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Validity of the Reflux Symptoms Index for post-pubescent female vocalists

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VALIDITY OF THE REFLUX SYMPTOMS INDEX FOR POST-PUBESCENT FEMALE VOCALISTS

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ABSTRACT

The Reflux Symptoms Index (RSI), a nine-item self-rated questionnaire, has been suggested as a way of monitoring severity of laryngopharyngeal reflux (LPR) symptoms during treatment. However, limited research has been conducted to assess the validity of the RSI as a way of identifying severity of laryngopharyngeal reflux (LPR) symptoms as differentiated from gastroesophageal reflux (GER) symptoms. Twenty-five post-pubescent female vocalists participated by completing a one-hour voice evaluation, including a Voice Handicap Index (VHI), an RSI, a Reflux Finding Score (RFS) completed with videostroboscopy for visualization of the laryngeal cavity, and analysis of an acoustic sample with the Multi-Dimensional Voice Profile for harmonic to noise ratio (NHR) and perceptual ratings of hoarseness and breathiness. The investigation placed each participant into one of three groups based upon symptoms reported in her case history form. In an effort to evaluate the validity of the RSI as a tool for differentiating LPR from GER and the absence of reflux, these scores were analyzed for correlations or group relationships. Predictions were that, if the RSI were an indicator of severity of LPR, the RSI raw score would correlate with type of symptoms, RFS raw score, NHR, and/or perceptions of hoarseness. Results failed to reveal statistically significant group differences; however, informal inspection of the data indicated that the RSI scores were generally higher for the GER group than the LPR and asymptomatic groups. Also, RSI scores correlated with VHI raw scores, as both were self-rated items, and the NHR values and the perceptual ratings of hoarseness correlated with the VHI raw scores.

CHAPTER ONE
INTRODUCTION

The variety of clients seen at university speech, language, and hearing clinics includes vocal performers with an array of complaints regarding their voice production; the majority of those with vocal complaints are females. Laryngeal assessment of these performers reveals a high incidence of both laryngeal dysphonias and laryngoscopic evidence of acid reflux. The performers who are being evaluated for the vocal side effects of acid reflux also report experiencing a decline in their vocal performance, often stating that they can hear and feel changes in their own voices. Client reports, which are subsequently validated by laryngoscopic evidence, suggest that self-perception could be a useful component of diagnosis and treatment. In order to be clinically useful, a standardized method is needed for rating the severity of the self-perceived consequences of acid reflux on the larynx, such as hoarseness, throat clearing, and physical discomfort. One method is a perceptual rating scale that has been shown to positively correlate with laryngoscopic and acoustic data. Such a scale may allow clients to operationally see the severity of their complaints, as well as the improvement of symptoms over time, in a form that they can understand. Client severity ratings could then be incorporated into diagnostic interpretations, which are explanations for the client so that visual and acoustic data can be more easily understood.

The purpose of this chapter is to report prevalence data, to differentiate and review symptoms of acid reflux and its effects, as well as to determine the population most concerned with the laryngeal consequences of reflux and the optimal measures used for that population's assessment. A review of current severity rating scales used to describe the impact of vocal pathologies on the individual will lead to a discussion of other measures that identify the presence of reflux in the larynx. In recent years, media interest has given more attention to both the symptoms and the pharmaceutical treatment of reflux. To the layperson, reflux is a single condition; however, its presence in different locations of the body divides the phenomenon into two forms: gastroesophageal reflux (GER) and laryngopharyngeal reflux (LPR). LPR is of interest to this study because it is this form of reflux that results in irritation or injury to the larynx, which may impair vocal performance. A review of literature is therefore necessary in order to determine specifics of LPR diagnosis based on the following: client symptoms, laryngoscopic examination, and acoustic assessment. Then, measures currently available for rating client-perceived severity of vocal pathology symptoms can be compared to these diagnostic indicators of LPR for an investigation into the validity of a pre-existing self-perceptual rating scale of LPR symptoms.

CHAPTER TWO
REVIEW OF LITERATURE

Acid reflux is becoming a more commonly used term as its familiarity grows due to its more frequent diagnosis, treatment, and media exposure. Selby, Gilbert, and Lerman (2003) cited Olson's 1986 study, which reported that reflux affected at least seven percent of adults in the United States on a daily basis. Now, according to the *American Dietetic Association Guide to Better Digestion* (2003), approximately 25 million Americans (almost 9%) experience gastroesophageal reflux daily, while about 60 million Americans (more than 20%) have acid reflux symptoms at least one or two times each month. This process of reflux occurs due to the weakening of the lower esophageal sphincter (LES), a valve between the esophagus and the stomach. During normal ingestion of food, the LES relaxes enough to allow the passage of food into the stomach. However, when weakened, the LES may relax after digestion has already commenced, allowing acids to pass from the stomach into the esophagus (Bonci, 2003).

Differential Diagnosis

Acid reflux is typically thought to be a single phenomenon involving acids from the stomach flowing back into the esophagus following ingestion, swallowing, and initiation of food or liquid breakdown in the stomach by hydrochloric acid. Yet recent literature differentiates two forms of acid reflux. The most well known is gastroesophageal reflux (GER), which is the backflow of acids from the stomach into the esophagus, causing such common symptoms as heartburn and indigestion. The second and less familiar type of reflux, known as laryngopharyngeal reflux (LPR), is differentiated from GER because, in this form, stomach acids flow beyond the esophagus into the laryngeal and pharyngeal cavities (Selby, Gilbert, and Lerman, 2003).

Heartburn and indigestion are not common symptoms of LPR (Selby, Gilbert, and Lerman, 2003). Rather, acid injury to the tissues of the larynx and pharynx cause other symptoms including hoarseness, vocal fatigue, and postnasal drip, leading to excessive throat clearing or a chronic cough, eventually affecting voice production (Belafsky, Postma, and Koufman, 2002). Most likely due to compensatory strategies used when experiencing voice problems, clients with suspected LPR have reported other symptoms such as musculoskeletal tension, hard glottal attack, glottal fry, and restricted pitch range (Selby, Gilbert, and Lerman, 2003). It is now believed that up to 50% of patients with voice disorders also experience LPR (Belafsky, Postma, and Koufman, 2002). Although voice disorders span many ages and livelihoods, there are certain populations that present with more complaints of vocal dysphonias. Female vocal performers are one such population with a high incidence of voice disorders. Self-reported voice difficulties most commonly come from post-pubescent girls who regularly participate in choral singing (Tepe et. al, 2002, p. 244).

The diagnosis of GER is determined by a gastroenterologist who finds evidence of reflux in one of three ways: upper endoscopy of the esophagus, upper gastrointestinal x-ray of a barium swallow, or acid (pH) probe test. While GER has no visual presence in the larynx, the diagnosis of LPR is often accompanied by vocal fold edema (swelling), erythema (inflammation or redness), thick mucus, interarytenoid pachyderma, contact ulcers, and/or granuloma in the laryngeal cavity (Selby, Gilbert, and Lerman, 2003). Therefore, the assessment of such a voice disorder must include visual imaging of the laryngeal structure and function via videoendoscopy, ideally accompanied by a thorough case history, objective voice measures (acoustic, and sometimes aerodynamic), and an auditory perceptual description, such as a perceptual rating of hoarseness or breathiness to describe the vocal quality as it is perceived by the observer (Sandage & Emerich, 2003).

Visual Analysis

For the analysis of visual images of the larynx, the Reflux Finding Score (RFS) is a clinically used scale specifically designed to document the degree of a reflux indicator's presence in the laryngeal cavity. This tool quantifies the severity of visual evidence of LPR by assigning a numeric value to the severity rating of eight of the most common laryngeal findings seen in clients with LPR, specifically infraglottic edema (edema of the undersurface of the vocal fold, creating the appearance of a groove or sulcus), ventricular obliteration (swelling of both the true vocal folds and the ventricular folds so that the space between diminishes or disappears), erythema, vocal fold edema, diffuse laryngeal edema (swelling that encroaches on the airway), posterior commisure hypertrophy, granuloma, and thick endolaryngeal mucus (Belafsky et. al, 2002).

