
| fa10arF | 0 | 38 | 0 | n/a | a | non | female |
| fa03arF | 0 | 0 | 24 | n/a | a | non | female |
| nv16irM | 44 | 0 | 0 | n/a | i | non | male |
| fa12arF | 21 | 0 | 35 | n/a | a | non | female |
| nv18orM | 36 | 0 | 0 | n/a | u | non | male |
| fa12orF | 51 | 3 | 0 | n/a | u | disordered | female |
| fa06arF | 0 | 62 | 38 | n/a | a | disordered | female |
| nv15arM | 0 | 0 | 0 | n/a | a | non | male |
| fa17orM | 52 | 0 | 82 | n/a | u | disordered | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv19irM | 23 | 42 | 0 | n/a | i | non | male |
| fa19orF | 47 | 61 | 0 | n/a | u | disordered | female |
| fa08arF | 41 | 0 | 78 | n/a | a | disordered | female |
| nv13orF | 0 | 0 | 0 | n/a | o | non | female |
| fa18arF | 13 | 0 | 40 | n/a | a | non | male |
| nv19orM | 0 | 0 | 0 | n/a | n/a | non | male |
| fa23orM | 65 | 41 | 90 | n/a | o | disordered | male |
| fa09orM | 100 | 53 | 97 | n/a | u | disordered | female |
| nv12irF | 0 | 0 | 0 | n/a | i | non | female |
| fa19arF | 93 | 0 | 77 | n/a | a | disordered | female |
| fa23orM2 | 37 | 0 | 62 | n/a | o | disordered | male |
| nv01arF | 6 | 0 | 0 | n/a | a | non | female |
| fa11orF | 35 | 63 | 17 | n/a | ʊ | disordered | male |
| nv11orM | 65 | 0 | 0 | n/a | ʊ | non | male |
| fa20orM | 0 | 18 | 4 | n/a | ʊ | disordered | male |
| nv03orF2 | 0 | 0 | 1 | n/a | o | non | female |
| nv07arF | 3 | 51 | 35 | n/a | a | non | female |
| fa13irF | 57 | 0 | 62 | n/a | i | disordered | female |
| nv10arM | 12 | 3 | 0 | n/a | a | non | male |
| fa22orM | 45 | 52 | 0 | n/a | u | disordered | male |
| nv01orF2 | 0 | 64 | 37 | n/a | o | disordered | female |
| nv11arM | 0 | 0 | 3 | n/a | a | non | male |
| fa18irF | 34 | 38 | 91 | n/a | i | disordered | female |
| nv09irM | 0 | 0 | 0 | n/a | i | non | male |
| fa25arF | 0 | 0 | 36 | n/a | a | non | female |
| fa06arF2 | 0 | 67 | 0 | n/a | a | disordered | female |

Listener 2

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------|---------------------|--------------------|--------|
| fa07arM | 0 | 4 | 2 | n/a | a | non | male |
| nv15orM | 3 | 0 | 0 | n/a | o | non | male |
| fa20irM | 1 | 15 | 22 | n/a | i | non | male |
| nv08arF | 0 | 0 | 0 | n/a | a | non | female |
| fa25irF | 0 | 5 | 5 | n/a | i | non | female |
| fa27irM | 27 | 35 | 42 | n/a | i | n/a | male |
| fa13arF | 60 | 76 | 76 | n/a | a | disordered | female |
| fa07orM2 | 2 | 25 | 2 | slight tremor | o | n/a | male |
| fa23arM | 10 | 50 | 53 | n/a | a | disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 9 | 20 | 0 | n/a | a | non | male |
| fa06irF | 4 | 26 | 0 | n/a | i | non | female |
| fa33arM | 4 | 0 | 34 | n/a | a | non | male |
| fa33irM2 | 0 | 20 | 10 | n/a | i | non | male |
| fa33irM | 0 | 0 | 10 | n/a | i | non | male |
| nv04orF | 0 | 0 | 2 | high pitch | a | non | female |
| fa29irM | 12 | 1 | 42 | n/a | i | n/a | male |
| nv12arF | 25 | 1 | 36 | n/a | a | n/a | female |
| nv05irF2 | 10 | 0 | 25 | n/a | i | non | female |
| nv03irF | 0 | 0 | 5 | n/a | i | non | female |
| nv03orF | 5 | 0 | 5 | n/a | o | n/a | female |
| fa30arM | 0 | 0 | 34 | small tremor | a | disordered | male |
| nv07irF | 3 | 20 | 47 | n/a | i | disordered | female |
| nv20irM | 0 | 0 | 0 | n/a | i | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-----------|---------------------|--------------------|--------|
| nv05irF | 0 | 0 | 42 | n/a | i | n/a | female |
| nv02arF | 12 | 0 | 65 | n/a | a | disordered | female |
| fa30irM | 35 | 21 | 39 | n/a | i | disordered | male |
| fa27arM | 25 | 0 | 17 | n/a | a | non | male |
| nv18irM | 40 | 2 | 53 | n/a | i | disordered | male |
| nv09arM | 24 | 4 | 33 | n/a | a | disordered | male |
| fa30orM | 15 | 36 | 39 | low pitch | o | disordered | male |
| nv01orF | 55 | 44 | 61 | n/a | o | disordered | female |
| fa11irF | 46 | 35 | 59 | n/a | i | disordered | male |
| nv16arM | 45 | 18 | 35 | n/a | a | disordered | male |
| nv10irM | 34 | 16 | 23 | n/a | i | disordered | male |
| fa29orM | 11 | 0 | 15 | n/a | o | disordered | male |
| nv02irF | 35 | 10 | 63 | n/a | i | disordered | female |
| fa19irF | 24 | 0 | 35 | n/a | i | disordered | female |
| nv14arM | 15 | 11 | 2 | n/a | a | non | male |
| nv13arF | 35 | 44 | 33 | n/a | a | disordered | female |
| fa27orM | 66 | 0 | 23 | Tremor | o | disordered | male |
| nv03arF | 35 | 0 | 53 | n/a | a | disordered | female |
| nv10orM | 24 | 0 | 10 | n/a | o | disordered | male |
| nv11irM | 56 | 3 | 53 | n/a | i | disordered | male |
| nv14irM | 12 | 3 | 15 | Shaky | i | n/a | male |
| fa23irM | 58 | 51 | 66 | n/a | i | disordered | male |
| nv04arF | 66 | 23 | 68 | n/a | a | disordered | female |
| nv05orF | 37 | 1 | 63 | n/a | o | disordered | female |
| nv08orF | 0 | 0 | 0 | n/a | a | non | female |
| nv17irM | 25 | 0 | 11 | n/a | i | disordered | male |
| fa22arM | 48 | 1 | 23 | n/a | a | disordered | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv04irF | 2 | 0 | 12 | n/a | i | non | female |
| nv17arM | 50 | 41 | 48 | n/a | a | disordered | male |
| nv05arF | 13 | 0 | 0 | Shaky | a | non | female |
| nv20orM | 5 | 0 | 4 | n/a | o | non | male |
| fa18orF | 62 | 0 | 64 | n/a | o | disordered | male |
| nv06arF | 25 | 5 | 28 | n/a | a | disordered | male |
| nv13irF | 24 | 0 | 76 | n/a | i | disordered | female |
| nv02orF | 38 | 0 | 61 | n/a | o | disordered | female |
| nv08orF2 | 0 | 0 | 2 | n/a | a | non | female |
| fa17arM | 26 | 0 | 24 | n/a | a | disordered | male |
| nv06orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08irF | 3 | 1 | 14 | n/a | i | disordered | female |
| fa33orM | 0 | 0 | 0 | low pitch | o | non | male |
| fa29arM2 | 10 | 0 | 0 | n/a | a | non | male |
| fa12irF | 45 | 0 | 75 | n/a | i | n/a | female |
| nv07orF | 48 | 0 | 10 | deep voice | o | non | female |
| nv01irF | 0 | 0 | 15 | n/a | i | non | female |
| fa25orF | 13 | 0 | 10 | n/a | o | non | female |
| fa20orM2 | 39 | 0 | 16 | n/a | o | non | male |
| fa11arF | 15 | 0 | 0 | n/a | o | non | male |
| nv09orM | 19 | 0 | 0 | n/a | a | non | female |
| fa22irM | 49 | 0 | 64 | n/a | i | disordered | male |
| fa20arM | 44 | 12 | 33 | n/a | a | disordered | male |
| nv11orM2 | 17 | 5 | 42 | Tremor | o | disordered | male |
| fa09arM | 26 | 0 | 55 | pitch instability | a | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------|---------------------|--------------------|--------|
| nv12orF | 4 | 0 | 2 | n/a | o | non | female |
| fa17irM | 22 | 10 | 60 | Tremor | i | disordered | male |
| fa13orF | 11 | 16 | 75 | n/a | o | disordered | female |
| nv15orM2 | 45 | 0 | 26 | n/a | o | non | male |
| fa08irF | 3 | 0 | 11 | n/a | i | non | female |
| nv14orM | 0 | 0 | 0 | n/a | o | non | male |
| fa10orF | 10 | 0 | 51 | n/a | o | disordered | female |
| fa09irM | 0 | 0 | 73 | n/a | i | disordered | female |
| nv20arM | 0 | 0 | 4 | n/a | a | non | male |
| fa07orM | 11 | 0 | 18 | n/a | o | non | male |
| nv15irM | 4 | 0 | 19 | n/a | i | non | male |
| fa03irF | 16 | 0 | 42 | Loud | i | n/a | female |
| fa06orF | 58 | 11 | 80 | n/a | o | disordered | male |
| nv19arM | 13 | 36 | 52 | n/a | a | disordered | male |
| fa08orF | 53 | 0 | 51 | n/a | o | disordered | female |
| nv16orM | 22 | 0 | 12 | n/a | o | non | male |
| fa07irM | 9 | 0 | 19 | n/a | i | non | male |
| fa03orF | 51 | 0 | 20 | n/a | o | disordered | female |
| nv17orM | 39 | 0 | 67 | n/a | o | disordered | male |
| fa10irF | 35 | 0 | 25 | n/a | i | disordered | female |
| nv18arM | 4 | 4 | 0 | n/a | a | non | male |
| fa10arF | 10 | 0 | 44 | n/a | a | disordered | female |
| fa03arF | 52 | 0 | 46 | n/a | a | disordered | female |
| nv16irM | 2 | 0 | 4 | n/a | i | non | male |
| fa12arF | 3 | 0 | 16 | n/a | a | non | female |
| nv18orM | 5 | 0 | 8 | n/a | o | non | male |
| fa12orF | 5 | 0 | 0 | n/a | o | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------|---------------------|--------------------|--------|
| fa06arF | 14 | 0 | 13 | n/a | a | non | female |
| nv15arM | 0 | 0 | 0 | n/a | a | non | male |
| fa17orM | 3 | 37 | 76 | Tremor | o | disordered | male |
| nv19irM | 0 | 0 | 0 | n/a | i | non | male |
| fa19orF | 37 | 0 | 51 | Tremor | o | disordered | female |
| fa08arF | 11 | 0 | 59 | Tremor | a | disordered | female |
| nv13orF | 10 | 1 | 39 | n/a | o | disordered | female |
| fa18arF | 22 | 0 | 24 | n/a | a | non | male |
| nv19orM | 61 | 0 | 57 | n/a | a | disordered | male |
| fa23orM | 11 | 0 | 9 | n/a | o | non | male |
| fa09orM | 78 | 0 | 93 | n/a | o | disordered | female |
| nv12irF | 0 | 0 | 14 | n/a | i | non | female |
| fa19arF | 48 | 0 | 73 | n/a | a | disordered | female |
| fa23orM2 | 23 | 0 | 68 | n/a | o | disordered | male |
| nv01arF | 2 | 0 | 4 | n/a | a | non | female |
| fa11orF | 40 | 0 | 24 | n/a | o | non | male |
| nv11orM | 45 | 0 | 64 | Tremor | o | disordered | male |
| fa20orM | 13 | 17 | 21 | n/a | o | disordered | male |
| nv03orF2 | 16 | 0 | 21 | n/a | o | non | female |
| nv07arF | 44 | 0 | 55 | n/a | a | disordered | female |
| fa13irF | 23 | 0 | 26 | n/a | i | non | female |
| nv10arM | 0 | 0 | 6 | n/a | a | non | male |
| fa22orM | 6 | 0 | 7 | n/a | o | non | male |
| nv01orF2 | 39 | 3 | 60 | n/a | o | disordered | female |
| nv11arM | 7 | 2 | 36 | Tremor | a | n/a | male |
| fa18irF | 15 | 0 | 5 | n/a | i | non | female |
| nv09irM | 0 | 0 | 0 | n/a | i | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------------|-----------------------|--------|
| fa25arF | 16 | 0 | 55 | n/a | a | disordered | female |
| fa06arF2 | 6 | 37 | 46 | n/a | a | disordered | female |

