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An Investigation of Vocal Abuse in School Teachers

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AN INVESTIGATION OF VOCAL ABUSE IN SCHOOL TEACHERS

by

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This thesis meets the standards for appearance, conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.

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ABSTRACT

The purpose of this study was to examine the effects of vocal abuse in school teachers and teacher's aides pre and post one academic term. Vocal abuse was defined as any of several behaviors, including long periods of talking, yelling, smoking, consuming alcohol, etc. that can result in damage to the laryngeal mechanism. Initially, the participants of the study included fifteen elementary school teachers and five elementary teacher's aides from two schools: the Red Lake Madsen Public School, and Golden Learning Center. Six participants were excluded from the study for various reasons. Participants were randomly assigned to either Group 1 or Group 2. Group 1 included two teacher's aides and five teachers on a daily term (short term) and Group 2 included one teacher's aide and six teachers during one academic term (long term).

It was hypothesized that the school teachers and teacher's aides who participated in vocally abusive behaviors will display differences in the measured vocal qualities pre and post testing. Data collection included voice recording productions of the vowels /a/. A paired samples t-test was used to determine if a statistically significant difference existed between teachers in the short term group versus the long term group and between pre and post terms. The results for the short term group revealed a statistically significant difference in one acoustic measure fundamental frequency.

CHAPTER I

INTRODUCTION

Presently, there are numerous occupations in which practitioners use their voice as a primary tool of trade. School teachers (private and public) represent the largest group of professionals who have a high demand on vocal use. Teachers are required to speak loudly and continuous in noisy classrooms for long periods of time without allowing any time for vocal fold tissues to rest or recover. It appears that this prolonged and intense use of voice often places teachers at a higher risk for occupation related voice disorders than the general population (Roy, Merrill, Thibeault, Gray, & Smith, 2004; Roy, Merrill, Thibeault, Parsa, Gray, & Smith, 2004; Yiu & Ma, 2002).

During the last several years, research in the area of voice problems, voice disorders, vocal fatigue, voice disorders on daily activities and the quality of life, voice activity limitation and participation restriction, and instruction for voice disorders have all been studied for the teaching profession (Roy et al, 2004; Roy et al, 2004; Roy et al, 2002; Yiu & Ma, 2002; Ma & Yiu, 2001; Simberg, 2000; Kostyk & Putnam, 1998; Smith et al, 1998; Russell et al, 1998; Smith, 1997; Smith et al, 1996; Gotaas & Starr, 1993).

Voice problems for teachers and teacher's aides can be difficult to deal with perhaps and potentially detrimental to their careers. Depending on the type and the severity of the voice problem, numerous complications could occur. One complication could be if a voice problem occurs and continues to persist and nothing is done to prevent further stress on the voice, it can lead into some kind of voice disorder.

Other complications could be that voice disorders may need some kind of medical intervention. Depending on the severity of the voice disorder teachers or teacher's aides may need to take a leave of absence. Therefore, job security could be affected.

Throughout their careers, teachers and teacher's aides teach students many different subjects as well as life lessons, however, no one teaches them about their voice. Teachers and teacher's aides fail to warm up and rest their most important muscle, the vocal folds. Over the course of a school year, teachers and teacher's aides may abuse their voice repeatedly by whispering, speaking loudly and continuously throughout the day as well as speaking in an inappropriate pitch. Constant abuse of their voice may result in vocal abuse, and if this persists, may lead into a voice disorder. This study attempted to examine the effects of possible vocal abuse in school teachers and teacher's aides over the course of a daily term (short term) and one academic term (long term).

CHAPTER II

REVIEW OF LITERATURE

The vocal mechanism is a unique and complex structure. This mechanism consists of a bone, cartilages, and muscles. More specifically, the vocal mechanism is composed of the laryngeal skeleton and their joints, three pairs of folds, and extrinsic and intrinsic muscles (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998). All of these components are used in voice production and are uniquely related to each other (Deem & Miller, 2000). The primary biological purpose of the vocal mechanism is to assist in life support. This life support mechanism has also been adapted to produce voice in humans (Deem & Miller, 2000). A basic understanding of the anatomic components of the vocal mechanism and their complexities is essential in order to understand its function (Ferrand, 2001; Deem & Miller, 2000).