Belafsky, Postma, and Koufman (2001) conducted an investigation into the validity and reliability of the RFS (Belafsky, Postma, and Koufman, 2001). The study monitored forty patients with LPR (seventy-three percent of whom were women). These patients underwent laryngoscopic evaluations before treatment and two, four, and six months after treatment with proton-pump inhibitors, which reduce the production of stomach acid by blocking the acid-producing enzyme. At every interval, a laryngologist rated each patient's visual findings using the RFS. A comparison of the mean RFS score at each interval demonstrated intraobserver reliability ($P < .001$ with trend). Two laryngologists independently determined the RFS scores on two separate occasions (Table 1); results indicated an interobserver variability with a correlation coefficient of 0.90 (P <.001) (Belafsky, Postma, and Koufman, 2001).

TABLE 1. Mean RFS values as scored by two blinded laryngologists at a pre-treatment session and a post-treatment session. Standard deviations appear in parentheses.

	Initial Evaluation	Repeat Evaluation	Correlation Coefficient
Laryngologist #1	10.8 (4.1 SD)	10.8 (4.0 SD)	r = 0.95, P <.001
Laryngologist #2	11.1 (3.8 SD)	10.9 (3.7 SD)	r = 0.95, P <.001

Perceptual Rating and Acoustic Analysis

When an evaluation includes an acoustic analysis, results are often compared to voice quality as it is perceived by the client or the clinician. One study investigated the correlation between these acoustic and perceptual parameters (Bhuta, Patrick, and Garnett, 2004). Thirty-seven voice patients (sixty-eight percent of whom were female) provided an audio sample of vocal production on sustained phonation of a vowel, to be objectively analyzed using the Multi-Dimensional Voice Program (MDVP). Another acoustic task required the patients to read a phonetically balanced passage. Subjective analysis of this recorded sample was completed using a severity rating (0:normal; 1:mild; 2:moderate; or 3:severe) of perceptual labels.

The perceptual labels used in the analysis included: grade, the overall degree of voice deviance; roughness, irregular fluctuation of fundamental frequency; breathiness, turbulent noise produced by air leakage; aesthenia, overall weakness of the voice; and strain, the impression of tenseness or excess effort. A multivariate regression model identified only three acoustic parameters with significant perceptual correlates (Table 2). These acoustic-perceptual relationships were identified as follows: voice turbulence index (VTI) correlated with grade, noise to harmonic ratio (NHR) correlated with roughness and grade, and soft phonation index (SPI) correlated with breathiness, aesthenia, and grade (Bhuta, Patrick, and Garnett, 2004).

TABLE 2. Multivariate Regression Analysis of Acoustic Parameters and Perceptual Ratings

	VTI	NHR	SPI	R Square Value
Grade	p = 0.001	p = 0.007	p = 0.04	0.43
Roughness		p = 0.02		0.14
Breathiness			p = 0.01	0.32
Aesthenia			p = 0.04	0.35
Strain				

According to a study by Selby, Gilbert, and Lerman (2003), though few, some acoustic and perceptual measurements indicated the presence or absence of acid reflux. These investigators studied the effects of LPR on vocal function by documenting perceptual and acoustic measures of the voices of 13 LPR patients (forty-six percent of whom were female) pre-treatment and post-treatment. The perceptual measures were based upon an analysis of a speech sample, while the acoustic analysis used sustained phonation and connected speech. These acoustic data were analyzed using the Speech Studio, software designed by Laryngograph Ltd. Analysis included fundamental frequency (F_o), jitter, and harmonic-to-noise ratio (HNR) for sustained sounds and connected speech (Selby, Gilbert, and Lerman, 2003).

Pre-post treatment test results indicated no significant changes in F_o and jitter, but a significant decrease in the perceptual rating of hoarseness and roughness was noted, along with a significant increase in HNR ($F(1,11) = 6.81$, $p = 0.02$). The authors did note that a limitation of the study was the mild degree of LPR observed in the majority of the participants (Selby, Gilbert, and Lerman, 2003). Although mean HNR values differed significantly depending on vowel type ($F(2,11) = 16.16$, $p = 0.02$), the increase in HNR values (Table 3) suggested that less air turbulence was present in the participants' voice signals after treatment of LPR symptoms was completed.

TABLE 3. Mean HNR values (dB) for the sustained vowels /i/, /u/, and /a/ pre- and post-treatment. Ranges appear in parentheses.

	Pre-treatment	Post-Treatment
/i/	25.19 (7.9 – 34.8)	30.23 (21.7 -36.7)
/u/	31.87 (17.6 - 42.1)	34.58 (24.3 – 41.4)
/a/	21.20 (7.42 – 33.8)	25.51 (17.1 – 35.5)

Analysis of Self-Perceived Voice Problems

There are additional assessment considerations to be made when there are laryngeal changes in a vocal performer. According to Sandage and Emerich (2003), "singing voice impairments are often not accompanied by speaking voice difficulties." Many singers may have vocal complaints that are not audible to the clinician. The vocal performer may describe something like breathiness in his or her singing tone. Another symptom described by some vocalists is a "sticky" feeling, particularly when attempting to sing higher pitches (Sandage & Emerich, 2003). Many vocalists present with morning hoarseness, a symptom consistent with the presence of acid reflux in the laryngeal cavity, as well as insomnia or fatigue; this is often indicative of emotional stress and/or tension, yet without a perceptual correlate of hoarseness (Sandage & Emerich, 2003; Tepe et. al, 2002). Thus, these perceptions can be described by the vocalist in terms of the severity of what he or she is feeling and hearing, but they may not be measurable beyond self-rating scales.

Although there are many methods of providing subjective and objective data on voice disorders, there are few tools currently available for providing a self-perceived rating of the psychosocial consequences caused by voice disorders (Jacobson et. al, 1997, p. 66). In order to address this need, a team from the Henry Ford Hospital and Health Sciences Center in Detroit, Michigan, joined by Craig W. Newman from The Cleveland Clinic Foundation in Cleveland, Ohio, created the Voice Handicap Index (VHI), a 30-item self-rating form. This tool was developed to address the functional, emotional, and physical aspects of voice disorders. In a study conducted by the VHI's creators, 63 patients with a range of diagnoses (varying from the severity of laryngectomy or mass lesions to less severe musculoskeletal tension or laryngeal inflammation) completed the VHI on two occasions with the purpose of assessing the instrument's test-retest reliability.

A Pearson product-moment coefficient indicated a strong positive correlation with VHI subscales (functional: $r = 0.84$, emotional: $r = 0.92$, and physical: $r = 0.86$) and VHI total scores ($r = 0.92$) for test-retest reliability, as well as a moderately positive correlation ($r = 0.60$) between the VHI total score and participant severity ratings (Jacobson et. al, pp.68-69). Despite the VHI's positive correlations for reliability, the scale does not specifically incorporate symptoms of acid reflux, but instead acts as a more general assessment of the psychometric parameters of an array of voice disorders.

In order to address the need for a means of rating the self-perceived severity of LPR symptoms, as they differ from GER symptoms, the Reflux Symptoms Index (RSI) was created and tested for validity and reliability by Peter C. Belafsky, Gregory N. Postma, and James A. Koufman (2002). Their study looked at correlations between the scores on the VHI and those on the RSI for two different groups of participants before and after a six month treatment plan, which involved voice therapy and administration of proton-pump inhibitors for reduction of stomach acid, to be taken twice daily. One group consisted of members (forty-four percent of whom were women) who exhibited symptoms of LPR, while the other group consisted of asymptomatic participants. The VHI scores were used as a predictor, with the dependent variable being a five-point improvement in the total score. The Pearson product-moment correlation coefficient was calculated to evaluate the linear association between index measures, while the paired-sample t-test and the chi-square test were applied for evaluation of statistical differences between continuous and categorical data (Belafsky, Postma, and Koufman, 2002).