Listener 3

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------------|---------------------|--------------------|--------|
| fa07arM | 0 | 0 | 0 | n/a | a | non | male |
| nv15orM | 0 | 0 | 0 | n/a | o | non | male |
| fa20irM | 0 | 0 | 5 | n/a | i | n/a | male |
| nv08arF | 0 | 0 | 0 | n/a | a | n/a | female |
| fa25irF | 0 | 0 | 25 | Nasal | i | n/a | female |
| fa27irM | 19 | 0 | 6 | pitch slightly unstable | i | non | male |
| fa13arF | 4 | 5 | 4 | n/a | a | disordered | female |
| fa07orM2 | 3 | 2 | 0 | n/a | o | non | male |
| fa23arM | 0 | 6 | 25 | pitch instability | a | disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 5 | 0 | 0 | n/a | a | non | male |
| fa06irF | 0 | 5 | 31 | n/a | i | disordered | female |
| fa33arM | 26 | 0 | 25 | n/a | a | non | male |
| fa33irM2 | 10 | 0 | 28 | n/a | i | non | male |
| fa33irM | 4 | 1 | 18 | n/a | i | non | male |
| nv04orF | 0 | 5 | 2 | n/a | a | non | female |
| fa29irM | 44 | 26 | 56 | n/a | i | disordered | male |
| nv12arF | 0 | 0 | 0 | n/a | a | non | female |
| nv05irF2 | 0 | 0 | 1 | n/a | i | non | female |
| nv03irF | 0 | 0 | 0 | n/a | i | non | female |
| nv03orF | 0 | 0 | 5 | n/a | o | non | female |
| fa30arM | 27 | 20 | 30 | n/a | a | disordered | male |
| nv07irF | 0 | 5 | 0 | n/a | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv20irM | 0 | 0 | 0 | n/a | i | non | female |
| nv05irF | 0 | 0 | 3 | n/a | i | non | female |
| nv02arF | 0 | 13 | 4 | n/a | a | disordered | female |
| fa30irM | 27 | 28 | 33 | n/a | i | disordered | male |
| fa27arM | 18 | 4 | 26 | n/a | a | disordered | male |
| nv18irM | 0 | 15 | 13 | n/a | i | non | male |
| nv09arM | 0 | 0 | 0 | n/a | a | non | male |
| fa30orM | 27 | 31 | 30 | n/a | o | disordered | male |
| nv01orF | 0 | 35 | 20 | n/a | o | disordered | female |
| fa11irF | 0 | 13 | 43 | pitch instability | i | disordered | male |
| nv16arM | 20 | 0 | 44 | n/a | a | disordered | male |
| nv10irM | 30 | 0 | 37 | wet/gurgly | i | disordered | male |
| fa29orM | 22 | 5 | 30 | n/a | o | disordered | male |
| nv02irF | 0 | 4 | 8 | pitch instability | i | non | female |
| fa19irF | 0 | 4 | 36 | pitch instability | i | non | female |
| nv14arM | 0 | 0 | 2 | n/a | a | non | male |
| nv13arF | 0 | 0 | 3 | n/a | a | non | female |
| fa27orM | 23 | 14 | 29 | Tremor | o | disordered | male |
| nv03arF | 0 | 0 | 1 | n/a | a | non | female |
| nv10orM | 0 | 3 | 3 | n/a | o | non | male |
| nv11irM | 9 | 0 | 22 | pitch instability | i | non | male |
| nv14irM | 3 | 0 | 5 | n/a | i | non | male |
| fa23irM | 24 | 30 | 0 | Nasal | i | disordered | male |
| nv04arF | 0 | 14 | 14 | n/a | a | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv05orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08orF | 0 | 0 | 0 | n/a | a | non | female |
| nv17irM | 0 | 0 | 27 | n/a | i | non | male |
| fa22arM | 4 | 23 | 23 | pitch instability | a | disordered | male |
| nv04irF | 0 | 0 | 0 | n/a | i | non | female |
| nv17arM | 28 | 14 | 26 | Aphonia | a | disordered | male |
| nv05arF | 0 | 0 | 0 | n/a | a | non | female |
| nv20orM | 0 | 0 | 0 | n/a | o | non | male |
| fa18orF | 7 | 5 | 0 | n/a | o | non | female |
| nv06arF | 0 | 4 | 12 | n/a | a | non | female |
| nv13irF | 0 | 0 | 0 | n/a | i | non | female |
| nv02orF | 0 | 28 | 25 | n/a | o | disordered | female |
| nv08orF2 | 0 | 0 | 0 | n/a | a | non | female |
| fa17arM | 8 | 5 | 4 | low pitch | o | non | female |
| nv06orF | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| nv08irF | 0 | 0 | 0 | n/a | i | non | female |
| fa33orM | 22 | 22 | 30 | pitch instability | o | disordered | male |
| fa29arM2 | 35 | 17 | 29 | n/a | a | disordered | male |
| fa12irF | 15 | 40 | 51 | n/a | i | disordered | female |
| nv07orF | 33 | 0 | 29 | n/a | a | disordered | male |
| nv01irF | 0 | 0 | 7 | Nasal | i | non | female |
| fa25orF | 11 | 0 | 20 | n/a | o | disordered | female |
| fa20orM2 | 22 | 3 | 33 | Tremor | o | disordered | male |
| fa11arF | 0 | 0 | 0 | n/a | a | non | female |
| nv09orM | 0 | 0 | 5 | n/a | o | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------------------|---------------------|--------------------|--------|
| fa22irM | 0 | 12 | 38 | n/a | i | disordered | male |
| fa20arM | 17 | 5 | 34 | n/a | a | disordered | male |
| nv11orM2 | 25 | 0 | 32 | n/a | i | disordered | male |
| fa09arM | 12 | 36 | 49 | pitch instability, tremor | a | disordered | female |
| nv12orF | 2 | 17 | 27 | n/a | o | disordered | female |
| fa17irM | 64 | 34 | 71 | n/a | i | disordered | male |
| fa13orF | 22 | 33 | 48 | n/a | o | disordered | female |
| nv15orM2 | 0 | 3 | 11 | n/a | o | non | male |
| fa08irF | 2 | 23 | 32 | n/a | i | disordered | female |
| nv14orM | 0 | 0 | 0 | n/a | o | non | male |
| fa10orF | 12 | 21 | 34 | pitch instability | o | disordered | female |
| fa09irM | 1 | 47 | 65 | Aphonia | i | disordered | female |
| nv20arM | 0 | 0 | 4 | n/a | a | non | male |
| fa07orM | 34 | 24 | 34 | n/a | o | disordered | male |
| nv15irM | 2 | 32 | 35 | Nasal | i | disordered | male |
| fa03irF | 0 | 13 | 13 | n/a | i | non | female |
| fa06orF | 0 | 19 | 35 | n/a | o | disordered | female |
| nv19arM | 33 | 15 | 31 | pitch instability, tremor | a | disordered | male |
| fa08orF | 16 | 0 | 34 | pitch instability | o | disordered | female |
| nv16orM | 50 | 16 | 47 | n/a | o | disordered | male |
| fa07irM | 13 | 13 | 14 | n/a | i | non | male |
| fa03orF | 4 | 20 | 24 | pitch inst | o | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv17orM | 59 | 17 | 62 | Fry | o | disordered | male |
| fa10irF | 0 | 13 | 13 | n/a | i | non | female |
| nv18arM | 3 | 0 | 16 | n/a | a | non | male |
| fa10arF | 0 | 0 | 18 | pitch instability | a | disordered | female |
| fa03arF | 12 | 14 | 25 | pitch instability | a | disordered | female |
| nv16irM | 13 | 0 | 20 | Fry | i | non | male |
| fa12arF | 13 | 21 | 16 | n/a | a | disordered | female |
| nv18orM | 12 | 0 | 23 | n/a | o | non | male |
| fa12orF | 0 | 36 | 36 | n/a | o | disordered | female |
| fa06arF | 14 | 49 | 36 | n/a | a | disordered | female |
| nv15arM | 0 | 0 | 0 | n/a | a | non | male |
| fa17orM | 23 | 38 | 62 | Tremor | o | disordered | male |
| nv19irM | 0 | 0 | 13 | n/a | i | non | male |
| fa19orF | 0 | 0 | 34 | n/a | o | disordered | female |
| fa08arF | 15 | 23 | 37 | pitch instability | a | disordered | female |
| nv13orF | 0 | 17 | 32 | n/a | o | disordered | female |
| fa18arF | 0 | 40 | 26 | Tremor | a | disordered | female |
| nv19orM | 0 | 0 | 0 | n/a | a | non | male |
| fa23orM | 23 | 1 | 21 | pitch instability | o | disordered | male |
| fa09orM | 36 | 36 | 34 | n/a | o | disordered | female |
| nv12irF | 0 | 0 | 0 | n/a | i | non | female |
| fa19arF | 0 | 20 | 39 | pitch instability | a | disordered | female |
| fa23orM2 | 17 | 18 | 35 | pitch inst | o | disordered | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv01arF | 0 | 3 | 0 | n/a | a | non | female |
| fa11orF | 40 | 20 | 39 | low pitch | o | disordered | female |
| nv11orM | 53 | 21 | 39 | n/a | o | disordered | male |
| fa20orM | 25 | 0 | 41 | pitch instability | o | disordered | male |
| nv03orF2 | 0 | 0 | 0 | n/a | o | non | female |
| nv07arF | 0 | 0 | 4 | n/a | a | non | female |
| fa13irF | 25 | 25 | 40 | Nasal | i | disordered | female |
| nv10arM | 0 | 0 | 0 | n/a | a | non | male |
| fa22orM | 13 | 15 | 13 | n/a | o | non | male |
| nv01orF2 | 14 | 25 | 25 | n/a | o | disordered | female |
| nv11arM | 0 | 0 | 39 | pitch instability | a | disordered | male |
| fa18irF | 0 | 0 | 0 | low pitch | i | non | female |
| nv09irM | 0 | 0 | 0 | n/a | i | non | male |
| fa25arF | 15 | 17 | 37 | n/a | a | disordered | female |
| fa06arF2 | 0 | 45 | 19 | n/a | a | disordered | female |