Laryngeal Anatomy & Physiology

Larynx

The larynx has many biological functions including the control "of air into and out of the lungs; to provide oxygen to the body and eliminate carbon dioxide; prevent food, water, and other substances from entering the lungs; to aid in swallowing; and to enable a buildup of pressure within the thorax for such functions as coughing, vomiting, defecating, and lifting heavy objects" (Borden, Harris, & Raphael 2003, p.65).

The larynx is an "unpaired, midline, musculocartilaginous structure located in the anterior neck region" (Zemlin, 1998, p.101). The larynx is located above the trachea and below the hyoid bone and is suspended from the hyoid bone by the hyothyroid membrane (Borden, Harris, & Raphael, 2003; Ferrand, 2001; Zemlin, 1998). The position of the larynx may vary depending upon age, gender, head position, and laryngeal activity. Usually the larynx is vertically located at around the level of the 3rd, 4th, 5th, and 6th cervical vertebrae (Zemlin, 1998).

Hyoid Bone

The hyoid bone is described as a small U- shaped or horseshoe-shaped bone that forms a supportive structure for the attachment of the root of the tongue (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998). This single bone is the only bone that does not articulate with any other bone in the human body. The hyoid bone is located at the level of the third cervical vertebrae and it is bound in place by a complex system of ligaments and muscles (Zemlin, 1998).

Cartilages of the Larynx

The structural framework of the human larynx is comprised of nine individual cartilages. These cartilages are divided into two groups: large cartilages and small cartilages. There are three large cartilages, the epiglottis, the thyroid cartilage, and the cricoid cartilage. These cartilages are unpaired. There are three small paired cartilages, the arytenoid cartilages, the corniculate cartilages, and the cuneiform cartilages (Deem & Miller, 2000; Zemlin, 1998; Stemple, Glaze, & Gerdeman, 1995).

Epiglottis

The unpaired epiglottis is a broad and flexible leaf shaped laryngeal elastic cartilage and, thus, does not ossify with age. It is located behind the hyoid bone and the root of the tongue, and its base attaches with the inner portion of the thyroid cartilage. During swallowing, the main function of the epiglottis is to prevent foods and liquids from entering the larynx by covering the laryngeal vestibule, directing the foods and liquids into the esophagus (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998; Stemple, Glaze, & Gerdeman, 1995).

Thyroid Cartilage

The unpaired thyroid cartilage is the largest of the laryngeal cartilages and it is shaped like a shield or saddle. "The thyroid is composed of hyaline cartilage that does ossify and limits flexibility with age (Stemple, Glaze, & Gerdeman, 1995). This cartilage is formed by two plates called lamina, that are fused together in the middle resulting in an angle what is commonly called the "Adam's apple" (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998; Colton & Casper, 1996; Stemple, Glaze, & Gerdeman, 1995; Case, 1984). The two lamina of the thyroid cartilage are fused at an angle of approximately 90 degrees for an adult female and approximately 80 degrees for the adult male (Ferrand, 2001; Deem & Miller; 2000; Zemlin, 1998; Colton & Casper, 1996). This angle difference makes the thyroid cartilage more noticeable and obvious in adult males than adult females.

Posteriorly, the thyroid cartilage has two long projections which are known as superior horns and two shorter projections which are known as inferior horns. The superior horns are situated at either side of the thyroid, which extend upward and backward and are attached by means of a ligament to the hyoid bone. The inferior horns are situated downward and slightly medially and are attached to the cricoid cartilage by the means of articular facets that are situated on the medial surface of the cricoid cartilage. The attachment results in a pivot joint which allows the thyroid or cricoid to rotate on a horizontal axis (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998; Colton & Casper, 1996).

Cricoid Cartilage

The unpaired cricoid cartilage is a complete ring shaped cartilage which is located directly above the trachea. It forms the base of the larynx and has two parts: an anterior arch and a posterior quadrate lamina (Ferrand, 2001; Deem & Miller, 2000, Zemlin, 1998, Stemple, Glaze, & Gerdeman, 1995).