As compared to the untreated LPR group, the asymptomatic group had a significantly lower mean RSI score; however, the group scores were statistically similar after the LPR group received six months of treatment. Results also indicated improvement in the mean RSI score for the LPR group when pretreatment RSI score was compared to RSI score at the completion of the six-month treatment period. Likewise, VHI scores of the LPR group improved after the treatment; yet, of the three VHI subscales, only the functional subscale improved significantly ($p = 0.037$). Findings demonstrated that participants who experienced a five-point or better improvement on the RSI were 11 times more likely to experience a five-point improvement on the VHI (95% confidence interval (CI) = 1.7, 76.8). It is suggested that the high positive correlation between improved scores on the scales displays good construct validity of the RSI (Belafsky, Postma, and Koufman, 2002). LPR group scores were reported as follows:

TABLE 4. LPR group scores on the RSI and the VHI pre-treatment and post-treatment. Standard deviations are shown in parentheses.

	Pre-Treatment	Post-Treatment	Correlation
RSI	20.9 (9.6)	12.8 (10.0)	$p < 0.001$
VHI	52.2 (24.7)	41.5 (25)	$p = 0.065$

Summary

As a relatively new phenomenon in medicine, many investigators have tried to discover new and more accurate ways of diagnosing and treating LPR. As discovered recently, LPR is differentiated from GER in that the presence of reflux extends to the laryngeal cavity and is proceeded by symptoms, such as hoarseness, vocal fatigue, chronic cough or throat clearing, musculoskeletal tension, and/or glottal fry (although not always excluding heartburn and indigestion, the tell-tale symptoms of GER). Recommended assessment for LPR included videoendoscopy with a tool such as the RFS to rate indicators of LPR.

Acoustic analysis, with software such as the MDVP, and a perceptual rating of hoarseness (roughness) also provided LPR diagnostic information. In the 2004 study by Bhuta, Patrick, & Garnett, statistical analysis indicated a correlation between hoarseness (roughness) and NHR, while the Selby, Gilbert, and Lerman study (2003) indicated a significant decrease in the perceptual rating of hoarseness (roughness), along with a significant increase in HNR, in LPR patients post-treatment In order to determine the clinical applicability of various tools currently available to objectively and subjectively measure voice. Thus, these studies indicate a relationship between HNR, hoarseness, and the presence or absence of LPR.

Finally, an essential component of the discussion regarding LPR diagnosis was the client's perception of its severity. Sandage and Emerich (2003) identified female post-pubescent vocalists as the population with the most self-reported voice difficulties. Perceptual rating tools like the RSI for populations such as these could provide an individual with the opportunity to demonstrate her own perception of the severity of the problem. However, in Belafsky, Postma, and Koufman's (2002) test of reliability of the RSI, the VHI was used as a constant, and as it only indirectly addresses some of the symptoms of LPR, more investigation is needed to validate the RSI as a measurement of LPR severity. The correlation between the RSI and the VHI cannot be attributed to symptoms of LPR alone; if the correlation persists, it may be necessary to investigate why an instrument which is designed to rate psychometric aspects of all voice disorders was positively correlated with an instrument designed to specifically address symptoms of LPR.

Research Questions

Due to limited research available on the Reflux Symptoms Index (RSI), its practicality as a clinical tool for the measurement of LPR symptoms needs further investigation. The purpose of the proposed study is to test the validity of the RSI as a self-perceptual severity rating tool for the assessment of vocalists experiencing LPR symptoms. This will be determined using the following questions:

1. Does the type of reflux affect total raw score on the RSI?
2. Is there a relationship between the total raw score on the RSI and visual, acoustic, and perceptual measurements of voice?
3. Is there a correlation between the VHI raw score and the RSI raw score?

CHAPTER THREE
METHODS

In order to answer the three research questions, female vocal performers were enlisted to participate in a study. They were assigned to one of three groups based on their reflux status complaints: laryngopharyngeal reflux (LPR) symptoms, gastroesophageal reflux (GER) symptoms, and no reflux symptoms. These three groups made up the independent variable that was categorized by the type of symptoms present. Each group participant completed the RSI to determine whether the type of reflux affected the total raw score, thus answering the first research question. A correlation design addressed the second research question by comparing visual, acoustic, and perceptual measurements to the raw score on the RSI. The third research question was also addressed by correlation design by comparing total raw scores on the VHI and the RSI.

Participants

Thirty-five post-pubescent females participated in the study; however, ten of the participants could not participate due to discomfort during the attempt to visualize the laryngeal cavity. All 25 acting participants were vocal performers between 18 and 25 years of age (mean age = 21), who sang as a student for the Louisiana State University School of Music, individually and/or chorally, for a minimum of ten hours per week. Each participant was assigned to one of three groups. Ten of the participants reported experiencing at least two of the following symptoms of LPR: hoarseness, vocal fatigue, chronic cough or throat clearing, musculoskeletal tension, or glottal fry. Six of the participants reported experiencing at least one of the symptoms of GER, specifically heartburn or indigestion, with or without accompanying symptoms of LPR. The final nine participants were asymptomatic or reported experiencing only one LPR-related symptom. Table 5 specifies each individual participant's age, hours, and symptoms.

TABLE 5. Participants as identified by age, hours of singing per week, and voice-related symptoms.

Group	Age	Hours	Symptoms
LPR (Group #1) (mean age = 20.4) (mean hours = 16.1)	19	10	Fatigue, hoarseness, sore throat
	19	10	Muscle tension, throat clearing
	19	15	Hoarseness, muscle tension
	19	25	Fatigue, hoarseness, sore throat
	19	35	Fatigue, throat clearing, voice worsens late in the day
	20	10	Fatigue, hoarseness, muscle tension, sore throat
	20	16	Hoarseness, glottal fry, sore throat, muscle tension
	21	15	Fatigue, muscle tension, glottal fry, throat pain
	23	15	Fatigue, hoarseness, throat clearing
	25	10	Fatigue, hoarseness
GER (Group # 2) (mean age = 21.6) (mean hours = 11)	19	10	Heartburn, throat clearing
	21	10	Heartburn & indigestion, Fatigue, muscle tension
	21	10	Heartburn, fatigue, hoarseness, throat clearing
	21	13	Heartburn & indigestion, Hoarseness, muscle tension
	23	11	Heartburn & indigestion, Fatigue, throat clearing
	25	12	Heartburn, fatigue, muscle tension, sore throat
Asymptomatic of Reflux (Group #1)) (mean age = 21.2) (mean hours = 15.2)	19	11	Hoarseness
	19	18	Voice worsens late in day
	20	14	Muscle tension
	20	15	Muscle tension
	21	20	Fatigue
	22	12	Hoarseness
	22	15	None
	23	12	Fatigue
	25	20	Muscle tension

Materials

Required materials included the Kay/Pentax Videostroboscope for visualization of the larynx and the Computerized Speech Lab Model 4400 (CSL) for acoustic analysis of vocal quality. The two variables used for visual assessment and acoustic assessment were the Reflux Finding Score (RFS) and the Noise to Harmonic Ratio (NHR), respectively.

Visualization was completed by means of videostroboscopy, in which a rigid endoscope was rested on the tongue, then passed through the oral cavity and into the posterior oropharynx so that the laryngeal cavity could be visualized. Movement of the vocal folds was then elicited by requesting the client to sustain the vowel /i/. The strobe light then enabled the investigator to visualize a composite image of the opening and closing of the vocal folds in order to identify specific pathologies. One electroglottograph transducer was positioned on each thyroid lamina at the level of the vocal folds in order to set the strobe flash needed for slowing or stopping the visual image and to monitor the regularity of vocal fold phases cycle after cycle. The RFS (Appendix A) was applied to visual findings in order to rate visualized indicators of LPR in the laryngeal cavity.