Listener 4

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|----------|---------------------|--------------------|--------|
| fa07arM | 0 | 60 | 0 | n/a | a | disordered | male |
| nv15orM | 0 | 40 | 0 | n/a | o | disordered | male |
| fa20irM | 19 | 0 | 18 | n/a | i | disordered | male |
| nv08arF | 0 | 0 | 0 | n/a | a | non | female |
| fa25irF | 0 | 0 | 17 | n/a | i | non | female |
| fa27irM | 0 | 0 | 0 | n/a | i | non | male |
| fa13arF | 0 | 19 | 0 | n/a | a | non | female |
| fa07orM2 | 48 | 0 | 0 | n/a | o | disordered | male |
| fa23arM | 0 | 12 | 12 | Asthenia | a | disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 80 | 0 | 0 | n/a | a | non | male |
| fa06irF | 0 | 0 | 9 | n/a | i | non | female |
| fa33arM | 38 | 0 | 0 | n/a | a | disordered | male |
| fa33irM2 | 0 | 0 | 0 | n/a | i | non | male |
| fa33irM | 0 | 0 | 0 | n/a | i | non | male |
| nv04orF | 0 | 0 | 0 | n/a | a | non | female |
| fa29irM | 0 | 0 | 75 | n/a | i | disordered | male |
| nv12arF | 0 | 0 | 0 | n/a | a | non | female |
| nv05irF2 | 0 | 0 | 0 | n/a | i | non | female |
| nv03irF | 0 | 0 | 0 | n/a | i | non | female |
| nv03orF | 0 | 0 | 0 | n/a | o | non | male |
| fa30arM | 0 | 43 | 18 | n/a | a | disordered | male |
| nv07irF | 0 | 14 | 0 | n/a | i | non | female |
| nv20irM | 0 | 0 | 0 | n/a | e | non | male |
| nv05irF | 0 | 0 | 0 | n/a | e | non | female |
| nv02arF | 18 | 0 | 82 | n/a | a | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| fa30irM | 20 | 16 | 46 | n/a | a | disordered | male |
| fa27arM | 0 | 0 | 0 | n/a | a | non | male |
| nv18irM | 22 | 21 | 0 | n/a | i | non | male |
| nv09arM | 0 | 0 | 0 | n/a | a | non | male |
| fa30orM | 0 | 72 | 82 | n/a | o | disordered | male |
| nv01orF | 0 | 55 | 40 | n/a | o | disordered | female |
| fa11irF | 48 | 0 | 85 | n/a | i | disordered | male |
| nv16arM | 0 | 20 | 0 | n/a | a | non | male |
| nv10irM | 0 | 21 | 0 | n/a | i | non | male |
| fa29orM | 0 | 0 | 0 | n/a | i | non | male |
| nv02irF | 0 | 40 | 0 | n/a | i | disordered | female |
| fa19irF | 23 | 0 | 56 | n/a | i | disordered | female |
| nv14arM | 8 | 0 | 0 | n/a | a | non | male |
| nv13arF | 0 | 0 | 0 | n/a | a | non | female |
| fa27orM | 48 | 53 | 0 | n/a | o | disordered | male |
| nv03arF | 0 | 0 | 0 | n/a | a | non | female |
| nv10orM | 39 | 15 | 45 | n/a | o | disordered | male |
| nv11irM | 0 | 0 | 0 | n/a | E | non | male |
| nv14irM | 0 | 20 | 0 | n/a | e | non | male |
| fa23irM | 42 | 0 | 23 | n/a | E | disordered | male |
| nv04arF | 0 | 0 | 0 | n/a | a | b | female |
| nv05orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08orF | 0 | 0 | 0 | n/a | o | non | female |
| nv17irM | 0 | 21 | 0 | n/a | i | non | male |
| fa22arM | 0 | 0 | 0 | n/a | A | non | male |
| nv04irF | 0 | 0 | 0 | n/a | E | non | female |
| nv17arM | 20 | 25 | 46 | n/a | a | disordered | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv05arF | 0 | 0 | 0 | n/a | a | non | female |
| nv20orM | 0 | 0 | 0 | n/a | o | non | male |
| fa18orF | 0 | 0 | 0 | n/a | o | non | male |
| nv06arF | 0 | 0 | 22 | n/a | a | non | female |
| nv13irF | 0 | 0 | 0 | n/a | E | non | female |
| nv02orF | 0 | 22 | 20 | n/a | o | disordered | female |
| nv08orF2 | 0 | 0 | 0 | n/a | o | non | female |
| fa17arM | 0 | 46 | 0 | n/a | a | non | male |
| nv06orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08irF | 0 | 0 | 0 | n/a | E | non | female |
| fa33orM | 42 | 0 | 0 | n/a | o | disordered | male |
| fa29arM2 | 0 | 0 | 0 | n/a | a | non | male |
| fa12irF | 0 | 0 | 52 | n/a | E | disordered | female |
| nv07orF | 0 | 0 | 0 | n/a | o | non | female |
| nv01irF | 0 | 0 | 35 | n/a | E | non | female |
| fa25orF | 0 | 15 | 38 | n/a | o | non | female |
| fa20orM2 | 0 | 35 | 36 | n/a | o | non | male |
| fa11arF | 0 | 0 | 0 | n/a | a | non | male |
| nv09orM | 0 | 0 | 0 | n/a | o | non | male |
| fa22irM | 0 | 14 | 0 | n/a | E | non | male |
| fa20arM | 0 | 22 | 0 | n/a | a | non | male |
| nv11orM2 | 39 | 40 | 21 | n/a | o | disordered | male |
| fa09arM | 20 | 0 | 55 | n/a | a | disordered | female |
| nv12orF | 0 | 0 | 0 | n/a | a | non | female |
| fa17irM | 44 | 17 | 87 | n/a | I | disordered | male |
| fa13orF | 0 | 41 | 47 | n/a | o | disordered | male |
| nv15orM2 | 0 | 23 | 0 | n/a | o | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| fa08irF | 0 | 0 | 25 | n/a | E | non | female |
| nv14orM | 0 | 0 | 0 | n/a | o | non | male |
| fa10orF | 0 | 24 | 78 | n/a | o | disordered | female |
| fa09irM | 0 | 20 | 61 | n/a | E | disordered | female |
| nv20arM | 0 | 0 | 0 | n/a | a | non | male |
| fa07orM | 0 | 0 | 18 | n/a | o | non | male |
| nv15irM | 0 | 0 | 0 | n/a | E | non | male |
| fa03irF | 0 | 0 | 20 | n/a | E | non | female |
| fa06orF | 0 | 23 | 0 | n/a | o | non | female |
| nv19arM | 0 | 25 | 20 | n/a | a | disordered | male |
| fa08orF | 0 | 0 | 37 | n/a | o | non | female |
| nv16orM | 60 | 0 | 0 | n/a | o | non | male |
| fa07irM | 0 | 0 | 0 | n/a | E | non | male |
| fa03orF | 0 | 0 | 62 | n/a | o | disordered | female |
| nv17orM | 81 | 0 | 47 | n/a | o | disordered | male |
| fa10irF | 0 | 0 | 33 | n/a | E | disordered | male |
| nv18arM | 0 | 0 | 24 | n/a | a | disordered | male |
| fa10arF | 29 | 0 | 42 | n/a | o | disordered | female |
| fa03arF | 40 | 0 | 42 | n/a | a | disordered | female |
| nv16irM | 0 | 0 | 0 | n/a | e | non | male |
| fa12arF | 0 | 13 | 0 | n/a | a | non | female |
| nv18orM | 0 | 0 | 0 | n/a | o | non | male |
| fa12orF | 10 | 0 | 24 | n/a | o | disordered | female |
| fa06arF | 0 | 0 | 24 | n/a | a | non | female |
| nv15arM | 0 | 0 | 0 | n/a | a | non | male |
| fa17orM | 48 | 60 | 78 | n/a | o | disordered | male |
| nv19irM | 0 | 0 | 0 | n/a | E | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| fa19orF | 0 | 0 | 19 | n/a | o | non | female |
| fa08arF | 0 | 0 | 45 | n/a | a | disordered | male |
| nv13orF | 0 | 0 | 19 | n/a | o | non | female |
| fa18arF | 0 | 24 | 55 | n/a | a | disordered | male |
| nv19orM | 0 | 0 | 0 | n/a | o | non | male |
| fa23orM | 0 | 46 | 45 | n/a | o | disordered | male |
| fa09orM | 22 | 0 | 86 | n/a | o | disordered | female |
| nv12irF | 0 | 0 | 0 | n/a | E | non | female |
| fa19arF | 0 | 13 | 53 | n/a | a | disordered | female |
| fa23orM2 | 0 | 21 | 0 | n/a | o | non | male |
| nv01arF | 0 | 0 | 0 | n/a | a | non | female |
| fa11orF | 0 | 29 | 29 | n/a | o | disordered | male |
| nv11orM | 22 | 38 | 35 | n/a | o | disordered | male |
| fa20orM | 0 | 0 | 21 | n/a | o | non | male |
| nv03orF2 | 0 | 0 | 0 | n/a | o | non | female |
| nv07arF | 0 | 24 | 0 | n/a | a | non | female |
| fa13irF | 25 | 0 | 88 | n/a | E | disordered | female |
| nv10arM | 0 | 0 | 0 | n/a | a | non | male |
| fa22orM | 0 | 0 | 0 | n/a | o | non | male |
| nv01orF2 | 0 | 0 | 35 | n/a | o | disordered | female |
| nv11arM | 42 | 0 | 47 | n/a | a | disordered | male |
| fa18irF | 0 | 0 | 40 | n/a | E | disordered | male |
| nv09irM | 0 | 0 | 0 | n/a | E | non | male |
| fa25arF | 0 | 0 | 39 | n/a | a | disordered | female |
| fa06arF2 | 0 | 0 | 0 | n/a | a | non | female |

Listener 5

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| fa07arM | 0 | 5 | 0 | n/a | a | non | male |
| nv15orM | 3 | 3 | 0 | n/a | o | non | male |
| fa20irM | 2 | 0 | 0 | n/a | i | non | male |
| nv08arF | 0 | 0 | 0 | n/a | a | non | female |
| fa25irF | 0 | 0 | 4 | n/a | i | non | female |
| fa27irM | 14 | 1 | 1 | n/a | i | non | male |
| fa13arF | 25 | 15 | 19 | n/a | a | disordered | female |
| fa07orM2 | 0 | 19 | 3 | n/a | o | disordered | male |
| fa23arM | 19 | 21 | 1 | n/a | a | disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 5 | 35 | 0 | n/a | i | disordered | female |
| fa06irF | 12 | 26 | 0 | n/a | a | disordered | male |
| fa33arM | 26 | 11 | 0 | n/a | a | disordered | male |
| fa33irM2 | 24 | 0 | 0 | n/a | i | disordered | male |
| fa33irM | 26 | 0 | 0 | n/a | i | disordered | male |
| nv04orF | 0 | 0 | 0 | n/a | a | non | female |
| fa29irM | 5 | 5 | 0 | n/a | i | non | male |
| nv12arF | 0 | 5 | 0 | n/a | a | non | female |
| nv05irF2 | 0 | 0 | 5 | n/a | i | non | female |
| nv03irF | 0 | 0 | 0 | n/a | i | non | female |
| nv03orF | 0 | 5 | 0 | n/a | a | non | male |
| fa30arM | 0 | 5 | 0 | n/a | o | non | female |
| nv07irF | 5 | 11 | 0 | n/a | i | non | female |
| nv20irM | 0 | 0 | 0 | n/a | i | non | male |
| nv05irF | 0 | 5 | 1 | n/a | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv02arF | 0 | 0 | 25 | n/a | a | disordered | female |
| fa30irM | 5 | 5 | 0 | n/a | i | non | male |
| fa27arM | 11 | 0 | 0 | n/a | a | non | male |
| nv18irM | 13 | 19 | 0 | Shaky | i | disordered | male |
| nv09arM | 2 | 5 | 0 | n/a | a | non | male |
| fa30orM | 0 | 21 | 9 | Weak | o | disordered | male |
| nv01orF | 0 | 12 | 11 | n/a | o | non | female |
| fa11irF | 0 | 14 | 13 | n/a | i | disordered | male |
| nv16arM | 17 | 33 | 0 | n/a | a | disordered | male |
| nv10irM | 5 | 22 | 0 | n/a | i | disordered | male |
| fa29orM | 3 | 10 | 0 | n/a | o | non | male |
| nv02irF | 4 | 20 | 20 | Shaky | i | disordered | female |
| fa19irF | 5 | 5 | 4 | n/a | i | non | female |
| nv14arM | 5 | 14 | 0 | n/a | a | non | male |
| nv13arF | 0 | 0 | 0 | n/a | a | non | female |
| fa27orM | 0 | 0 | 0 | n/a | o | non | male |
| nv03arF | 0 | 1 | 1 | n/a | a | non | female |
| nv10orM | 13 | 27 | 0 | n/a | o | disordered | male |
| nv11irM | 3 | 20 | 0 | Shaky | i | disordered | male |
| nv14irM | 5 | 4 | 0 | n/a | i | non | male |
| fa23irM | 18 | 19 | 19 | n/a | i | disordered | male |
| nv04arF | 0 | 13 | 12 | n/a | a | non | female |
| nv05orF | 0 | 18 | 19 | n/a | o | non | female |
| nv08orF | 0 | 2 | 2 | n/a | a | non | female |
| nv17irM | 13 | 12 | 0 | Shaky | i | non | male |
| fa22arM | 13 | 14 | 4 | n/a | a | non | male |
| nv04irF | 4 | 7 | 0 | n/a | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------|---------------------|--------------------|--------|
| nv17arM | 33 | 21 | 4 | n/a | a | disordered | male |
| nv05arF | 0 | 0 | 0 | n/a | a | non | female |
| nv20orM | 0 | 0 | 0 | n/a | o | non | male |
| fa18orF | 5 | 19 | 2 | n/a | o | disordered | female |
| nv06arF | 4 | 12 | 3 | n/a | a | disordered | female |
| nv13irF | 0 | 10 | 25 | n/a | i | disordered | female |
| nv02orF | 14 | 14 | 0 | n/a | o | disordered | female |
| nv08orF2 | 0 | 0 | 0 | n/a | a | non | female |
| fa17arM | 12 | 12 | 0 | n/a | a | disordered | male |
| nv06orF | 0 | 4 | 0 | n/a | o | non | female |
| nv08irF | 0 | 3 | 13 | n/a | i | disordered | female |
| fa33orM | 5 | 4 | 0 | n/a | o | non | male |
| fa29arM2 | 21 | 21 | 0 | n/a | a | disordered | male |
| fa12irF | 0 | 14 | 13 | n/a | i | disordered | female |
| nv07orF | 5 | 4 | 0 | n/a | o | non | female |
| nv01irF | 0 | 0 | 0 | n/a | i | non | female |
| fa25orF | 0 | 18 | 17 | n/a | o | disordered | female |
| fa20orM2 | 19 | 20 | 5 | n/a | a | disordered | male |
| fa11arF | 22 | 21 | 11 | n/a | a | disordered | female |
| nv09orM | 20 | 19 | 0 | n/a | o | disordered | male |
| fa22irM | 5 | 18 | 0 | n/a | i | non | male |
| fa20arM | 21 | 19 | 0 | n/a | a | disordered | male |
| nv11orM2 | 26 | 26 | 2 | Tremor | o | disordered | male |
| fa09arM | 24 | 24 | 0 | n/a | a | disordered | female |
| nv12orF | 5 | 12 | 0 | n/a | o | non | female |
| fa17irM | 20 | 55 | 0 | n/a | i | disordered | male |
| fa13orF | 5 | 26 | 40 | n/a | o | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv15orM2 | 12 | 12 | 0 | n/a | o | disordered | male |
| fa08irF | 2 | 3 | 0 | n/a | i | non | female |
| nv14orM | 5 | 5 | 0 | n/a | o | non | male |
| fa10orF | 12 | 26 | 12 | n/a | o | disordered | female |
| fa09irM | 21 | 37 | 23 | n/a | i | disordered | female |
| nv20arM | 5 | 4 | 0 | n/a | a | non | male |
| fa07orM | 14 | 35 | 4 | n/a | o | disordered | male |
| nv15irM | 5 | 5 | 0 | n/a | i | non | male |
| fa03irF | 4 | 5 | 0 | n/a | i | non | female |
| fa06orF | 4 | 26 | 0 | n/a | o | disordered | female |
| nv19arM | 26 | 25 | 2 | n/a | a | disordered | male |
| fa08orF | 13 | 13 | 11 | Shaky | o | disordered | female |
| nv16orM | 32 | 23 | 0 | n/a | o | disordered | male |
| fa07irM | 26 | 26 | 0 | n/a | i | disordered | male |
| fa03orF | 30 | 30 | 5 | n/a | o | disordered | female |
| nv17orM | 49 | 34 | 3 | n/a | a | disordered | male |
| fa10irF | 16 | 26 | 2 | n/a | i | disordered | male |
| nv18arM | 25 | 25 | 0 | n/a | a | disordered | male |
| fa10arF | 5 | 19 | 0 | n/a | a | non | female |
| fa03arF | 4 | 3 | 19 | n/a | a | disordered | female |
| nv16irM | 23 | 24 | 0 | n/a | u | disordered | male |
| fa12arF | 4 | 25 | 0 | n/a | a | disordered | female |
| nv18orM | 26 | 26 | 0 | n/a | o | disordered | male |
| fa12orF | 0 | 26 | 0 | n/a | o | disordered | female |
| fa06arF | 27 | 26 | 3 | n/a | a | disordered | female |
| nv15arM | 35 | 35 | 0 | n/a | a | disordered | male |
| fa17orM | 25 | 48 | 0 | Shaky | o | disordered | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------|---------------------|--------------------|--------|
| nv19irM | 16 | 14 | 5 | n/a | i | disordered | male |
| fa19orF | 0 | 1 | 1 | n/a | o | non | female |
| fa08arF | 11 | 11 | 18 | n/a | a | disordered | female |
| nv13orF | 3 | 2 | 0 | n/a | o | non | female |
| fa18arF | 0 | 2 | 0 | n/a | a | non | male |
| nv19orM | 4 | 22 | 0 | n/a | a | disordered | female |
| fa23orM | 10 | 19 | 1 | n/a | o | disordered | male |
| fa09orM | 10 | 35 | 25 | n/a | o | disordered | female |
| nv12irF | 0 | 0 | 0 | n/a | i | non | female |
| fa19arF | 5 | 5 | 0 | n/a | a | non | female |
| fa23orM2 | 5 | 5 | 0 | n/a | o | non | male |
| nv01arF | 0 | 0 | 0 | n/a | a | non | female |
| fa11orF | 5 | 4 | 0 | n/a | o | non | male |
| nv11orM | 5 | 26 | 0 | Tremor | a | disordered | male |
| fa20orM | 4 | 3 | 0 | n/a | a | non | male |
| nv03orF2 | 5 | 4 | 0 | n/a | i | non | female |
| nv07arF | 6 | 5 | 0 | n/a | a | non | female |
| fa13irF | 0 | 12 | 13 | n/a | i | non | female |
| nv10arM | 4 | 13 | 0 | n/a | a | non | male |
| fa22orM | 0 | 0 | 0 | n/a | o | non | male |
| nv01orF2 | 12 | 19 | 0 | Shaky | o | disordered | female |
| nv11arM | 13 | 11 | 0 | Shaky | a | non | male |
| fa18irF | 0 | 0 | 0 | n/a | i | non | female |
| nv09irM | 6 | 6 | 0 | n/a | i | non | male |
| fa25arF | 3 | 21 | 4 | n/a | a | disordered | female |
| fa06arF2 | 24 | 26 | 1 | n/a | a | disordered | female |