Arytenoid Cartilage

The paired arytenoid cartilages are small pyramid-shaped structures which are situated on the posterior superior surface of the quadrate lamina of the cricoid cartilage. By being pyramid-shaped, these cartilages have two projections which extend from the base. The first projection is known as the elastic vocal process which is located anteriorly toward the thyroid cartilage. The second projection is known as the muscular process which extends laterally and posteriorly. Various muscles attach to the muscular process resulting in movement of the arytenoids (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998; Stemple, Glaze, & Gerdeman, 1995). The bases of the arytenoids are smooth, thus, allowing smooth articulation with the superior portion of the cricoid cartilages, at the cricoarytenoid joint. This joint is a salient feature of the larynx, as it allows both rocking and sliding movements of the arytenoids cartilages. These movements aid in abduction, adduction, and stabilization of the vocal folds (Stemple, Glaze, & Gerdeman, 1995).

Corniculate Cartilages

The paired corniculate cartilages, also known as cartilages of Santorini, are hornlike-shaped and are situated at the apex of the arytenoids. These cartilages presently do not play a significant role in laryngeal function, however, at one point in time may have served as a protective function of the airway (Deem & Miller, 2000; Zemlin, 1998).

Cuneiform Cartilages

The paired cuneiform cartilages, also known as cartilages of Wrisberg, are small elastic wedge-shaped rods of cartilage which are embedded within the aryepiglottis folds. The aryepiglottis folds extend from the sides of the epiglottis to the apexes of the arytenoids cartilages. The cuneiform cartilages function to facilitate the aryepiglottis folds in maintaining an opening of the airway into the larynx (Deem & Miller, 2000; Zemlin, 1998).

Muscles of the Larynx

The laryngeal muscles are usually divided into two groups based on functional and anatomic differences. One group is called the extrinsic muscles. Extrinsic muscles have one point of attachment to the larynx and other point of attachment to a structure outside the larynx. The extrinsic muscles are responsible for supporting and anchoring the larynx in position. The other group of muscles is called the intrinsic muscles. Intrinsic muscles have both points of attachment within the larynx. The intrinsic muscles are responsible for the control of sound production (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998).

Extrinsic Muscles

The extrinsic muscles are subdivided into two groups. The suprahyoid muscles lie above the hyoid bone and are classified as laryngeal elevators. The infrahyoid muscles lie below the hyoid bone and are classified as laryngeal depressors (Ferrand, 2001; Deem & Miller, 2000; Zemlin, 1998, Colton & Casper, 1996). The suprahyoid muscles form a sling which support the hyoid bone and the larynx. These muscles, the digastric (anterior belly), the geniohyiod, and the mylohyoid, form the anterior part of the sling (Colton & Casper, 1996). When contracted these muscles elevate the hyoid bone and larynx up and forward (Ferrand, 2001; Deem & Miller, 2000; Colton & Casper, 1996). The suprahyoid muscles, the digastric (posterior belly) and the stylohyoid, form the posterior part of the sling. When contracted, these muscles pull the hyoid posteriorly (Colton & Casper, 1996). (See Appendix A for further information on extrinsic suprahyoid muscles of the larynx). When contracted the infrahyoid muscles lower the larynx which results in lengthening the vocal tract (Ferrand, 2001; Deem & Miller, 2000; Colton & Casper, 1996). (See Appendix A for further information on extrinsic infrahyoid muscles of the larynx).

Intrinsic Muscles

The intrinsic muscles control sound production and are responsible for rapid changes that are required during speech. These muscles can be subdivided into groups in relation to their effects on the shape of the glottis and vibratory action of the vocal folds (Zemlin, 1998). The muscle groups are abductors, adductors, tensors, and relaxers. The abductor muscles main function is to separate the arytenoids and the vocal folds during respiratory activities. In contrast, the adductor muscles main function is to approximate the arytenoid cartilages and the vocal folds during phonation and for protection purposes. The tensor muscles are responsible for elongating and tightening the vocal folds. In contrast, the relaxers are responsible for shortening the vocal folds (Zemlin, 1998). (See Appendix B for further information on intrinsic muscles).

Vocal Fold Anatomy & Physiology

The vocal folds are necessary for the production of phonation. Humans only utilize a single pair of vocal folds which produces many different varieties of tones, fundamental frequencies, and intensities. This phenomenon's secret lies in the make-up or structure and control of the vocal folds (Hirano, 1981).