Acoustic assessment was completed with the CSL, a computer-interfaced system containing both hardware and software for the analysis of components of the speech signal. The software, Multi-Dimensional Voice Profile (MDVP), analyzed sustained phonation of the vowel /a/ as in 'mom' so that the perceptual correlates of voice quality, specifically hoarseness or roughness, could be quantified. The acoustic correlate of hoarseness that was isolated and analyzed for the purposes of this study was Noise to Harmonic Ratio (NHR), a measurement of the extent to which noise replaces the harmonic structure of a sustained sound (in this case, the vowel /a/).

Self-perceived ratings completed by the participants included the Voice Handicap Index (VHI – see Appendix B) and the Reflux Symptoms Index (RSI - see Appendix C). The VHI is a 30-item psychometric self-perceptual scale that rates severity of the effects of a voice disorder on functional, emotional, and physical aspects of daily living. The RSI is a criterion-based, nine-item outcome instrument for patients with symptoms of LPR, such as hoarseness, throat clearing, and coughing.

Setting

Evaluations were conducted individually in the university clinic by the author, accompanied by two trained clinicians. A doctor of speech-language pathology with a specialty in voice sciences was available on site to supply a reliability check on all visual findings. Each participant was seen in a therapy room prior to the evaluation for completion of paperwork, including a release form (Appendix D), a case history form (Appendix E), the VHI, and the RSI, as well as to address any questions the participant may have regarding the study. The participant was then taken into the diagnostic room for perceptual, visual, and acoustic evaluation, along with the completion of the VHI and the RSI severity rating scales.

Procedures

Prior to initiating the study, the author obtained LSU Institutional Review Board approval for the study. Upon receiving approval, the author distributed flyers to the voice faculty at the LSU School of Music containing specific information as to the purpose, procedures, and subject criteria of the study. The volunteers were then contacted by telephone, asked to participate in the study, and, upon accepting the offer, notified of available time slots. The author then called to confirm the time and date of participation at least twenty-four hours prior to the agreed date and time.

On these designated days, the investigator and facilitating clinicians (all enrolled in a communication sciences and disorders master's program and trained in the use of computerized equipment) collected the data. The first 15 minutes were allotted for completing paperwork. Then, the instrumental evaluation occurred in the following 45 minutes. Two clinicians completed a subjective rating of each participant's vocal quality for breathiness and hoarseness (i.e. 0:normal; 1:mild; 2:moderate; 3:severe) based upon a phonetically balanced reading sample elicited during the evaluation and videotaped for review. Subsequently, each participant underwent visualization of the laryngeal cavity by means of videostroboscopic assessment; visual findings were rated using the Reflux Finding Score (RFS). A vocal acoustic assessment was conducted following visualization in order to determine the participant's NHR on sustained phonation of /a/, which was analyzed by the Multi-Dimensional Voice Profile software (see Appendix F). Prior to being released, participants received a one-page summary form of the assessment containing recommendations, as needed, for further assessment and/or treatment (see Appendix G) and a statement of gratification for participating in the study. Upon completion of the study, all participants were notified of research findings by means of fliers and e-mails to all vocalists in the LSU School of Music.

Reliability

In order to control for variation in clinician technique, the investigator conducted all evaluations using a standard script. A recording of all visual and auditory samples, collected during the stroboscopic procedure, allowed for reviewing of each individual participant's vocal quality and laryngeal anatomy and physiology. Each recording received a different letter-number identification code for the purpose of maintaining anonymity of participants and linking each participant's case history, and visual, acoustic, and self-rated data.

The investigator scored a Reflux Finding Score (RFS) for each participant's pre-recorded laryngeal images. To account for the possibility of differences in perception of reflux indicators present in the laryngeal cavity, a professor of speech-language pathology with a specialty in voice sciences scored the RFS a second time for all twenty-five participants. When the two RFS scores were compared for each participant, the greatest difference in one participant's RFS scores was five points, occurring only once, with the next greatest difference being three points, which also occurred only one time. Out of the twenty five comparisons (see Table 6), 36 percent differed by only one point; however, an exact matching score occurred only three times. Therefore, the investigator elected to average the two RFS scores for each participant in order to improve reliability of the RFS during data analysis.

TABLE 6. Raw scores on the RFS as rated by the investigator (#1) and the professor of speech-language pathology (#2), along with averages used for analysis.

Investigator	#1	#2	Average
LPR Symptomatic Individuals (Group #1)	6	7	6.5
	12	12	12
	2	4	3
	0	3	1.5
	7	10	8.5
	6	4	5
	6	7	6.5
	7	4	5.5
	8	9	8.5
	3	5	4
GER Symptomatic Individuals (Group # 2)	2	3	2.5
	6	7	6.5
	6	7	6.5
	13	11	12
	6	8	7
	12	13	12.5

TABLE 6. Continued.

Individuals Asymptomatic of Reflux (Group #1))	5	6	5.5
	8	10	9
	9	7	8
	4	4	4
	4	2	3
	0	3	1.5
	2	3	2.5
	6	11	8.5
	3	3	3

Likewise, two clinicians separately provided subjective ratings of each participant's acoustic sample, during which the vowel /a/ as in 'father' was sustained and analyzed over a duration of 3.75 seconds. The severity ratings consisted of a clinicians' perception of hoarseness and breathiness, scored as follows: 0 = none, 1 = mild, 2 = moderate, and 3 = severe. For all 25 ratings of breathiness and all 25 ratings of hoarseness, the first and second clinicians' ratings never differed more than one point. Overall, both clinicians scored severity of breathiness equally 44 percent of the time, while hoarseness received the same score 76 percent of the time. As seen in Table 7, the investigator averaged the two scores for breathiness and hoarseness to improve reliability.

TABLE 7. Breathiness and hoarseness as rated by investigators (#1) and (#2), along with averages of the individual scores.

Perceptual Quality	Breathiness			Hoarseness		
Investigator	#1	#2	Average	#1	#2	Average
LPR (Group #1) (mean age = 20.4) (mean hours = 16.1)	1	1	1	0	0	0
	1	2	1.5	2	1	1.5
	1	1	1	1	1	1
	2	1	1.5	1	0	.5
	2	2	2	0	0	0
	1	1	1	2	2	2
	1	0	.5	1	1	1
	0	1	.5	2	2	2
	1	1	1	1	1	1
	0	0	0	0	0	0

TABLE 7. Continued.

GER (2) (Group # 2) (mean age = 21.6) (mean hours = 11)	1 3 0 1 1 2	1 2 0 2 1 1	1 2.5 0 1.5 1 1.5	0 2 1 2 1 1	0 1 1 1 1 1	0 1.5 1 1.5 1 1
Asymptomatic of Reflux (Group #1)) (mean age = 21.2) (mean hours = 15.2)	0 1 2 1 2 2 0 1 2	1 2 2 1 1 1 1 1 1	.5 1.5 2 1 1.5 1.5 .5 1 1.5	1 1 1 2 1 0 0 0 0	1 1 1 2 1 1 1 0 0	1 1 1 2 1 .5 .5 0 0

Finally, prior to initiating the Multi-Dimensional Voice Profile (MDVP) task, the participant was asked to provide a speaking sample on a neutral topic that would demonstrate her fundamental frequency, or more commonly referred to as a 'natural speaking pitch'. The fundamental frequency was then used as a relative target for the task of sustained phonation. Due to natural fluctuations in frequency, each participant completed two MDVPs in order to provide a reliability check of the acoustic analysis. The participant was required to remain within a 10 Hertz range of her initial MDVP fundamental frequency in the subsequent trial; otherwise, the task was repeated until the investigator obtained two samples with fundamental frequencies within 10 Hertz. An exact replication of NHR occurred in only two of the participants' MDVPs. The two NHRs differed no more than 0.01 for 68 percent of the participants. For purposes of improving reliability, the two NHR scores were averaged to obtain a mean score for each individual participant.