Listener 6

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| fa07arM | 7 | 25 | 2 | n/a | a | non | male |
| nv15orM | 0 | 2 | 0 | n/a | o | non | male |
| fa20irM | 1 | 0 | 15 | n/a | i | non | male |
| nv08arF | 0 | 1 | 0 | n/a | a | non | female |
| fa25irF | 0 | 0 | 18 | n/a | i | non | female |
| fa27irM | 8 | 4 | 6 | n/a | i | non | male |
| fa13arF | 45 | 11 | 58 | n/a | a | disordered | female |
| fa07orM2 | 26 | 45 | 25 | n/a | o | disordered | male |
| fa23arM | 38 | 38 | 37 | n/a | a | disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 9 | 3 | 1 | n/a | a | non | male |
| fa06irF | 0 | 10 | 4 | n/a | i | non | female |
| fa33arM | 32 | 0 | 35 | n/a | a | disordered | male |
| fa33irM2 | 6 | 0 | 8 | n/a | i | non | male |
| fa33irM | 8 | 0 | 8 | n/a | i | non | male |
| nv04orF | 0 | 8 | 4 | n/a | a | non | female |
| fa29irM | 8 | 0 | 34 | n/a | i | disordered | male |
| nv12arF | 0 | 1 | 0 | n/a | a | non | male |
| nv05irF2 | 0 | 1 | 8 | n/a | i | non | female |
| nv03irF | 0 | 1 | 1 | n/a | i | non | female |
| nv03orF | 0 | 1 | 0 | n/a | o | non | female |
| fa30arM | 11 | 30 | 6 | n/a | a | disordered | male |
| nv07irF | 0 | 3 | 1 | n/a | i | non | female |
| nv20irM | 0 | 1 | 0 | n/a | i | non | male |
| nv05irF | 1 | 5 | 3 | n/a | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------------------------|---------------------|--------------------|--------|
| nv02arF | 1 | 4 | 6 | n/a | a | non | male |
| fa30irM | 15 | 25 | 11 | n/a | i | disordered | male |
| fa27arM | 39 | 1 | 2 | n/a | a | non | male |
| nv18irM | 1 | 0 | 5 | n/a | i | disordered | male |
| nv09arM | 8 | 1 | 1 | n/a | a | non | male |
| fa30orM | 12 | 51 | 1 | n/a | o | disordered | male |
| nv01orF | 0 | 6 | 4 | n/a | o | non | female |
| fa11irF | 11 | 0 | 38 | n/a | i | disordered | male |
| nv16arM | 33 | 1 | 8 | n/a | a | disordered | male |
| nv10irM | 5 | 2 | 1 | n/a | i | non | male |
| fa29orM | 8 | 11 | 8 | n/a | o | disordered | male |
| nv02irF | 0 | 10 | 4 | n/a | i | non | female |
| fa19irF | 9 | 0 | 25 | n/a | i | disordered | female |
| nv14arM | 8 | 2 | 9 | n/a | a | non | male |
| nv13arF | 0 | 1 | 0 | n/a | a | non | female |
| fa27orM | 24 | 14 | 9 | tremor, poor vowel sound | o | disordered | male |
| nv03arF | 0 | 2 | 1 | n/a | a | non | female |
| nv10orM | 8 | 0 | 1 | n/a | o | non | male |
| nv11irM | 8 | 1 | 4 | n/a | i | non | male |
| nv14irM | 8 | 1 | 5 | n/a | i | non | male |
| fa23irM | 24 | 44 | 21 | some hypernasality | i | disordered | male |
| nv04arF | 6 | 8 | 6 | n/a | a | non | female |
| nv05orF | 0 | 6 | 0 | n/a | o | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---|---------------------|--------------------|--------|
| nv08orF | 0 | 4 | 0 | n/a | o | non | female |
| nv17irM | 3 | 2 | 6 | n/a | i | non | male |
| fa22arM | 24 | 1 | 50 | slight hyponasality | o | disordered | male |
| nv04irF | 0 | 2 | 1 | n/a | i | non | female |
| nv17arM | 20 | 1 | 10 | bit of pitch instability/ cracking of voice | a | non | male |
| nv05arF | 0 | 1 | 0 | n/a | a | non | female |
| nv20orM | 4 | 2 | 1 | n/a | o | non | male |
| fa18orF | 1 | 30 | 2 | n/a | o | non | female |
| nv06arF | 0 | 8 | 0 | n/a | a | non | female |
| nv13irF | 0 | 0 | 8 | slight hyponasality | i | non | female |
| nv02orF | 0 | 4 | 1 | n/a | o | non | female |
| nv08orF2 | 0 | 3 | 0 | n/a | o | non | male |
| fa17arM | 32 | 34 | 8 | slightly hyponasal, tremor | a | Disordered | male |
| nv06orF | 0 | 1 | 0 | n/a | o | non | female |
| nv08irF | 0 | 5 | 3 | n/a | i | non | female |
| fa33orM | 38 | 1 | 1 | n/a | o | non | Male |
| fa29arM2 | 30 | 2 | 1 | n/a | a | non | Male |
| fa12irF | 0 | 8 | 12 | slight hypernasal | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---|---------------------|--------------------|--------|
| nv07orF | 0 | 1 | 0 | n/a | o | non | female |
| nv01irF | 0 | 0 | 4 | n/a | i | non | female |
| fa25orF | 0 | 1 | 3 | n/a | o | non | female |
| fa20orM2 | 30 | 0 | 25 | slightly hyponasal, slight pitch instability (almost "shaky" voice) | o | non | Male |
| fa11arF | 4 | 0 | 24 | n/a | a | non | female |
| nv09orM | 0 | 2 | 0 | n/a | o | non | Male |
| fa22irM | 1 | 2 | 10 | slightly hyponasal, some pitch instability | i | non | Male |
| fa20arM | 4 | 12 | 4 | n/a | a | non | Male |
| nv11orM2 | 27 | 3 | 0 | n/a | o | non | Male |
| fa09arM | 27 | 35 | 4 | noticeable pitch instability | a | disordered | female |
| nv12orF | 0 | 3 | 0 | n/a | o | non | female |
| fa17irM | 8 | 66 | 0 | slightly hypernasal, very weak voice, maybe slight tremor | i | Disordered | Male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------------------------------|---------------------|--------------------|--------|
| fa13orF | 1 | 8 | 30 | slightly hyponasal, pitch instability | o | non | female |
| nv15orM2 | 0 | 1 | 0 | n/a | o | non | Male |
| fa08irF | 8 | 0 | 45 | slightly hypernasal | i | non | female |
| nv14orM | 3 | 2 | 1 | n/a | o | non | Male |
| fa10orF | 3 | 58 | 1 | unstable voice | o | disordered | female |
| fa09irM | 0 | 36 | 37 | slightly hypernasal | i | disordered | female |
| nv20arM | 8 | 3 | 0 | n/a | a | non | Male |
| fa07orM | 4 | 28 | 1 | weak voice, slightly tremulous | o | disordered | Male |
| nv15irM | 1 | 5 | 0 | n/a | i | non | Male |
| fa03irF | 9 | 3 | 25 | n/a | i | non | female |
| fa06orF | 1 | 11 | 0 | n/a | o | non | female |
| nv19arM | 28 | 2 | 6 | harsh fry at one point | a | non | Male |
| fa08orF | 8 | 14 | 1 | pitch instability, tremor | o | non | female |
| nv16orM | 37 | 18 | 1 | slight fry, slightly weak voice | o | n/a | Male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-----------------------------------|---------------------|--------------------|--------|
| fa07irM | 11 | 8 | 22 | slight tremor | i | non | Male |
| fa03orF | 12 | 8 | 1 | pitch instability, slight tremor | o | non | female |
| nv17orM | 43 | 0 | 26 | fry, slight tremor (shaky voice) | o | non | Male |
| fa10irF | 3 | 0 | 36 | hyponasal, tremulous | i | disordered | female |
| nv18arM | 35 | 0 | 27 | harsh-sounding voice | a | non | Male |
| fa10arF | 25 | 12 | 6 | tremulous/unstable | a | disordered | female |
| fa03arF | 34 | 1 | 26 | tremulous/unstable | a | disordered | female |
| nv16irM | 11 | 4 | 1 | n/a | i | non | Male |
| fa12arF | 0 | 21 | 0 | n/a | a | non | female |
| nv18orM | 32 | 0 | 8 | slight fry | o | non | Male |
| fa12orF | 0 | 35 | 0 | slightly hyponasal, slightly weak | o | disordered | female |
| fa06arF | 41 | 40 | 1 | n/a | a | disordered | female |
| nv15arM | 25 | 11 | 0 | n/a | a | non | Male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---|---------------------|--------------------|--------|
| fa17orM | 28 | 45 | 0 | slight nasal air emission, very weak, tremulous | o | disordered | Male |
| nv19irM | 4 | 10 | 1 | n/a | i | non | Male |
| fa19orF | 4 | 33 | 1 | pitch instability | o | disordered | female |
| fa08arF | 12 | 0 | 39 | slightly hyponasal, tremor, pitch instability | a | disordered | female |
| nv13orF | 0 | 14 | 0 | n/a | o | non | female |
| fa18arF | 8 | 53 | 1 | tremor, pitch instability, weak | a | disordered | Male |
| nv19orM | 3 | 8 | 0 | n/a | o | non | Male |
| fa23orM | 6 | 56 | 27 | some nasal air emission, slight tremor, pitch instability | o | disordered | Male |
| fa09orM | 32 | 71 | 48 | Hyponasality | o | disordered | female |
| nv12irF | 0 | 11 | 4 | Hypernasal | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---|---------------------|--------------------|--------|
| fa19arF | 19 | 35 | 40 | tremor, pitch instability | a | Disordered | female |
| fa23orM2 | 41 | 61 | 54 | inconsistent hyponasality, tremor, pitch instability, some weakness | o | disordered | Male |
| nv01arF | 3 | 8 | 1 | n/a | a | non | female |
| fa11orF | 13 | 48 | 3 | hyponasal, pitch instability, slight tremor | o | disordered | Male |
| nv11orM | 18 | 8 | 4 | slightly tremulous | o | non | Male |
| fa20orM | 39 | 4 | 4 | pitch instability, slightly tremulous | o | non | Male |
| nv03orF2 | 0 | 8 | 0 | n/a | o | non | female |
| nv07arF | 16 | 1 | 30 | tremulous | a | non | female |
| fa13irF | 20 | 8 | 68 | hyponasal, tremor | i | disordered | female |
| nv10arM | 22 | 5 | 8 | n/a | a | non | Male |
| fa22orM | 11 | 3 | 17 | slightly hyponasal | o | non | Male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--|---------------------|--------------------|--------|
| nv01orF2 | 0 | 5 | 1 | n/a | o | non | female |
| nv11arM | 27 | 0 | 11 | Fry | a | non | Male |
| fa18irF | 1 | 27 | 31 | hypernasal , pitch instability | i | disordered | female |
| nv09irM | 4 | 0 | 1 | n/a | i | Non | male |
| fa25arF | 20 | 1 | 34 | hypernasal , slightly tremulous, pitch instability | a | disordered | female |
| fa06arF2 | 5 | 50 | 0 | weak voice | a | disordered | female |