Within the larynx, there are three sets of folds: the aryepiglottic folds, the false or ventricular vocal folds, and the true vocal folds, which open and close to perform a variety of functions. These folds consist of bundles of connective tissues and muscle fibers. These folds are arranged from superior to inferior (Ferrand, 2001; Colton & Casper, 1996).

The aryepiglottiic folds, the ones most superior, are located at the sides of the epiglottis to the top of each arytenoid cartilage. These folds contract in a circular motion to pull the epiglottis backward during swallowing as a protective act to close the entrance to the larynx (Ferrand, 2001; Colton & Casper, 1996), therefore, protecting the airway.

The false vocal folds lie in between the aryepiglottic folds and the true vocal folds. These folds have few muscle fibers and have limited movement (Ferrand, 2001; Colton & Casper, 1996). During phonation, they remain open and close during swallowing and effortful activities such as child birth, lifting heavy objects, etc. A small space called the laryngeal ventricle separates the false and true vocal folds. The laryngeal ventricle secretes mucus, thus, keeping the larynx moist and lubricated (Ferrand, 2001).

The true vocal folds are the most complex and the major folds of interest of all the laryngeal folds. These vocal folds consist of five layers: the thyroarytenoid muscle, three layers of mucous membrane called lamina propria, and a layer of epithelium.

The epithelium is the outer most layer of the vocal folds. This layer of tissue is composed of squamous cells and is tough and stiff but extremely thin and its purpose is to maintain the shape of the vocal folds (Ferrand, 2001; Colton & Casper, 1996; Hirano, 1981). The second layer is deep to the epithelium and is the superficial layer of the lamina propria, also referred to as Reinke's space. This layer is composed of mostly elastic fibers which give it a high degree of pliability. Superficial layer of the lamina propria can be described as a mass of soft gelatin. The third layer is the intermediate layer of the lamina propria and is also composed of elastic fibers. These fibers are less flexible and denser than the superficial layer. This layer is usually described as a bundle of soft rubber bands. The fourth layer is the deep layer of the lamina propria and it consists of collagenous fibers. This layer is less flexible than the intermediate layer and is similar to a bundle of cotton thread. The final layer is the vocalis (thyroarytenoid) muscle and constructs the main body of the vocal folds. It is thicker and denser than all other layers of the vocal folds. This layer is often described like a stiff rubber band (Ferrand, 2001; Deem & Miller, 2000; Hirano, 1981).

For many different reasons, the layered structures of the vocal folds are of great importance. One reason is that each of the five layers has a different mechanical property. Another reason is the mechanical properties of the outer four layers are controlled passively, while the innermost layer's mechanical properties are regulated both actively and passively. A final reason is all pathologies originate from a specific layer of the vocal folds (Hirano, 1981).

Normal Voice Production

For humans to produce voice, a constant air flow from the lungs is required to activate the vocal folds into vibration (Borden, Harris, & Rapeal, 2003; Colton & Casper, 1996). For speech, speakers use two different methods of transforming the air into sounds. The first method uses air pressure to set the vocal folds into vibration which is termed phonation. These vibrations produce periodic (repeated pattern) sound waves. The second method allows air to be passed through the larynx and into the upper vocal tract where air stream modifications can result in noises such as hisses, bursts, etc. These vibrations produce aperiodic (no repeated pattern) sound waves (Borden, Harris, & Raphael, 2003).

When the vocal folds are adducted and vibrating this is referred to phonatory mode (Borden, Harris, & Raphael, 2003). The onset of phonation can be divided into two phases. The prephonation phase is the first phase and is described as the period of time during which the vocal folds move from a position of abduction to a position of partially or completely adduction. In this phase, the duration and extent of the vocal fold adduction is unpredictable, depending upon the utterance to be produced. When the vocal folds partially or completely adduct the air pressure beneath the vocal folds build up and the velocity of the airflow increases as it passes through the glottis (Zemlin, 1998).

The second phase is known as the attack phase. This phase begins when the vocal folds are partially or completely adducted and continuing through the vibratory cycles. The duration of the attack phase greatly depends on the amount the vocal folds are adducted and the way the air stream is released (Zemlin, 1998).

Presently, van den Berg's myoelastic aerodynamic theory is the most widely accepted theory of phonation (van den Berg, 1958). This aerodynamic theory suggests that the vocal fold vibration is activated by the air stream from the lungs. The term "myoelastic" explains the ways the muscles that are involved change their elasticity and tension to cause changes in the frequency of vibration (Border, Harris, &Raphael, 2003).