<u>Data Coding and Analysis</u>

The author collected and organized each participant's data across visual (RFS), perceptual (severity of breathiness and hoarseness), acoustic (NHR), and client-perceived (VHI & RSI) parameters. A one-way ANOVA determined whether there were differences across groups, as identified by type of reflux symptoms. Correlation between variables was determined using Pearson's r coefficient.

TABLE 8. NHR for sustained vowel /a/ as analyzed by the Multi-Dimensional Voice Profile software.

Participants	#1	#2	Average
LPR (Group #1)	0.112	0.118	0.115
	0.135	0.132	0.1335
	0.125	0.085	0.105
	0.108	0.141	0.1245
	0.127	0.120	0.1235
	0.143	0.075	0.109
	0.135	0.143	0.139
	0.102	0.067	0.0845
	0.088	0.138	0.113
	0.127	0.130	0.1285
GER (Group # 2)	0.128	0.131	0.1295
	0.165	0.077	0.121
	0.113	0.105	0.109
	0.113	0.113	0.113
	0.116	0.116	0.116
	0.113	0.120	0.1165
Asymptomatic of Reflux (Group #1))	0.118	0.111	0.1145
	0.102	0.092	0.097
	0.103	0.111	0.107
	0.107	0.138	0.1225
	0.067	0.106	0.0865
	0.114	0.115	0.1145
	0.127	0.129	0.128
	0.095	0.105	0.100
	0.120	0.112	0.116

CHAPTER FOUR
RESULTS

Does Type of Reflux Affect Total Raw Score on the RSI?

The first question was whether reflux symptoms are related to the RSI raw score. As seen in Table 9, the GER group appeared to score higher on the RSI (mean = 12.83, sd = 8.09) than the LPR group (mean = 8.40, sd = 6.02) and the asymptomatic group (mean = 6.78, sd = 5.59). However, analysis of variance results ($F = 1.65$, df 2, 22, $p<0.001$) indicated that the groups were not significantly different. Furthermore, when classified by symptom group, no other variables (including participant age, weekly hours of singing, RFS rating, VHI score, breathy vocal quality, hoarse vocal quality, and NHR) displayed significant between-group differences.

Subsequently, a descriptive M-ANOVA was completed to display a complete analysis of all indices at the group level, as seen in Table 9. For most of the indices, the GER group seemed to contrast most with the LPR and asymptomatic groups, while the LPR and asymptomatic groups looked more similar. Participants in the GER group had the oldest mean age (21.67, sd = 2.07), though the LPR group (mean age = 20.4, sd = 2.07) and the asymptomatic group (mean age = 21.22, sd = 1.99) were not significantly younger. Hours of singing also differed by group, with the GER group singing fewer hours per week (mean = 11, sd = 1.27) than both the LPR group (mean hours per week = 16.10, sd = 8.09) and the asymptomatic group (mean hours per week = 15.22, sd = 3.42). Visual findings were most severe for the GER group (mean RFS score = 7.83, sd = 3.79), while the RFS scores for the LPR group (mean = 6.10, sd = 3.04) and the asymptomatic group (mean = 5.0, sd =2.85) emerged with less severe ratings.

Exceptions to the GER group differing from the remaining groups occurred for the VHI raw score, the perceptual rating of breathiness and hoarseness, and the NHR. The LPR group appeared to have the highest scores on the VHI (mean = 20.20, sd = 18.99), while the GER group (mean = 11.0, sd = 8.94) emerged with the lowest scores and the asymptomatic group (mean = 15.22, sd =9.09) averaged somewhere in between the other two groups. Likewise, the LPR group had the lower ratings of breathiness as compared to the mean ratings of the GER (mean = 1.25, sd = .82) and the asymptomatic group (mean = 1.22, sd = .51). Hoarse vocal quality was rated most severe for the GER group (mean = 1.0, sd = .55), though the LPR group (mean = .90, sd = .78) fell closely behind, with the asymptomatic group (mean = .78, sd = .62) exhibiting the least severe scores. Finally, the NHRs averaged out as equal for the LPR (mean = .118, sd = .016) and the GER (mean = .118, sd = .007) groups, while NHRs for the asymptomatic group were only slightly lower (mean = .11, sd = .013).

TABLE 9. M-ANOVA for group comparisons of all indices. Standard deviations are shown in parentheses. Groups are marked as follows: 1- LPR, 2- GER; 3- Asymptomatic.

Dependent Variable	Group Analysis	Group Means			F	df	Sum of Squares
		1	2	3			
Age	Between Groups	20.40 (2.07)	21.67 (2.07)	21.22 (1.99)	.809	2	6.711
	Within Groups					22	91.289
	Total	21.0 (2.02)				24	98.000
Hours	Between Groups	16.10 (8.09)	11.00 (1.27)	15.22 (3.42)	1.652	2	103.704
	Within Groups					22	690.456
	Total	14.56 (5.75)				24	794.160
RSI	Between Groups	8.40 (6.02)	12.83 (8.09)	6.78 (5.59)	1.655	2	135.851
	Within Groups					22	902.789
	Total	8.88 (6.58)				24	1038.640

TABLE 9. Continued.

Dependent Variable	Group Analysis	Group Means			F	df	Sum of Squares
		1	2	3			
RFS	Between Groups	6.10 (3.04)	7.83 (3.79)	5.00 (2.85)	1.444	2	28.907
	Within Groups					22	220.233
	Total	6.12 (3.22)				24	249.140
VHI	Between Groups	20.20 (18.99)	11.00 (8.94)	15.22 (9.09)	.845	2	330.844
	Within Groups					22	4307.156
	Total	16.20 (13.90)				24	4638.000
Breathy	Between Groups	1.00 (.58)	1.25 (.82)	1.22 (.51)	.430	2	.329
	Within Groups					22	8.431
	Total	1.14 (.60)				24	8.760
Hoarse	Between Groups	.90 (.78)	1.00 (.55)	.78 (.62)	.204	2	.184
	Within Groups					22	9.956
	Total	.88 (.65)				24	10.140
NHR	Between Groups	.118 (.016)	.118 (.007)	.110 (.013)	1.032	2	.000
	Within Groups					22	.004
	Total	.115 (.013)				24	.004

Is There a Relationship between the RSI Total Raw Score and Visual, Acoustic, and Perceptual Measurements of Voice?

In order to determine whether a relationship existed between the total raw score of the RSI and visual (RFS), acoustic (NHR), and perceptual (breathiness and hoarseness) measurements of voice, the investigator used a Pearson product-moment correlation analysis to examine the possibility of associations between any given variables. As seen in Table 10, the analysis did not identify any statistically significant correlations between the RSI raw score and other measurements of voice production, including the visual findings of the RFS, the acoustic findings (NHR), and the perceptual ratings of breathiness and hoarseness. However, a moderate correlation was identified at the alpha level 0.01 for the VHI raw score and the perceptual rating of hoarseness (r = 0.540), as well as a relationship between the VHI raw score and the acoustic measure NHR (r = 0.402).

Is There a Correlation between the VHI Raw Score and the RSI Raw Score?

As exhibited in Table 10, the Pearson analysis exposed a statistically significant correlation between the raw scores of the RSI and the VHI (r =0.431, p<0.05). Thus, the final research question resulted in a positive answer: yes, a relationship exists between the VHI and the RSI raw scores.

TABLE 10. Pearson Correlation analysis for all indices.