Listener 7

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| fa07arM | 0 | 0 | 0 | n/a | a | non | Male |
| nv15orM | 0 | 0 | 0 | n/a | o | non | Male |
| fa20irM | 0 | 0 | 0 | n/a | i | non | male |
| nv08arF | 0 | 0 | 0 | n/a | a | non | female |
| fa25irF | 0 | 0 | 0 | n/a | i | n/a | n/a |
| fa27irM | 0 | 0 | 0 | n/a | i | non | male |
| fa13arF | 8 | 0 | 3 | n/a | a | non | female |
| fa07orM2 | 0 | 0 | 0 | n/a | o | non | male |
| fa23arM | 6 | 0 | 0 | n/a | a | non | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 0 | 0 | 0 | n/a | a | non | male |
| fa06irF | 0 | 8 | 0 | n/a | i | non | female |
| fa33arM | 0 | 0 | 0 | n/a | a | non | male |
| fa33irM2 | 0 | 0 | 0 | n/a | i | non | male |
| fa33irM | 0 | 0 | 0 | n/a | i | non | male |
| nv04orF | 0 | 0 | 0 | n/a | a | non | female |
| fa29irM | 0 | 0 | 0 | n/a | i | non | male |
| nv12arF | 0 | 0 | 0 | n/a | a | non | female |
| nv05irF2 | 0 | 0 | 0 | n/a | i | non | female |
| nv03irF | 0 | 0 | 0 | n/a | i | non | female |
| nv03orF | 0 | 0 | 0 | n/a | o | non | female |
| fa30arM | 8 | 0 | 0 | n/a | a | non | male |
| nv07irF | 0 | 0 | 0 | n/a | i | non | female |
| nv20irM | 0 | 0 | 0 | n/a | i | non | male |
| nv05irF | 0 | 0 | 0 | n/a | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv02arF | 0 | 0 | 8 | n/a | a | non | female |
| fa30irM | 0 | 0 | 0 | n/a | i | non | male |
| fa27arM | 0 | 0 | 0 | n/a | a | non | male |
| nv18irM | 0 | 0 | 0 | n/a | i | non | male |
| nv09arM | 0 | 0 | 0 | n/a | a | non | male |
| fa30orM | 0 | 0 | 0 | n/a | o | non | male |
| nv01orF | 0 | 0 | 0 | n/a | o | non | female |
| fa11irF | 0 | 0 | 5 | n/a | i | non | female |
| nv16arM | 0 | 0 | 0 | n/a | a | non | male |
| nv10irM | 3 | 0 | 0 | n/a | i | non | male |
| fa29orM | 0 | 0 | 0 | n/a | a | non | male |
| nv02irF | 0 | 0 | 0 | n/a | i | non | female |
| fa19irF | 0 | 0 | 0 | n/a | i | non | female |
| nv14arM | 0 | 0 | 0 | n/a | a | non | male |
| nv13arF | 0 | 0 | 0 | n/a | a | non | female |
| fa27orM | 0 | 0 | 0 | pitch instability | o | non | male |
| nv03arF | 0 | 0 | 0 | n/a | a | non | female |
| nv10orM | 0 | 0 | 0 | n/a | o | non | male |
| nv11irM | 0 | 0 | 0 | n/a | i | non | male |
| nv14irM | 0 | 0 | 0 | n/a | i | non | male |
| fa23irM | 0 | 17 | 0 | n/a | i | non | male |
| nv04arF | 0 | 0 | 0 | n/a | a | non | female |
| nv05orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08orF | 0 | 0 | 0 | n/a | a | non | female |
| nv17irM | 0 | 0 | 0 | n/a | i | non | male |
| fa22arM | 8 | 0 | 0 | n/a | a | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| nv04irF | 0 | 0 | 0 | n/a | i | non | female |
| nv17arM | 0 | 0 | 8 | n/a | a | non | male |
| nv05arF | 0 | 0 | 0 | n/a | a | non | female |
| nv20orM | 0 | 0 | 0 | n/a | o | non | male |
| fa18orF | 1 | 1 | 0 | n/a | o | non | female |
| nv06arF | 0 | 0 | 0 | n/a | a | non | female |
| nv13irF | 0 | 0 | 0 | n/a | i | non | female |
| nv02orF | 0 | 0 | 0 | n/a | a | non | female |
| nv08orF2 | 0 | 0 | 0 | n/a | a | non | female |
| fa17arM | 0 | 0 | 0 | n/a | a | non | male |
| nv06orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08irF | 0 | 0 | 0 | n/a | i | non | female |
| fa33orM | 0 | 0 | 0 | n/a | o | non | male |
| fa29arM2 | 0 | 0 | 0 | n/a | a | non | male |
| fa12irF | 0 | 0 | 0 | n/a | i | non | female |
| nv07orF | 0 | 0 | 0 | n/a | o | non | female |
| nv01irF | 0 | 0 | 0 | n/a | i | non | female |
| fa25orF | 0 | 0 | 0 | n/a | o | non | female |
| fa20orM2 | 0 | 0 | 0 | n/a | o | non | male |
| fa11arF | 0 | 0 | 0 | n/a | a | non | female |
| nv09orM | 0 | 0 | 0 | n/a | o | non | male |
| fa22irM | 8 | 0 | 0 | n/a | i | non | male |
| fa20arM | 0 | 0 | 0 | n/a | a | non | male |
| nv11orM2 | 0 | 0 | 0 | n/a | o | non | male |
| fa09arM | 0 | 0 | 0 | n/a | a | non | female |
| nv12orF | 0 | 0 | 0 | n/a | o | non | female |
| fa17irM | 0 | 14 | 0 | n/a | i | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| fa13orF | 0 | 0 | 0 | n/a | o | non | female |
| nv15orM2 | 0 | 0 | 0 | n/a | o | non | male |
| fa08irF | 0 | 0 | 0 | n/a | i | non | female |
| nv14orM | 0 | 0 | 0 | n/a | o | non | male |
| fa10orF | 12 | 0 | 3 | Tremor | o | disordered | female |
| fa09irM | 4 | 0 | 0 | pitch instability | i | disordered | female |
| nv20arM | 0 | 0 | 0 | n/a | a | non | male |
| fa07orM | 0 | 0 | 0 | n/a | o | non | male |
| nv15irM | 0 | 0 | 0 | n/a | i | non | male |
| fa03irF | 0 | 0 | 0 | n/a | i | non | female |
| fa06orF | 0 | 0 | 0 | n/a | o | non | female |
| nv19arM | 0 | 0 | 12 | n/a | a | disordered | male |
| fa08orF | 0 | 0 | 0 | n/a | o | non | female |
| nv16orM | 4 | 0 | 0 | n/a | o | non | male |
| fa07irM | 0 | 0 | 0 | n/a | i | non | male |
| fa03orF | 0 | 0 | 0 | n/a | o | non | female |
| nv17orM | 8 | 0 | 0 | n/a | o | non | male |
| fa10irF | 0 | 0 | 0 | n/a | i | non | female |
| nv18arM | 0 | 0 | 0 | n/a | a | non | male |
| fa10arF | 0 | 0 | 0 | n/a | a | non | female |
| fa03arF | 0 | 0 | 0 | n/a | a | non | female |
| nv16irM | 1 | 0 | 0 | n/a | i | non | male |
| fa12arF | 0 | 0 | 0 | n/a | a | non | female |
| nv18orM | 0 | 0 | 0 | n/a | o | non | male |
| fa12orF | 0 | 0 | 0 | n/a | u | non | female |
| fa06arF | 0 | 0 | 0 | n/a | a | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv15arM | 0 | 0 | 0 | n/a | a | non | male |
| fa17orM | 0 | 0 | 0 | Tremor | o | non | male |
| nv19irM | 0 | 0 | 0 | n/a | i | non | male |
| fa19orF | 0 | 0 | 0 | n/a | o | non | female |
| fa08arF | 0 | 0 | 0 | n/a | a | non | female |
| nv13orF | 0 | 0 | 0 | n/a | o | non | female |
| fa18arF | 0 | 3 | 0 | n/a | a | non | male |
| nv19orM | 0 | 0 | 0 | n/a | a | non | male |
| fa23orM | 0 | 0 | 0 | n/a | o | non | male |
| fa09orM | 6 | 2 | 0 | n/a | o | disordered | female |
| nv12irF | 0 | 0 | 0 | n/a | i | non | female |
| fa19arF | 18 | 0 | 0 | n/a | a | non | female |
| fa23orM2 | 0 | 0 | 0 | n/a | o | non | male |
| nv01arF | 0 | 0 | 0 | n/a | a | non | female |
| fa11orF | 1 | 1 | 0 | n/a | a | non | male |
| nv11orM | 0 | 0 | 0 | n/a | a | non | male |
| fa20orM | 0 | 0 | 0 | n/a | o | non | male |
| nv03orF2 | 0 | 0 | 0 | n/a | o | non | female |
| nv07arF | 0 | 0 | 0 | n/a | a | non | female |
| fa13irF | 0 | 0 | 0 | pitch instability | i | non | female |
| nv10arM | 0 | 0 | 0 | n/a | a | non | male |
| fa22orM | 0 | 0 | 0 | n/a | a | non | male |
| nv01orF2 | 0 | 3 | 0 | n/a | o | non | female |
| nv11arM | 0 | 0 | 0 | Tremor | a | non | male |
| fa18irF | 0 | 0 | 0 | n/a | i | non | female |
| nv09irM | 0 | 0 | 0 | n/a | i | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------------|-----------------------|--------|
| fa25arF | 6 | 0 | 0 | n/a | a | non | female |
| fa06arF2 | 0 | 7 | 0 | n/a | a | non | female |