Air pressure beneath the vocal folds is referred to as subglottal pressure. This subglottal pressure begins to increase when the vocal folds are adducted and when this pressure is greater than the resistance of the adducted vocal folds, the vocal folds are blown apart. When the vocal folds are blown apart it results in air rushing through the glottis at an increased velocity and a decrease in the subglottal pressure will occur. After this happens the vocal folds come back together due to their elasticity and the Bernoulli effect (Border, Harris, & Rapheal, 2003; Boone & McFarence, 2000; Zemlin, 1998; van de Berg, Zantema, & Doornenbal, 1957).

The Bernoulli effect is defined as an increase in the velocity of air going through the vocal folds that creates a suction effect. When this occurs a negative pressure is developed between and below the vocal folds. This action will result in the vocal folds being "sucked" back together. A repetitive cycle of the vocal folds being "blown" apart and "sucked" back together is therefore produced (van de berg, 1958).

As expiration begins, the vibratory cycle of the vocal folds begins when the vocal folds are adducted. As the vocal folds are adducted, the subglottal pressure and the velocity air flow increases as it passes through the glottis, thus, resulting in the vocal folds being blown apart. The Bernoulli effect and the elasticity of the vocal folds occur and the folds are brought back together again (Border, Harris, & Raphael, 2003). This vibratory cycle occurs many times per second and is periodic (repeated pattern). In the phonation of an adult male, this cycle repeats itself approximately 125 times per second and for an adult female approximately 225 times per second (Boone & McFarlane, 2000).

Acoustic Measures of Voice

The acoustic measures of voice can provide objective and noninvasive information about vocal fold movement. The voice can be assessed by using a number of different acoustic measures. One acoustic measure often used is fundamental frequency (FO). The fundamental frequency is a measurement of the rate of vibration of the vocal folds per second and is measured in Hertz (Hz) or cycles per second (cycles/s). The fundamental frequency is perceived by humans as the pitch (Ferrand, 2001; Boone & McFarlane, 2000; Stemple, Colton & Casper, 1996;

Glaze, & Gerdeman, 1995; Case, 1984). In determining fundamental frequency there are many factors that play a role. These factors are the length, mass, and tension of the vocal folds. The relationship between the length of the vocal folds, mass of the vocal folds, and the fundamental frequency is an inverse relationship. The greater the length and mass of the vocal folds the lower the fundamental frequency. Shorter, thinner, and tense vocal folds produce a higher fundamental frequency. The reason for this is the additional length and mass results in the vocal folds vibrating at a slower rate (Border, Harris, & Raphael, 2003; Ferrand, 2001; Boone & McFarlane, 2000).

Other factors that play a role in determining fundamental frequency include age, gender, patterns of stress (syllable or word level), intonation (questions vs. statements), and the context of speech (Ferrand, 2001). Adult females usually have shorter and thinner vocal folds than adult males, which results in a higher fundamental frequency. Typically, adult females have a fundamental frequency between 180 to 250 Hz, while adult males have a fundamental frequency between 100 to 150 Hz (Ferrand, 2001; Boone & McFarlance, 2000; Deem & Miller, 2000; Colton & Casper, 1996).

A measure that is associated with the fundamental frequency is called vocal jitter. Jitter is a measurement of the variation in pitch from cycle to cycle and is expressed in percentages. This measurement is used to assess normal aspects of voice development over an individual's life. Another measurement that is often used to study the quality of voice is called vocal shimmer. Shimmer is a measurement of intensity variation from cycle to cycle and is expressed in percent or decibels (dB).

Humans usually interpret intensity as loudness (Ferrand, 2001; Deem & Miller, 2000; Colton & Casper, 1996; Stemple, Glaze, & Gerdeman, 1995).

There are many clinical uses of jitter and shimmer. Jitter and shimmer measurements can identify laryngeal pathologies, assess harshness or hoarseness, and can be used to supplement diagnostic information. Jitter and Shimmer can also reflect changes in the mucosa of the vocal folds, variations in muscle functions, and can be used to detect and monitor voice changes over the duration of therapy (Ferrand, 2001; Colton & Casper, 1996).