Correlations										
		RSI	RFS	VHI	Breathy	Hoarse	NHR	Label	Age	Hours
RSI	Pearson Correlation	1	.286	.431(*)	.099	.255	-.202	.346	.288	-.014
	Sig. (2-tailed)	.	.166	.032	.639	.219	.333	.090	.162	.949
	N	25	25	25	25	25	25	25	25	25
RFS	Pearson Correlation	.286	1	.003	.248	.246	-.013	.337	.061	-.109
	Sig. (2-tailed)	.166	.	.990	.232	.236	.951	.099	.773	.603
	N	25	25	25	25	25	25	25	25	25
VHI	Pearson Correlation	.431(*)	.003	1	.036	.540(**)	-.402(*)	-.086	.009	-.080
	Sig. (2-tailed)	.032	.990	.	.864	.005	.046	.683	.966	.703
	N	25	25	25	25	25	25	25	25	25
Breathy	Pearson Correlation	.099	.248	.036	1	.045	-.047	-.007	-.154	.354
	Sig. (2-tailed)	.639	.232	.864	.	.832	.824	.973	.464	.082
	N	25	25	25	25	25	25	25	25	25

TABLE 10. Continued.

Correlations										
		RSI	RFS	VHI	Breathy	Hoarse	NHR	Label	Age	Hours
Hoarse	Pearson Correlation	.255	.246	.540(**)	.045	1	-.251	.135	-.222	-.254
	Sig. (2-tailed)	.219	.236	.005	.832	.	.226	.521	.286	.220
	N	25	25	25	25	25	25	25	25	25
NHR	Pearson Correlation	-.202	-.013	-.402(*)	-.047	-.251	1	.252	-.028	-.031
	Sig. (2-tailed)	.333	.951	.046	.824	.226	.	.225	.895	.884
	N	25	25	25	25	25	25	25	25	25
Age	Pearson Correlation	.288	.061	.009	-.154	-.222	-.028	.053	1	-.186
	Sig. (2-tailed)	.162	.773	.966	.464	.286	.895	.802	.	.372
	N	25	25	25	25	25	25	25	25	25
Hours	Pearson Correlation	-.014	-.109	-.080	.354	-.254	-.031	-.253	-.186	1
	Sig. (2-tailed)	.949	.603	.703	.082	.220	.884	.222	.372	.
	N	25	25	25	25	25	25	25	25	25

Correlation is significant at the *0.05 level or at the ** 0.01 level (2-tailed).

CHAPTER FIVE
DISCUSSION

As the focal group with self-reported vocal complaints, 25 post-pubescent female vocalists participated in this experiment in order to examine the reliability of the Reflux Symptoms Index (RSI) as a self-rating of the symptoms of laryngopharyngeal reflux (LPR). The RSI was assessed for validity as a differential diagnostic tool using three symptom groups: LPR, gastro-esophageal reflux (GER), and asymptomatic. The LPR group consisted of ten participants who demonstrated a minimum of two symptoms identified with LPR. The six participants in the GER group presented with symptoms of heartburn and/or indigestion, with or without accompanying symptoms. Finally, the nine asymptomatic group members did not report any symptoms related to LPR or GER.

When analyzed by group, the results failed to support any significant between-group differences as indicated by RSI raw score. Thus, the first research question was answered: type of reflux, as classified by symptoms, did not significantly affect the total raw score on the RSI. Furthermore, no statistically relevant between-group differences were established for any other variables, including other participant scores, such as RFS, VHI, breathiness, hoarseness, and NHR. In this instance, such findings suggested that the symptoms alone were not a sufficient method of group classification. However, the GER group appeared to have the highest RSI and RFS scores. Contrary to expectations based on current literature, if truly experiencing reflux in the laryngeal cavity, the LPR group would be expected to have the most severe symptoms of LPR, as noted by RSI scores, and the most visual indicators of reflux presence in the larynx, as quantified by the RFS scores.

The statistically significant findings identified by data analysis were found within variable relationships. Although results refuted a relationship between the total raw score of the

RSI and visual (RFS), acoustic (NHR), and perceptual (breathiness and hoarseness) measurements of voice, moderate correlations between specific variables reinforced and supported previous investigative findings, specifically that the total raw scores on the RSI and the VHI were related.

As Belafsky, Postma, and Koufman (2002) discovered, the RSI and the VHI were related at some level. They found that patients with a five-point or better improvement on the RSI were 11 times more likely to experience a five-point improvement on the VHI (95% confidence interval). Although it was suggested that the correlation showed validity of the RSI, it was only valid as it related to a self-perceptual psychometric index, the VHI. Their findings, along with the correlation found in this study between the RSI and VHI raw scores suggested a deeper relationship. In the 1997 investigation into the validity of the VHI (Jacobson et. al), analysis identified a correlation between the VHI raw score and participant severity ratings, implying that self-perceived difficulties were interlaced with psychosocial difficulties. As self-perception falls into the realm of psychology, it seemed more likely that the way an individual participant perceived her voice difficulties would equally affect any self-rated voice perception tool. However, such a hypothesis merits further investigation.

Another significant finding was the relationship between the VHI raw score and the perceptual rating of hoarseness ($r = 0.540$), as well as the correlation between the VHI raw score and the acoustic measure NHR ($r = 0.402$). Although previous studies established a correlation between NHR and hoarseness (Bhuta, Patrick, and Garnett, 2004), the data collected and analyzed in this study revealed no such relationship. However, this information suggested that a perception of hoarseness or the acoustic measure of noise (NHR) could be predictors of a certain degree of self-perceived voice difficulty, and, likewise, the VHI total score could possibly predict the presence of a hoarse vocal quality and or an elevated NHR.

Experimental Confounds and Limitations of the Study

As it was mentioned earlier, many volunteers presented with a hyperactive gag reflex that inhibited the investigator from visualizing the laryngeal cavity. This restricted the number of participants included in data analysis, which could have affected the ability to identify significant findings. It was recommended that, for future studies, more participants would increase the strength of the study.

Unfortunately, the lack of a medical diagnosis also limited the possibility of grouping participants other than by symptoms. Psychometric and self-perceived difficulties, as discussed earlier, made distinctions and interpretations more difficult. Yet, the RSI was designed to identify severity of symptoms, thus some significance remained in the fact that no substantial relationship existed between the RSI raw score and any variable, other than the only other self-rated instrument, the VHI. Due to the overlapping symptoms, such as fatigue, throat clearing, and muscle tension, more research is needed to identify symptoms that could be clinically used as diagnostic indicators of LPR.

Clinical Application

Although the RSI may have been valid and reliable for monitoring improvement during a reflux treatment plan, this study did not find the tool valid for diagnostic purposes. When monitoring improvement, the patient perception could have incorporated some aspects of psychology and self-image that improved along with expectations of treatment outcome. A diagnostic tool, on the other hand, should have had criteria that could identify one problem as it differs from other similar problems. The RSI did not appear to be useful for differentiating laryngopharyngeal reflux from gastroesophageal reflux symptoms, nor did the score identify those who were asymptomatic as significantly different from participants who reported symptoms of reflux. However, as this study did report a subsequent finding of the correlation between the VHI and the RSI raw scores, it was evident that perhaps the severity of self-reported voice problems could be identified by both of these tools.

Implications for Future Research

Despite the largely negative results, examination of individual data revealed somewhat more interesting findings and relevant issues for future research, especially as it applied to post-pubescent female vocalists. As mentioned before, there were no significant group differences, partly due to the difficulty of identifying the type of reflux by symptom. Many of the participants shared common symptoms, thus making the distinctions between types of voice problems less clear. In fact, only one participant reported herself as completely void of voice difficulties. This issue may have been specific to the selected population, which was indicated as the most likely to report voice complaints. Moreover, training for vocalists included learning to be more vocally aware, since the larynx is viewed as the vocalist's musical instrument.

It was interesting to note that, regardless of the number of hours in which the individual participants performed vocally each week, there were no significant relationships found between frequency of singing and any variables. In fact, the occurrence of vocal fatigue ranged from participants who sang ten hours per week to one participant who sang 35 hours per week. Further investigation into the relationship between hours of singing and vocally pathological symptoms could be investigated to establish whether there is some immunity to pathological symptoms due to anatomical structure, vocal technique, or vocal experience.