Listener 8

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------|---------------------|--------------------|--------|
| fa07arM | 16 | 13 | 9 | n/a | a | disordered | male |
| nv15orM | 0 | 0 | 0 | n/a | o | non | male |
| fa20irM | 3 | 0 | 0 | n/a | i | non | male |
| nv08arF | 0 | 0 | 0 | n/a | a | non | female |
| fa25irF | 16 | 1 | 2 | n/a | i | non | male |
| fa27irM | 4 | 0 | 0 | lower pitch | i | non | female |
| fa13arF | 3 | 34 | 1 | n/a | o | disordered | male |
| fa07orM2 | 3 | 20 | 10 | n/a | a | disordered | female |
| fa23arM | 49 | 45 | 43 | n/a | a | disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 8 | 0 | 0 | n/a | a | n/a | male |
| fa06irF | 0 | 3 | 3 | n/a | i | non | female |
| fa33arM | 26 | 0 | 2 | n/a | a | non | male |
| fa33irM2 | 1 | 0 | 0 | n/a | i | non | Male |
| fa33irM | 1 | 0 | 0 | n/a | i | non | Male |
| nv04orF | 0 | 0 | 0 | n/a | a | non | Female |
| fa29irM | 58 | 12 | 57 | n/a | i | disordered | Male |
| nv12arF | 0 | 0 | 1 | n/a | a | non | female |
| nv05irF2 | 0 | 0 | 0 | n/a | i | non | female |
| nv03irF | 0 | 0 | 0 | n/a | i | non | female |
| nv03orF | 1 | 0 | 1 | n/a | o | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------------------------------|---------------------|--------------------|--------|
| fa30arM | 44 | 49 | 47 | n/a | a | disordered | male |
| nv07irF | 1 | 1 | 1 | n/a | i | non | female |
| nv20irM | 0 | 0 | 0 | slightly high pitch for gender | i | non | male |
| nv05irF | 0 | 0 | 0 | n/a | i | non | female |
| nv02arF | 3 | 1 | 5 | n/a | a | non | female |
| fa30irM | 25 | 30 | 25 | n/a | i | disordered | male |
| fa27arM | 6 | 1 | 5 | n/a | a | n/a | male |
| nv18irM | 24 | 24 | 22 | n/a | i | disordered | male |
| nv09arM | 20 | 35 | 36 | n/a | a | disordered | male |
| fa30orM | 46 | 44 | 44 | slight tremor | o | disordered | male |
| nv01orF | 3 | 49 | 43 | n/a | o | disordered | female |
| fa11irF | 49 | 41 | 60 | n/a | I | disordered | male |
| nv16arM | 12 | 2 | 22 | n/a | a | non | male |
| nv10irM | 7 | 1 | 2 | n/a | I | non | male |
| fa29orM | 13 | 3 | 22 | n/a | o | non | male |
| nv02irF | 0 | 3 | 3 | n/a | i | non | female |
| fa19irF | 1 | 1 | 36 | n/a | i | disordered | female |
| nv14arM | 1 | 0 | 1 | n/a | a | non | male |
| nv13arF | 3 | 1 | 1 | n/a | a | non | female |
| fa27orM | 34 | 18 | 31 | n/a | o | disordered | male |
| nv03arF | 0 | 0 | 0 | n/a | a | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------------------|---------------------|--------------------|--------|
| nv10orM | 9 | 1 | 21 | n/a | o | n/a | male |
| nv11irM | 2 | 0 | 3 | n/a | i | non | male |
| nv14irM | 21 | 1 | 21 | n/a | i | non | male |
| fa23irM | 58 | 61 | 56 | n/a | i | disordered | male |
| nv04arF | 0 | 0 | 2 | n/a | a | non | female |
| nv05orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08orF | 0 | 0 | 0 | n/a | o | non | female |
| nv17irM | 20 | 2 | 8 | n/a | i | non | male |
| fa22arM | 35 | 43 | 30 | n/a | a | disordered | male |
| nv04irF | 0 | 0 | 0 | n/a | i | non | female |
| nv17arM | 26 | 14 | 37 | n/a | a | disordered | male |
| nv05arF | 0 | 0 | 0 | n/a | a | non | female |
| nv20orM | 0 | 0 | 0 | n/a | o | non | male |
| fa18orF | 9 | 0 | 1 | lower pitch than expected | o | disordered | female |
| nv06arF | 0 | 2 | 2 | n/a | n/a | n/a | n/a |
| nv13irF | 1 | 1 | 11 | n/a | i | n/a | female |
| nv02orF | 1 | 1 | 15 | n/a | o | non | female |
| nv08orF2 | 0 | 0 | 0 | n/a | o | non | female |
| fa17arM | 13 | 1 | 1 | slight tremor | a | n/a | male |
| nv06orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08irF | 1 | 1 | 1 | n/a | i | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|------------------------|---------------------|--------------------|--------|
| fa33orM | 4 | 0 | 1 | n/a | o | non | male |
| fa29arM2 | 20 | 1 | 9 | n/a | a | disordered | male |
| fa12irF | 30 | 27 | 31 | n/a | i | disordered | female |
| nv07orF | 2 | 1 | 1 | lower pitch for female | o | non | female |
| nv01irF | 1 | 1 | 9 | n/a | i | non | female |
| fa25orF | 5 | 0 | 0 | lower pitch for female | o | non | female |
| fa20orM2 | 46 | 42 | 44 | n/a | o | disordered | male |
| fa11arF | 28 | 1 | 23 | n/a | a | disordered | female |
| nv09orM | 0 | 1 | 0 | n/a | o | non | male |
| fa22irM | 20 | 23 | 26 | n/a | i | disordered | male |
| fa20arM | 30 | 37 | 34 | n/a | a | disordered | male |
| nv11orM2 | 18 | 0 | 1 | slight tremor | o | non | male |
| fa09arM | 46 | 51 | 47 | n/a | a | disordered | female |
| nv12orF | 0 | 0 | 0 | n/a | o | non | female |
| fa17irM | 44 | 56 | 54 | n/a | i | disordered | male |
| fa13orF | 57 | 44 | 61 | n/a | o | disordered | female |
| nv15orM2 | 0 | 1 | 1 | n/a | o | non | male |
| fa08irF | 52 | 5 | 48 | n/a | i | disordered | female |
| nv14orM | 0 | 0 | 0 | n/a | o | non | male |
| fa10orF | 56 | 45 | 60 | n/a | o | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------|---------------------|--------------------|--------|
| fa09irM | 30 | 48 | 63 | n/a | i | disordered | female |
| nv20arM | 0 | 0 | 0 | n/a | a | non | male |
| fa07orM | 54 | 49 | 54 | n/a | i | disordered | male |
| nv15irM | 0 | 0 | 1 | n/a | i | non | male |
| fa03irF | 50 | 2 | 35 | n/a | i | disordered | female |
| fa06orF | 9 | 3 | 54 | n/a | i | non | female |
| nv19arM | 36 | 34 | 7 | n/a | a | disordered | male |
| fa08orF | 19 | 0 | 40 | n/a | o | non | female |
| nv16orM | 53 | 38 | 50 | n/a | o | disordered | male |
| fa07irM | 47 | 45 | 35 | n/a | i | disordered | male |
| fa03orF | 52 | 10 | 41 | n/a | o | disordered | female |
| nv17orM | 59 | 60 | 54 | n/a | o | disordered | male |
| fa10irF | 0 | 1 | 42 | n/a | i | non | female |
| nv18arM | 29 | 1 | 31 | n/a | a | disordered | male |
| fa10arF | 8 | 1 | 8 | n/a | a | non | female |
| fa03arF | 58 | 54 | 52 | n/a | a | disordered | female |
| nv16irM | 4 | 1 | 1 | n/a | i | non | male |
| fa12arF | 0 | 0 | 8 | n/a | a | non | female |
| nv18orM | 15 | 0 | 30 | n/a | o | non | male |
| fa12orF | 0 | 0 | 0 | n/a | o | non | female |
| fa06arF | 55 | 50 | 49 | n/a | a | disordered | female |
| nv15arM | 1 | 0 | 1 | n/a | a | non | male |
| fa17orM | 1 | 1 | 8 | slight tremor | o | non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-----------------------|---------------------|--------------------|--------|
| nv19irM | 0 | 0 | 0 | higher pitch for male | i | non | male |
| fa19orF | 0 | 1 | 5 | n/a | o | non | female |
| fa08arF | 58 | 8 | 57 | n/a | a | disordered | female |
| nv13orF | 1 | 0 | 0 | n/a | o | non | female |
| fa18arF | 1 | 13 | 15 | higher pitch for male | a | disordered | male |
| nv19orM | 0 | 0 | 0 | n/a | a | non | male |
| fa23orM | 5 | 40 | 56 | n/a | i | disordered | n/a |
| fa09orM | 55 | 49 | 58 | n/a | o | disordered | female |
| nv12irF | 0 | 0 | 0 | n/a | i | non | female |
| fa19arF | 47 | 33 | 54 | n/a | a | disordered | female |
| fa23orM2 | 45 | 44 | 49 | n/a | o | disordered | male |
| nv01arF | 0 | 0 | 1 | n/a | a | non | female |
| fa11orF | 30 | 0 | 1 | n/a | o | non | male |
| nv11orM | 0 | 0 | 1 | slight tremor | o | non | male |
| fa20orM | 51 | 1 | 43 | n/a | o | disordered | male |
| nv03orF2 | 0 | 0 | 0 | n/a | o | Non | female |
| nv07arF | 0 | 0 | 12 | slight tremor | a | Non | female |
| fa13irF | 8 | 6 | 45 | n/a | i | disordered | female |
| nv10arM | 1 | 0 | 1 | n/a | a | Non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------|--------------------|--------|
| fa22orM | 0 | 1 | 1 | n/a | o | n/a | male |
| nv01orF2 | 17 | 20 | 23 | n/a | o | disordered | female |
| nv11arM | 28 | 1 | 23 | n/a | a | disordered | male |
| fa18irF | 24 | 14 | 17 | n/a | i | disordered | female |
| nv09irM | 1 | 1 | 1 | n/a | i | Non | male |
| fa25arF | 17 | 0 | 19 | n/a | a | Non | female |
| fa06arF2 | 59 | 57 | 51 | n/a | a | disordered | female |