Voice Disorders

When the human voice changes in any way that is perceived to be negative, it is said to be disordered or dysphonic (Boone & McFarlane, 2000). A voice disorder is believed to exist when an individual's pitch, loudness, quality, or resonance is different from the normal range for the age, gender, cultural background, or geographic location (Deem & Miller, 2000; Boone & McFarlane, 2000).

Most prevalent and preventable types of voice disorders are vocal abuse and misuse (Health Management Technology, 1999). Vocal abuse is defined as any kind of behavior that strains or injures the vocal folds such as excessive talking, throat clearing, coughing, inhaling irritants, smoking, drug use, yelling, etc (Boone & Mcfarlane, 2000; Deem & Miller, 2000; Health Management Technology, 1999; Stemple, Glaze, & Gerdeman, 1995; Case, 1984). Voice misuse is defined as "improper voice usage such as speaking too loudly or at an abnormally low or high pitch" (Health Management Technology, 1999, p. 3).

Voice disorders can be divided into two categories: organic voice disorders and functional voice disorders. An organic voice disorder is one when there is some kind of physical abnormality in an individual's vocal mechanism. A functional voice disorder results from misuse of the vocal mechanism in ways of vibrating the vocal folds or by exposing the vocal folds to conditions that are harmful. Sometimes it is difficult to assign a voice disorder to one of these categories because a functional voice disorder may lead to an organic voice disorder or vice-versa (Boone & McFarlane, 2000). An example would be continuous misuses such as using a low pitch (functional voice disorder) that results in a structural change like contact ulcers (organic voice disorder) (Boone & McFarlane, 2000).

Many types of vocal abuse and misuse can lead to a voice disorder. Most common voice disorders include laryngitis, vocal nodules, vocal polyps, and contact ulcers. These voice disorders are a result of vocal abuse and misuse (Health Management Technology, 1999).

Laryngitis

Laryngitis, whether traumatic or functional, is an inflammation or swelling of the vocal folds. This voice disorder is caused by excessive and strained vocalization. It may also result from bacterial or viral infections, excessive use of alcohol, tobacco or drugs, inhaling chemicals, or gastroesophageal reflux, stomach acid backup into the throat (Boone & McFarlane, 2000; Health Management Technology, 1999; Colton & Casper, 1996; Stemple, Glaze, & Gerdeman, 1984). Appropriate treatment for functional laryngitis is to eliminate the cause which will allow the vocal mechanism to return to its normal state (Boone & McFarlane, 2000).

If excessive and strained vocalization continues to occur without adequate rest and recovery, chronic laryngitis may occur. In the case of chronic laryngitis, voice symptoms present will be more severe (Boone & McFarlane, 2000; Stemple, Glaze, & Gerdeman, 1984). An individual with laryngitis will display a raspy, breathy, and hoarse voice quality. The individual may also complain that his/her throat is dry (Boone & McFarlane, 2000; Health Management Technology, 1999; Colton & Casper, 1996).

Vocal Nodules

Vocal nodules are bilateral benign lesions which are located on the vocal folds. Vocal nodules are often described as whitish callous like lesions. These lesions manifest on the vocal fold areas that receives the most pressure when the vocal folds are approximated and vibrating (Shames & Anderson, 2002; Boone & McFarlane, 2000; Health Management Technology, 1999; Colton & Casper, 1996). Due to the damage by repeated pressure to the same area, "anterior and middle thirds of the vocal folds," nodules will eventually develop (Case, 1984, p. 100).

The major perceptual signs of vocal nodules are hoarseness, low pitch and breathiness. Vocal nodules add weight to the vocal folds which result in a slower vibrating rate, thus causing a voice to be low pitched. When nodules are present it is impossible for the vocal folds to have a smooth approximation which results in air escaping through the glottis and leading to breathiness. The degree to which the vocal characteristics are present is directly related to the size and firmness of the nodules (Boone & McFarlane, 2000; Health Management Technology, 1999; Colton & Casper, 1996). Some individuals may also complain of pain or soreness in their neck that may move upward to their ear or downward to the upper chest or may have a sensation of something in their throat (Boone & McFarlane, 2000).