Finally, there were many acoustic parameters collected during acoustic analysis using the Multi-Dimensional Voice Profile software. As the review of literature only indicated NHR as having a relationship with the presence of reflux in the larynx, no other parameters were analyzed for the possibility of statistically relevant relationships with the VHI, the RSI, or any of the visual, perceptual, or acoustic measurements. Other investigators could use these data to research the possibility of other correlations as they relate to populations with complaints of refllux or to the population of post-pubescent female vocal performers, who continue to present with the most complaints of voice problems.

In summary, it appeared obvious that there is a need for further research into the differences between gastroesophageal reflux and laryngopharygeal reflux. As laryngopharyngeal reflux could still be considered a relatively new phenomenon, this was not an unexpected outcome. There was also a large number of post-pubescent female vocal performers in want of further information to identify and treat an array of voice problems. Research should continue to identify and research such populations in order to provide the most effective tools possible for the diagnosis and treatment of voice problems.

REFERENCES

Selby, J.C., Gilbert, H.R., & Lerman, J.W. (2003, December). Perceptual and acoustic evaluation of individuals with laryngopharyngeal reflux pre- and post-treatment. *Journal of Voice, 17*(4), 557-571.

Bonci, Leslie. (2003). *American Dietetic Association Guide to Better Digestion*. Hoboken, New Jersey: John Wiley & Sons, Inc.

Belafsky, P.C., Postma, G.N., & Koufman, J.A. (2002, June). Validity and reliability of the reflux symptom index (RSI). *Journal of Voice*, *16*(2), 274-278.

Tepe, E.S., Deutsch, E.S., Sampson, Q., Lawless, S., Reilly, J.S., & Sataloff, R.T. (2002, June). A pilot survey of vocal health in young singers. *Journal of Voice*, *16*(2), 244-251.

Sandage, M.J. & Emerich, K. (2003, November). Singing Voice: Special Considerations for Evaluation and Treatment. *The ASHA Leader Online*.

Bhuta, T., Patrick, L., & Garnett, J. (2004, September). Perceptual Evaluation of Voice Quality and its Correlation with Acoustic Measurements. *Journal of Voice*, *18*(3), 299-304.

Belafsky, P.C., Postma, G.N., Amin, M.R., & Koufman, J.A. (2002, September). Symptoms and findings of laryngopharyngeal reflux. *Ear, Nose, & Throat Journal*, *81*(9), Supplement.

Belafsky, P.C., Postma, G.N., & Koufman, J.A. (2001, August). The Validity and Reliability of the Reflux Finding Score (RFS). *The Laryngoscope*, *111*(8), 1313-1317.

Jacobson, B.H., Johnson, A., Gryswalski, C., Silbergleit, A., Jacobson, G., & Benninger, M.S. (1997, August). The Voice Handicap Index (VHI): Development and Validation. *American Journal of Speech-Language Pathology*. *6*(3), 66-69.

APPENDIX A
REFLUX FINDING SCORE

Pseudosulcus (infraglottic edema)	0 = Absent 2 = Present	
Ventricular Obliteration	0 = None 2 = Partial 4 = Complete	
Erythema/hyperemia	0 = None 2 = Arytenoids only 4 = Diffuse	
Vocal fold edema	0 = None 1 = Mild 2 = Moderate 3 = Severe 4 = Polypoid	
Diffuse laryngeal edema	0 = None 1 = Mild 2 = Moderate 3 = Severe 4 = Obstructing	
Posterior commissure hypertrophy	0 = None 1 = Mild 2 = Moderate 3 = Severe 4 = Obstructing	
Granuloma/granulation	0 = Absent 2 = Present	
Thick endolaryngeal mucus	0 = Absent 2 = Present	
	Total	

APPENDIX B
VOICE HANDICAP INDEX

Instructions: These are statements that many people have used to describe their voices and the effects of their voices on their lives. Circle the response that indicates how frequently you have the same experience.

F1. My voice makes it difficult for people to hear me.	Never	Almost never	Sometimes	Almost always	Always
P2. I run out of air when I talk.	Never	Almost never	Sometimes	Almost always	Always
F3. People have difficulty understanding me in a noisy room.	Never	Almost never	Sometimes	Almost always	Always
P4. The sound of my voice varies throughout the day.	Never	Almost never	Sometimes	Almost always	Always
F5. My family has difficulty hearing me when I call them throughout the house.	Never	Almost never	Sometimes	Almost always	Always
F6. I use the phone less often than I would like.	Never	Almost never	Sometimes	Almost always	Always
E7. I'm tense when talking with others because of my voice.	Never	Almost never	Sometimes	Almost always	Always
F8. I tend to avoid groups of people because of my voice.	Never	Almost never	Sometimes	Almost always	Always
E9. People seem irritated with my voice.	Never	Almost never	Sometimes	Almost always	Always
P10. People ask, "What's wrong with your voice?"	Never	Almost never	Sometimes	Almost always	Always
F11. I speak with friends, neighbors, or relatives less often because of my voice.	Never	Almost never	Sometimes	Almost always	Always
F12. People ask me to repeat myself when speaking face-to-face.	Never	Almost never	Sometimes	Almost always	Always
P13. My voice sounds creaky and dry.	Never	Almost never	Sometimes	Almost always	Always
P14. I feel as though I have to strain to produce voice.	Never	Almost never	Sometimes	Almost always	Always
E15. I find other people don't understand my voice problem.	Never	Almost never	Sometimes	Almost always	Always
F16. My voice difficulties restrict my personal and social life.	Never	Almost never	Sometimes	Almost always	Always
P17. The clarity of my voice is unpredictable.	Never	Almost never	Sometimes	Almost always	Always
P18. I try to change my voice to sound different.	Never	Almost never	Sometimes	Almost always	Always
F19. I feel left out of conversations because of my voice.	Never	Almost never	Sometimes	Almost always	Always
P20. I use a great deal of effort to speak.	Never	Almost never	Sometimes	Almost always	Always
P21. My voice is worse in the evening.	Never	Almost never	Sometimes	Almost always	Always
F22. My voice problem causes me to lose income.	Never	Almost never	Sometimes	Almost always	Always
E23. My voice problem upsets me.	Never	Almost never	Sometimes	Almost always	Always
E24. I am less outgoing because of my voice problem.	Never	Almost never	Sometimes	Almost always	Always
E25. My voice makes me feel handicapped.	Never	Almost never	Sometimes	Almost always	Always
P26. My voice "gives out" on me in the middle of speaking.	Never	Almost never	Sometimes	Almost always	Always
E27. I feel annoyed when people ask me to repeat.	Never	Almost never	Sometimes	Almost always	Always
E28. I feel embarrassed when people ask me to repeat.	Never	Almost never	Sometimes	Almost always	Always
E29. My voice makes me feel incompetent.	Never	Almost never	Sometimes	Almost always	Always
E30. I'm ashamed of my voice problem.	Never	Almost never	Sometimes	Almost always	Always

APPENDIX C
REFLUX SYMPTOMS INDEX

Within the last month, how did the following problems affect you? Circle the appropriate response.