Listener 9

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------------------------------|---------------------|--------------------|--------|
| fa07arM | 0 | 7 | 0 | n/a | a | Non | male |
| nv15orM | 0 | 0 | 0 | pitch instability | o | Non | male |
| fa20irM | 9 | 0 | 8 | n/a | i | Non | male |
| nv08arF | 0 | 0 | 0 | n/a | a | Non | female |
| fa25irF | 0 | 0 | 9 | n/a | i | Non | female |
| fa27irM | 8 | 0 | 0 | Tremor | i | disordered | male |
| fa13arF | 29 | 29 | 7 | diplophonia | a | disordered | female |
| fa07orM2 | 0 | 13 | 0 | diplophonia, pitch instability | o | disordered | male |
| fa23arM | 29 | 0 | 61 | n/a | a | disordered | male |
| nv06irF | 2 | 0 | 0 | n/a | i | Non | female |
| fa29arM | 13 | 13 | 0 | n/a | a | Non | male |
| fa06irF | 0 | 0 | 0 | hypernasal | i | Non | female |
| fa33arM | 29 | 0 | 8 | n/a | ^ | Non | male |
| fa33irM2 | 0 | 0 | 8 | n/a | i | Non | male |
| fa33irM | 0 | 0 | 8 | n/a | i | Non | male |
| nv04orF | 7 | 8 | 0 | n/a | a | Non | female |
| fa29irM | 25 | 30 | 30 | n/a | i | disordered | male |
| nv12arF | 0 | 0 | 0 | pitch instability | a | Non | female |
| nv05irF2 | 5 | 1 | 0 | mild pitch instability | i | Non | female |
| nv03irF | 8 | 4 | 7 | n/a | i | Non | female |
| nv03orF | 0 | 0 | 0 | n/a | o | Non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------------------------|---------------------|--------------------|--------|
| fa30arM | 40 | 34 | 15 | pitch inst | a | disordered | male |
| nv07irF | 6 | 5 | 0 | n/a | i | Non | female |
| nv20irM | 0 | 0 | 0 | n/a | i | Non | male |
| nv05irF | 1 | 8 | 0 | pitch instability | i | Non | female |
| nv02arF | 39 | 12 | 22 | Tremor | a | disordered | female |
| fa30irM | 50 | 49 | 43 | hypernasal , tremor | i | disordered | male |
| fa27arM | 35 | 21 | 0 | minor fry | ^ | Non | male |
| nv18irM | 9 | 9 | 9 | pitch instability | i | Non | male |
| nv09arM | 8 | 13 | 0 | n/a | a | Non | male |
| fa30orM | 56 | 57 | 22 | n/a | o | disordered | male |
| nv01orF | 24 | 23 | 24 | pitch instability | o | disordered | female |
| fa11irF | 61 | 53 | 71 | diplophoni a, pitch instability | i | disordered | male |
| nv16arM | 50 | 54 | 15 | Fry | a | disordered | male |
| nv10irM | 31 | 32 | 0 | n/a | i | Non | male |
| fa29orM | 60 | 58 | 6 | pitch instability | u | disordered | male |
| nv02irF | 55 | 50 | 14 | pitch break | i | disordered | female |
| fa19irF | 58 | 60 | 76 | diplophoni a, tremor | i | disordered | female |
| nv14arM | 33 | 16 | 1 | pitch instability | a | Non | male |
| nv13arF | 31 | 6 | 0 | n/a | a | Non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|----------------------|---------------------|--------------------|--------|
| fa27orM | 24 | 21 | 4 | pitch instability | u | Non | male |
| nv03arF | 31 | 34 | 9 | n/a | a | Non | female |
| nv10orM | 41 | 49 | 0 | n/a | o | disordered | male |
| nv11irM | 38 | 17 | 3 | pitch instability | i | Non | male |
| nv14irM | 37 | 38 | 40 | pitch instability | i | disordered | male |
| fa23irM | 58 | 52 | 64 | diplophoni a | i | disordered | male |
| nv04arF | 33 | 24 | 14 | n/a | a | Non | female |
| nv05orF | 15 | 2 | 0 | n/a | o | Non | female |
| nv08orF | 3 | 23 | 0 | n/a | ^ | Non | female |
| nv17irM | 35 | 17 | 1 | Fry | i | disordered | male |
| fa22arM | 37 | 64 | 38 | diplophoni a, tremor | ^ | disordered | male |
| nv04irF | 35 | 22 | 10 | n/a | i | Non | female |
| nv17arM | 61 | 27 | 50 | pitch break | a | disordered | male |
| nv05arF | 18 | 29 | 1 | n/a | a | Non | female |
| nv20orM | 20 | 4 | 0 | n/a | o | Non | male |
| fa18orF | 49 | 68 | 25 | diplophoni a | o | disordered | male |
| nv06arF | 44 | 36 | 11 | pitch instability | a | Non | female |
| nv13irF | 38 | 40 | 29 | pitch instability | i | disordered | female |
| nv02orF | 57 | 52 | 8 | Fry | o | disordered | female |
| nv08orF2 | 10 | 37 | 0 | n/a | o | Non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|------------------------|---------------------|--------------------|--------|
| fa17arM | 60 | 52 | 60 | Tremor | a | disordered | male |
| nv06orF | 13 | 17 | 1 | n/a | o | Non | female |
| nv08irF | 58 | 45 | 9 | Fry | i | disordered | female |
| fa33orM | 65 | 63 | 53 | pitch inst, tremor | o | disordered | male |
| fa29arM2 | 60 | 70 | 18 | n/a | a | disordered | male |
| fa12irF | 51 | 1 | 0 | hypernasal | i | disordered | female |
| nv07orF | 58 | 23 | 1 | n/a | o | disordered | female |
| nv01irF | 50 | 16 | 30 | n/a | i | Non | female |
| fa25orF | 25 | 7 | 0 | n/a | o | Non | female |
| fa20orM2 | 59 | 52 | 17 | pitch instability | o | Non | male |
| fa11arF | 76 | 63 | 58 | diplophoni a | a | disordered | female |
| nv09orM | 12 | 20 | 0 | n/a | o | Non | male |
| fa22irM | 66 | 73 | 65 | Tremor | i | disordered | male |
| fa20arM | 54 | 41 | 34 | n/a | a | Non | male |
| nv11orM2 | 39 | 16 | 6 | pitch instability | o | Non | male |
| fa09arM | 70 | 59 | 75 | diplophoni a, tremor | a | disordered | female |
| nv12orF | 24 | 12 | 1 | n/a | o | Non | female |
| fa17irM | 61 | 91 | 5 | Tremor | i | disordered | male |
| fa13orF | 76 | 37 | 57 | pitch instability | o | disordered | female |
| nv15orM2 | 38 | 27 | 4 | n/a | o | Non | male |
| fa08irF | 78 | 73 | 61 | fry, pitch instability | i | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------------------------------|---------------------|--------------------|--------|
| nv14orM | 23 | 9 | 0 | n/a | o | Non | male |
| fa10orF | 57 | 63 | 55 | pitch instability | o | disordered | female |
| fa09irM | 71 | 64 | 54 | Tremor | i | disordered | female |
| nv20arM | 14 | 1 | 0 | n/a | a | Non | male |
| fa07orM | 88 | 77 | 51 | diplophoni a, tremor | o | disordered | male |
| nv15irM | 24 | 8 | 1 | n/a | i | Non | male |
| fa03irF | 87 | 76 | 76 | pitch instability | i | disordered | female |
| fa06orF | 11 | 40 | 0 | pitch instability | o | Non | female |
| nv19arM | 61 | 20 | 1 | Fry | a | Non | male |
| fa08orF | 62 | 21 | 31 | hypernasal , pitch instability | o | disordered | female |
| nv16orM | 84 | 48 | 6 | Fry | o | disordered | male |
| fa07irM | 45 | 58 | 14 | pitch instability | i | Non | male |
| fa03orF | 69 | 51 | 56 | n/a | o | disordered | female |
| nv17orM | 75 | 23 | 1 | Fry | o | disordered | male |
| fa10irF | 46 | 56 | 35 | Tremor | i | Non | male |
| nv18arM | 24 | 1 | 0 | pitch instability | a | Non | male |
| fa10arF | 63 | 54 | 59 | pitch instability | ^ | disordered | female |
| fa03arF | 78 | 46 | 65 | pitch instability | a | disordered | female |
| nv16irM | 21 | 4 | 0 | n/a | i | Non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------------------------------|---------------------|--------------------|--------|
| fa12arF | 31 | 36 | 3 | n/a | a | Non | female |
| nv18orM | 27 | 4 | 4 | n/a | o | Non | male |
| fa12orF | 47 | 0 | 0 | hypernasal | o | disordered | female |
| fa06arF | 79 | 56 | 26 | Fry | a | disordered | female |
| nv15arM | 24 | 12 | 1 | n/a | a | Non | male |
| fa17orM | 39 | 60 | 21 | Tremor | o | disordered | male |
| nv19irM | 19 | 4 | 0 | n/a | i | Non | male |
| fa19orF | 59 | 42 | 49 | diplophonia, pitch instability | o | disordered | female |
| fa08arF | 77 | 47 | 60 | fry, pitch instability | a | disordered | female |
| nv13orF | 34 | 13 | 1 | Fry | o | Non | female |
| fa18arF | 67 | 59 | 29 | n/a | a | disordered | male |
| nv19orM | 27 | 10 | 0 | n/a | o | Non | male |
| fa23orM | 60 | 76 | 36 | pitch instability | o | disordered | male |
| fa09orM | 65 | 52 | 39 | pitch instability, wet/gurgly | o | disordered | female |
| nv12irF | 25 | 3 | 11 | n/a | i | Non | female |
| fa19arF | 73 | 62 | 68 | fry, tremor | a | disordered | female |
| fa23orM2 | 61 | 68 | 44 | Tremor | o | disordered | male |
| nv01arF | 36 | 1 | 19 | n/a | a | Non | female |
| fa11orF | 54 | 43 | 33 | Tremor | o | disordered | male |
| nv11orM | 25 | 39 | 10 | Tremor | o | disordered | male |
| fa20orM | 39 | 29 | 25 | pitch instability | o | Non | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|--------------------------------|---------------------|--------------------|--------|
| nv03orF2 | 19 | 1 | 0 | n/a | o | Non | female |
| nv07arF | 17 | 19 | 6 | pitch instability | a | Non | female |
| fa13irF | 43 | 5 | 32 | hypernasal | i | disordered | female |
| nv10arM | 18 | 22 | 3 | n/a | a | Non | male |
| fa22orM | 36 | 42 | 1 | n/a | o | Non | male |
| nv01orF2 | 43 | 49 | 13 | pitch instability | o | Non | female |
| nv11arM | 29 | 1 | 0 | pitch instability | a | Non | male |
| fa18irF | 56 | 2 | 43 | hypernasal , pitch instability | i | disordered | female |
| nv09irM | 25 | 10 | 0 | n/a | i | Non | male |
| fa25arF | 38 | 1 | 17 | hypernasal , tremor | a | disordered | female |
| fa06arF2 | 52 | 88 | 40 | n/a | a | disordered | female |