0 = No problem
5 = Severe Problem

1. hoarseness or a problem with your voice	0	1	2	3	4	5
2. clearing your throat	0	1	2	3	4	5
3. excess throat mucus or postnasal drip	0	1	2	3	4	5
4. difficulty swallowing food, liquids, or pills	0	1	2	3	4	5
5. coughing after you ate or after lying down	0	1	2	3	4	5
6. breathing difficulties or episodes	0	1	2	3	4	5
7. troublesome or annoying cough	0	1	2	3	4	5
8. sensations of something sticking in your throat or a lump in your throat	0	1	2	3	4	5
9. heartburn or chest pain	0	1	2	3	4	5

APPENDIX D
CONSENT FORM

Study Title:	Validity of the *Reflux Symptoms Index* (RSI)
Performance Site:	LSU Speech, Language, and Hearing Clinic
Investigators:	Natalie H. Overall: Available to answer questions about the research, M-F 8:00 a.m. - 4:00 p.m. 225-907-3443
Purpose:	The purpose of this research project is to determine the validity of the RSI, a severity rating scale associated with the presence of acid reflux in the larynx.
Subject Inclusion:	Females, ages 18-25, who perform vocally at least 10 hours/week and may or may not have experienced symptoms of acid reflux.
Number of Subjects:	30
Study Procedures:	A case history form and two severity rating forms are completed initially. Then, a rigid endoscope is inserted into the oral cavity, rested on the tongue, and slid to the back of the oral cavity until the larynx is visualized. An acoustic assessment will also involve reading a passage and sustaining the vowel /a/.
Benefits:	Subjects benefit from a free assessment of laryngeal structure and function accompanied by color images. Information gained may provide early identification of at-risk individuals to whom prevention efforts can be directed.
Risks/Discomforts:	Although there is no risk of injury, there may be slight discomfort if individuals have a sensitive gag reflex.
Injury/Illness:	In the event of early identification of at-risk individuals, the participant will be referred to an ENT (Dr. Andrew McWhorter # 504-412-1570) for treatment, but the expense of medical treatment will be your responsibility. No compensation is available in case of study-related illness or injury.
Right to Refuse:	Subjects may choose not to participate or to withdraw from the study at any time with no jeopardy to their treatment by their respective doctors or other penalty at the present time or in the future.
Privacy:	The LSU Institutional Review Board (which oversees university research with human subjects) may inspect and/or copy the study records. Results of the study may be published, but no names or identifying information will be included in the publication. Other than as set forth above, subject identity will remain confidential unless disclosure is legally compelled.
Financial Information:	There is no cost, nor any compensation for participating in the study.
Signatures:	The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of the consent form.

Subject Signature _________________________ Date ______________

APPENDIX E
CASE HISTORY FORM

Age: ________ Race: ____________ Hours of Singing/Week: ________

1. Do you have any history of voice problems/acid reflux? Yes/No (if yes, circle those that apply)
2. If so, how long have you experienced the problem? ______________________________
3. What was the cause of the problem? ______________________________
4. Did it come on slowly or suddenly? ______________________________
5. Has it gotten better or worse or does it fluctuate? ______________________________
6. Please describe in detail:

Dates: *Voice Problems/Symptoms/Medical Visits/Diagnoses*:

_______ ____
_______ ____
_______ ____
_______ ____
_______ ____

7. Which symptoms do you have? (Please check all that apply.)

_______Hoarseness (coarse, rough, or scratchy sound)
_______Fatigue (voice tires or changes quality after speaking/singing)
_______Loss of range
_______Glottal fry
_______Breathiness
_______Tickling or choking sensation while speaking/singing
_______Pain in throat
_______Other: (Please specify) ______________________________

8. Please check all that apply to you:

_______Voice worse in the morning
_______Voice worse later in the day (after singing/speaking)
_______Frequent sore or burning throat
_______Bitter or acid taste in morning
_______Hoarseness in the morning
_______Frequent exercise (weight-lifting, aerobics) after eating
_______Live, work, or perform around smoke/fumes
_______Recent or current cold/sinus infection
_______Muscle tension in the throat or neck
_______Frequent 'heartburn'
_______Frequent throat clearing
_______Eating late at night
_______Frequent indigestion
_______Chronic coughing
_______Hearing loss
_______Difficulty swallowing
_______Difficulty breathing
_______Other:______________

9. Please list all current medications or those that were taken during occurrence of voice problems:

Medication: *Taken for:* *Frequency of Administration (times/day):* *Current or Date:*

____
____
____
____
____

10. Do you have any family history of voice problems or acid reflux? (If so, please describe.)

____
____
____
____

APPENDIX F
MULTI-DIMENSIONAL VOICE PROFILE

Measures	Client Data	Female Norms –
Mean Fo		
Fo Perturbations (> = hoarseness)		
RAP%		.38 (.21 sd)
PPQ%		.37 (.21 sd)
Amplitude Perturbations (> =hoarseness)		
Sh dB		.18 (.07 sd)
APQ%		1.39 (.53 sd)
Voice Breaks (> = voice breaks)		
DVB%		.20 (.10 sd)
Subharmonics (> = glottal fry, hoarseness)		
NSH		.20 (.10 sd)
DSH%		.20 (.10 sd)
Noise Measures (> = breathiness, turbulence)		
NHR		.11 (.01 sd)
VTI		.05 (.01 sd)
SPI		7.53 (.16 sd)

* Normative measurements are universally female, with the exception of fundamental frequency (Fo) which must be determined based upon the participant's age, race, and regional origin. Note that 'sd' indicates the standard deviation for each normative measurement.

APPENDIX G
ASSESSMENT SUMMARY

I. Significant Case History: ____
____
____

II. Perceptual Ratings
A. Vocal quality perceived by clinicians as ____________________________.
B. Vocal quality perceived by vocalist as ______________________________.

III. Visualization Findings *significant results are highlighted

Glottic Closure:	**Phase Closure:**
Vertical Level vf Approximation:	**Phase Symmetry:**
Periodicity(Regularity):	**Hyperfunction:**
Ventricular Folds (symmetry):	**Ventricular Folds (movement):**
Arytenoids (symmetry):	**Arytenoids (movement):**
Vocal Fold Edge Left:	**Vocal Fold Edge Right:**
Amplitude Left:	**Amplitude Right:**
Mucosal Wave Left:	**Mucosal Wave Right:**
Vibratory Behavior Left:	**Vibratory Behavior Right:**

IV. Acoustic Findings: *significant results are highlighted

Measures	Client Data	Female Norms –
Mean Fo		
Fo Perturbations (> = hoarseness)		
RAP%		.38 (.21 sd)
PPQ%		.37 (.21 sd)
Amplitude Perturbations (> =hoarseness)		
Sh dB		.18 (.07 sd)
APQ%		1.39 (.53 sd)
Voice Breaks (> = voice breaks)		
DVB%		.20 (.10 sd)
Subharmonics (> = glottal fry, hoarseness)		
NSH		.20 (.10 sd)
DSH%		.20 (.10 sd)
Noise Measures (> = breathiness, turbulence)		
NHR		.11 (.01 sd)
VTI		.05 (.01 sd)
SPI		7.53 (.16 sd)

V. Summary
____
____
____

VI. Recommendations: ________ None ________ See ENT regarding results

VITA

Natalie Herpin Overall is a native of Baton Rouge, Louisiana, where she first discovered her love of vocal performance. Throughout her middle and high school education, she pursued musically related extra-curricular activities, such as performing with the Baton Rouge Symphony Chorus, Baton Rouge Little Theater, and the Baton Rouge Gilbert and Sullivan Society. In the spring of 1999, she graduated from Baton Rouge Magnet High School, where she had been an active member in student organizations such as Beta Club, Mu Alpha Theta, National Honors Society, and the Festival Singers ensemble.

After her first two years of collegiate work toward a major in musical performance at Louisiana State University and Agricultural and Mechanical College in Baton Rouge, Mrs. Overall was awarded the Louis J. Cappazoli Ambassadorial Scholarship to Italy. Her studies were then put on hold for one year so that she could explore the cultural and academic opportunities in Bologna, Italy, where she was enrolled in music and literature courses at the oldest university in Europe, the Universite degli Studi di Bologna. After one year of education and exploration, Mrs. Overall recognized her appreciation and love of anatomy and physiology. Upon returning to Baton Rouge and recommencing her studies, she decided to merge her interests. In the spring of 2004, Mrs. Overall was awarded a Bachelor of Arts in Communication Disorders, with a minor in music and linguistics, from Louisiana State University. She completed this thesis in partial fulfillment of the requirements for the degree of Master of Arts in the Department of Communication Sciences and Disorders, for which she will be graduated by the Louisiana State University and Agricultural and Mechanical College in Baton Rouge in May of 2006.