Listener 10

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------------------|---------------------|--------------------|--------|
| fa07arM | 5 | 0 | 12 | n/a | a | disordered | male |
| nv15orM | 7 | 0 | 2 | n/a | o | disordered | male |
| fa20irM | 0 | 0 | 27 | n/a | i | disordered | male |
| nv08arF | 3 | 0 | 0 | n/a | a | non | female |
| fa25irF | 0 | 0 | 43 | n/a | i | disordered | male |
| fa27irM | 27 | 0 | 15 | pitch instability towards end | i | disordered | male |
| fa13arF | 20 | 43 | 11 | n/a | a | disordered | female |
| fa07orM2 | 22 | 0 | 12 | pitch instability | o | disordered | male |
| fa23arM | 21 | 0 | 27 | pitch instability | a | disordered | male |
| nv06irF | 0 | 0 | 0 | n/a | i | non | female |
| fa29arM | 50 | 0 | 6 | n/a | a | disordered | male |
| fa06irF | 0 | 0 | 5 | Hypernasality | i | disordered | female |
| fa33arM | 20 | 0 | 34 | Fry | a | disordered | male |
| fa33irM2 | 0 | 0 | 21 | n/a | i | disordered | male |
| fa33irM | 0 | 0 | 21 | n/a | i | disordered | male |
| nv04orF | 0 | 6 | 0 | n/a | a | non | female |
| fa29irM | 0 | 0 | 15 | n/a | i | disordered | male |
| nv12arF | 7 | 4 | 22 | n/a | a | disordered | female |
| nv05irF2 | 0 | 0 | 5 | pitch instability | i | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv03irF | 0 | 0 | 3 | n/a | i | non | female |
| nv03orF | 0 | 0 | 7 | low pitch | o | disordered | female |
| fa30arM | 44 | 24 | 5 | pitch instability | a | disordered | male |
| nv07irF | 0 | 20 | 0 | n/a | i | disordered | female |
| nv20irM | 0 | 0 | 0 | n/a | i | non | male |
| nv05irF | 0 | 0 | 25 | pitch instability | i | disordered | female |
| nv02arF | 0 | 0 | 10 | pitch instability | a | disordered | female |
| fa30irM | 0 | 15 | 22 | n/a | i | disordered | male |
| fa27arM | 37 | 0 | 0 | n/a | a | disordered | male |
| nv18irM | 12 | 0 | 21 | n/a | i | disordered | male |
| nv09arM | 19 | 0 | 0 | n/a | a | disordered | male |
| fa30orM | 0 | 18 | 0 | low pitch | o | disordered | male |
| nv01orF | 0 | 25 | 16 | pitch instability | o | disordered | female |
| fa11irF | 5 | 8 | 32 | pitch instability | i | disordered | male |
| nv16arM | 52 | 0 | 0 | n/a | a | disordered | male |
| nv10irM | 17 | 14 | 0 | n/a | i | disordered | male |
| fa29orM | 15 | 0 | 25 | n/a | o | disordered | male |
| nv02irF | 0 | 4 | 24 | pitch instability | i | disordered | female |
| fa19irF | 0 | 0 | 57 | pitch instability | i | disordered | female |
| nv14arM | 13 | 0 | 25 | Fry | a | disordered | male |
| nv13arF | 0 | 0 | 18 | n/a | a | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------------------|---------------------|--------------------|--------|
| fa27orM | 13 | 0 | 16 | pitch instability | o | disordered | male |
| nv03arF | 0 | 0 | 9 | n/a | a | non | female |
| nv10orM | 19 | 0 | 0 | n/a | o | disordered | male |
| nv11irM | 4 | 0 | 14 | pitch instability | i | disordered | male |
| nv14irM | 26 | 0 | 36 | n/a | i | disordered | male |
| fa23irM | 0 | 56 | 0 | n/a | i | disordered | male |
| nv04arF | 0 | 8 | 40 | n/a | a | disordered | female |
| nv05orF | 0 | 0 | 0 | n/a | o | non | female |
| nv08orF | 0 | 5 | 0 | n/a | o | non | female |
| nv17irM | 24 | 0 | 31 | n/a | i | disordered | male |
| fa22arM | 24 | 0 | 33 | n/a | a | disordered | male |
| nv04irF | 0 | 15 | 24 | n/a | i | disordered | female |
| nv17arM | 67 | 0 | 31 | n/a | a | disordered | male |
| nv05arF | 0 | 0 | 6 | n/a | a | non | female |
| nv20orM | 0 | 0 | 11 | n/a | o | non | male |
| fa18orF | 0 | 37 | 0 | n/a | o | disordered | male |
| nv06arF | 0 | 19 | 15 | pitch instability | a | disordered | female |
| nv13irF | 0 | 16 | 27 | pitch instability | i | disordered | female |
| nv02orF | 0 | 15 | 23 | n/a | o | disordered | female |
| nv08orF2 | 0 | 4 | 0 | n/a | o | non | female |
| fa17arM | 23 | 0 | 34 | pitch instability, tremor | o | disordered | male |
| nv06orF | 0 | 0 | 5 | n/a | o | non | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|---------------------------|---------------------|--------------------|--------|
| nv08irF | 12 | 0 | 22 | n/a | i | disordered | female |
| fa33orM | 26 | 0 | 26 | n/a | o | disordered | male |
| fa29arM2 | 50 | 6 | 0 | n/a | a | disordered | male |
| fa12irF | 0 | 0 | 27 | n/a | i | disordered | female |
| nv07orF | 46 | 11 | 11 | n/a | o | disordered | female |
| nv01irF | 0 | 0 | 17 | n/a | i | disordered | female |
| fa25orF | 0 | 0 | 26 | n/a | o | disordered | female |
| fa20orM2 | 33 | 0 | 16 | pitch instability | o | disordered | male |
| fa11arF | 23 | 0 | 30 | n/a | a | disordered | female |
| nv09orM | 9 | 0 | 5 | n/a | o | non | male |
| fa22irM | 0 | 0 | 24 | Hypernasality | i | disordered | male |
| fa20arM | 22 | 0 | 21 | n/a | a | disordered | male |
| nv11orM2 | 34 | 0 | 10 | n/a | o | disordered | male |
| fa09arM | 35 | 0 | 31 | pitch instability, tremor | a | disordered | female |
| nv12orF | 8 | 0 | 0 | n/a | o | non | female |
| fa17irM | 0 | 53 | 0 | pitch instability | i | disordered | male |
| fa13orF | 30 | 0 | 21 | pitch instability | o | disordered | female |
| nv15orM2 | 15 | 0 | 16 | n/a | o | disordered | male |
| fa08irF | 0 | 0 | 22 | n/a | i | disordered | male |
| nv14orM | 0 | 0 | 20 | n/a | o | disordered | male |
| fa10orF | 0 | 49 | 41 | n/a | o | disordered | male |
| fa09irM | 26 | 0 | 40 | n/a | i | disordered | female |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| nv20arM | 16 | 0 | 42 | n/a | a | disordered | male |
| fa07orM | 15 | 0 | 24 | pitch instability | o | disordered | male |
| nv15irM | 5 | 0 | 21 | n/a | i | disordered | male |
| fa03irF | 21 | 0 | 58 | n/a | i | disordered | female |
| fa06orF | 10 | 0 | 17 | n/a | o | disordered | female |
| nv19arM | 33 | 0 | 27 | pitch instability | a | disordered | male |
| fa08orF | 0 | 0 | 40 | pitch instability | o | disordered | male |
| nv16orM | 54 | 0 | 0 | n/a | o | disordered | male |
| fa07irM | 0 | 17 | 24 | n/a | i | disordered | male |
| fa03orF | 17 | 0 | 26 | pitch instability | o | disordered | female |
| nv17orM | 8 | 0 | 18 | | o | disordered | male |
| fa10irF | 0 | 23 | 19 | n/a | i | disordered | female |
| nv18arM | 55 | 0 | 25 | n/a | a | disordered | male |
| fa10arF | 0 | 11 | 26 | n/a | a | disordered | female |
| fa03arF | 45 | 0 | 51 | n/a | a | disordered | female |
| nv16irM | 29 | 0 | 24 | n/a | i | disordered | male |
| fa12arF | 0 | 20 | 0 | n/a | a | disordered | female |
| nv18orM | 13 | 0 | 27 | n/a | o | disordered | male |
| fa12orF | 0 | 24 | 0 | n/a | o | disordered | female |
| fa06arF | 27 | 26 | 0 | n/a | o | disordered | female |
| nv15arM | 38 | 0 | 17 | n/a | a | disordered | male |
| fa17orM | 0 | 35 | 0 | pitch instability | o | disordered | male |
| nv19irM | 0 | 0 | 29 | n/a | i | disordered | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------------------|---------------------|--------------------|--------|
| fa19orF | 0 | 22 | 0 | pitch instability | o | disordered | female |
| fa08arF | 52 | 0 | 40 | n/a | a | disordered | female |
| nv13orF | 44 | 0 | 23 | n/a | o | disordered | female |
| fa18arF | 35 | 20 | 0 | n/a | a | disordered | male |
| nv19orM | 0 | 0 | 0 | n/a | a | disordered | male |
| fa23orM | 0 | 0 | 23 | pitch instability | o | disordered | male |
| fa09orM | 0 | 13 | 0 | wet/gurgly | n/a | disordered | female |
| nv12irF | 22 | 0 | 25 | n/a | i | disordered | female |
| fa19arF | 24 | 0 | 24 | pitch instability | a | disordered | female |
| fa23orM2 | 0 | 0 | 20 | n/a | o | disordered | male |
| nv01arF | 23 | 0 | 20 | n/a | a | disordered | female |
| fa11orF | 37 | 0 | 24 | n/a | o | disordered | female |
| nv11orM | 0 | 0 | 0 | n/a | o | non | male |
| fa20orM | 16 | 0 | 14 | n/a | o | disordered | male |
| nv03orF2 | 0 | 3 | 0 | n/a | o | non | male |
| nv07arF | 23 | 0 | 0 | Fry | o | disordered | female |
| fa13irF | 0 | 0 | 33 | pitch instability | i | disordered | female |
| nv10arM | 33 | 0 | 0 | n/a | a | disordered | male |
| fa22orM | 0 | 0 | 5 | n/a | o | non | male |
| nv01orF2 | 0 | 27 | 17 | pitch instability | o | disordered | female |
| nv11arM | 30 | 0 | 35 | n/a | o | disordered | male |
| fa18irF | 0 | 24 | 0 | n/a | i | disordered | male |
| nv09irM | 17 | 0 | 23 | n/a | i | disordered | male |

| Participant | Roughness | Breathiness | Strain | Other | Perceived vowel IPA | Disordered or Non- | Gender |
|-------------|-----------|-------------|--------|-------|---------------------------|-----------------------|--------|
| fa25arF | 0 | 36 | 32 | n/a | a | disordered | female |
| fa06arF2 | 0 | 0 | 52 | n/a | a | non | female |

REFERENCES

- American Speech-Language Hearing Association (2002-2006). Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) ASHA Special Interest Division 3, Voice and Voice Disorders.
- Bencze, K., Kondapalli, K., Cook, J., McMahon, S., Millán-Pacheco, C., Pastor, N., & Stemmler, T. (2006). The structure and function of frataxin. *Critical Reviews In Biochemistry And Molecular Biology*, 41(5), 269-291.
- Blaney, B., & Hewlett, N. (2007). Dysarthria and Friedreich's ataxia: what can intelligibility assessment tell us?. *International Journal Of Language & Communication Disorders / Royal College Of Speech & Language Therapists*, 42(1), 19-37.
- Botez, M. I., Botez-Marquard, T. T., P.mayer, Marchand, L. L., Lalonde, R. R., & Reader, T. A. (n.d). The treatment of spinocerebellar ataxias: Facts and hypotheses. *Medical Hypotheses*, 51(5), 381-384.
- Brendel, B., Ackermann, H., Berg, D., Lindig, T., Schölderle, T., Schöls, L., & ... Ziegler, W. (2013). Friedreich Ataxia: Dysarthria Profile and Clinical Data. *Cerebellum* (London, England).
- Brice, A. (2004). Friedreich ataxia. *Orpha.net*
- Cossée, M., Dürr, A., Schmitt, M., Dahl, N., Trouillas, P., Allinson, P., & ... Pandolfo, M. (1999). Friedreich's ataxia: point mutations and clinical presentation of compound heterozygotes. *Annals Of Neurology*, 45(2), 200-206.

- Darley, F. L., Aronson, A. E., and Brown, J. R. (1975). *Motor speech disorders*. Philadelphia: W.B. Saunders.
- Eigentler, A., Rhomberg, J., Nachbauer, W., Ritzer, I., Poewe, W., & Boesch, S. (2011). The scale for the assessment and rating of ataxia correlates with dysarthria assessment in Friedreich's ataxia. *Journal of Neurology*, 259(3), 420-426.
- Estella P.-M., M., & Edwin M.-L., Y. (n.d). Multiparametric Evaluation of Dysphonic Severity. *Journal Of Voice*, 20380-390.
- Folker, J., Murdoch, B., Cahill, L., Delatycki, M., Corben, L., & Vogel, A. (2010). Dysarthria in Friedreich's ataxia: a perceptual analysis. *Folia Phoniatricae et Logopaedica: Official Organ Of The International Association Of Logopedics And Phoniatics (IALP)*, 62(3), 97-103.
- Folker, J., Murdoch, B., Rosen, K., Cahill, L., Delatycki, M., Corben, L., & Vogel, A. (2012). Differentiating profiles of speech impairments in Friedreich's ataxia: a perceptual and instrumental approach. *International Journal Of Language & Communication Disorders / Royal College Of Speech & Language Therapists*, 47(1), 65-76.
- Hertrich, I. & Ackermann, H. (1997). Acoustic analysis of durational speech parameters in neurological dysarthria. *Neuropsychology and cognition*, 12(1), 11-47.
- Joanette, Y., & Dudley, J. G. (1980). Dysarthric symptomatology of Friedreich's ataxia. *Brain And Language*, 10(1), 39-50.
- Karnell, M., Melton, S., Childes, J., Coleman, T., Dailey, S., & Hoffman, H. (2007). Reliability of clinician-based (GRBAS and CAPE-V) and patient-based (V-RQOL and IPVI) documentation of voice disorders. *Journal Of Voice: Official Journal Of The Voice Foundation*, 21(5), 576-590.

- Kempster, G. (2007). CAPE-V: development and future direction. *Consensus Auditory Perceptual Evaluation of Voice. Perspectives On Voice & Voice Disorders*, 17(2), 11-13.
- Kempster, G., Gerratt, B., Verdolini Abbott, K., Barkmeier-Kraemer, J., & Hillman, R. (2009). Consensus auditory-perceptual evaluation of voice: development of a standardized clinical protocol. *American Journal Of Speech-Language Pathology / American Speech-Language-Hearing Association*, 18(2), 124-132.
- Kent, R.D., Kent, J.F., Duffy, J.R., Thomas E. J., Weismer, G., & Stuntebeck, S. (2000). Ataxic Dysarthria. *Journal of Speech-Language-Hearing-Association*, 43(1), 1275-1289.
- Kreiman, J., Gerratt, B., Kempster, G., Erman, A., & Berke, G. (2001). Perceptual evaluation of voice quality: review, tutorial, and a framework for future research (English). *Journal Of Speech And Hearing Research*, 36(1), 21-40.
- Legge, J. (2010). Ataxia and speech. University of Chicago Medical Speech and Swallowing Department. [www.ataxia.org/pdf/2010_Presentations/Ataxia_and_Speech\(Legge\).pdf.1-21](http://www.ataxia.org/pdf/2010_Presentations/Ataxia_and_Speech(Legge).pdf.1-21).
- Mason, R. D., Lind, D. A., & Marchal, W. G. (1983). Statistics, an introduction. *Harcourt Brace Jovanovich*, (1).
- Mason, W. M., Wong, G. Y., Entwisle, B. (1993). Contextual analysis through the multilevel linear model.
- Metz, G., Coppard, N., Cooper, J., Delatycki, M., Durr, A., Di Prospero, N., Giunti, P., Lynch, D.R., Schulz, J.B., Rummey, C. & Meir, T. (2013). Rating disease progression of Friedreich's ataxia by the International Cooperative Ataxia Rating Scale: analysis of a 603-patient database. *Brain*, 136, 259-268.

National Institute of Neurological Disorders and Stroke.(2011). Friedreich Ataxia Fact Sheet-

What is Friedreich's Ataxia, *National Institutes of Health*.

Olshausen, B.A. (2000). Nyquist sampling theorem; Aliasing. University of California.

redwood.berkeley.edu/bruno/.../aliasing.pdf.

Pandolfo, M. (2009). Friedreich ataxia: the clinical picture. *Journal Of Neurology*, 256Suppl 13-8.

Rajeswari, M. (2012). DNA triplex structures in neurodegenerative disorder, Friedreich's ataxia. *Journal Of Biosciences*, 37(3), 519-532.

Rosen, K., Folker, J., Murdoch, B., Vogel, A., Cahill, L., Delatycki, M., & Corben, L. (2011).

Spectral measures of the effects of Friedreich's ataxia on speech. *International Journal Of Speech-Language Pathology*, 13(4), 329-334.

Rosen, K., Folker, J., Vogel, A., Corben, L., Murdoch, B., & Delatycki, M. (2012). Longitudinal change in dysarthria associated with Friedreich ataxia: a potential clinical endpoint.

Journal Of Neurology, 259(11), 2471-2477.

Sansone, F., & Emanuel, F. W. (1970). Spectral noise levels and roughness severity ratings for normal and simulated rough vowels produced by adult males. *Journal of Speech &*

Hearing Research, 13, 489-502.

Singh, A., Epstein, E., Myers, L., Farmer, J., & Lynch, D. (2010). Clinical measures of dysarthria in Friedreich Ataxia. *Movement Disorders*, 25(1), 108-111.

The American Speech-Language-Hearing Association (2006). Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V). *ASHA Special Interest Division 3, Voice and Voice Disorders*.