Vocal Polyps

Vocal polyps are very similar to vocal nodules. Vocal polyps are small benign lesions that are found at the same location on the folds as vocal nodules. However, polyps are usually unilateral and are described as softer and have the appearance of a blood blister. A vocal polyp may be broad based and is closely adhered to the vocal fold (sessile) or be attached by a thin stalk (pedunculated). A vocal polyp is caused by a single traumatic incident to the vocal folds such as yelling at a hockey game or during gym time (Shames & Anderson, 2002; Boone & McFarlane, 2000; Health Management Technology, 1999; Colton & Casper, 1996). Polyps may go away if proper voice rest and positive changes in vocal habits are made. However, if the problem continues surgery may be necessary (Boone & McFarlane, 2000; Colton & Casper, 1996).

The major perceptual signs of a vocal polyp are hoarseness, roughness, and breathiness. In addition to these vocal qualities, vocal polyps may also produce diplophonia. Diplophonia results when two different fundamental frequencies are heard simultaneously. This is due to the vocal fold with the polyp and the normal vocal fold vibrating at different rates (Boone & McFarlane, 2000). The individual may also complain of a sensation of something in the throat and will thus be consistently clearing his/her throat, similar to the voices of individuals who have vocal nodules (Boone & McFarlane, 2000; Health Management Technology, 1999; Colton & Casper, 1996). A vocal polyp can also be linked to gastroesophageal reflux, chronic vocal misuse, long-term tobacco use, or hypothyroidism (Health Management Technology, 1999).

Contact Ulcers

Contact ulcers are less common than other forms of vocal abuse. Contact ulcers are painful sores that are located on the posterior third of the glottal margin (Shames & Anderson, 2002; Boone & McFarlane, 2000). These sores result from one of many causes or a combination of causes. Contact ulcers can be caused from excessive slamming of the vocal folds during low pitched speech. In other words, excessive force at very low frequencies involving the folds will result in sores or a wearing away of the tissue either on or surrounding the cartilages of the larynx. Gastroesphageal reflux is another cause of contact ulcers. Gastroesphageal reflux is when stomach acid enters the esophagus and irritates the vocal folds. Intubation can also cause contact ulcers if the anesthesia tube is too large for the size of the glottis or the tube has been in for a long period of time. Individuals with contact ulcers can experience pain in their throat. They may also complain about their voice tiring easily (vocal fatigue) after prolonged use and may demonstrate a low pitched, hoarse voice (Boone & McFarlane, 2000; Health Management Technology, 1999).

Vocal Abuse in Teachers

There have been a few studies investigating voice fatigue among teachers. Gotaas and Starr's (1993) studied twenty-two teachers who experience vocal fatigue and seventeen teachers who do not experience fatigue. Their study determined that teachers who experience voice fatigue tend to spend more time in vocally demanding activities and are more likely to perceive these situations as being anxiety producing.

Their overall finding revealed that teachers who fatigue tend to be in good health. These teachers who experience vocal fatigue also had more hearing problems and allergies than the other teachers and they reported that more family members have had voice problems (Gotaas & Starr, 1993).

Faulty use of the voice appears to be associated with vocal fatigue. Kostyk & Putnam (1998) studied nine female teachers with symptoms of vocal fatigue and seven female teachers without symptoms of vocal fatigue. Kostyk and Putnam used a non-invasive pressure flow technique to compare laryngeal airway resistances. Their findings suggest that teachers who experience fatigue and teachers who do not, react to vocal demands differently by using two different strategies to maintain laryngeal airway resistance. One strategy employed was laryngeal adjustments. Another strategy employed was laryngeal adjustments plus increased respiratory drive. However, laryngeal adjustment strategy used by teachers with vocal fatigue may be less efficient, thus, causing conditions associated with vocal fatigue (Kostyk & Putnam, 1998).

There have been a few studies that investigated voice problems in teachers. Smith, Gray, Dove, Kirchner, & Heras (1997) investigated the frequency and effects of teachers' voice problems. Their study involved examining and comparing teachers' to non-teachers' voice symptoms. Results from the study indicated that teachers were more likely to report voice problems (15% vs. 6%), specific voice symptoms, and symptoms of physical discomfort. Teachers when compared to non-teachers were more likely to perceive that a voice problem would affect their future career options, had already affected them in the past, and would limit their job performance. Over 20% of teachers, however, none of the non-teachers reported missing days of work due to voice problems (Smith, Gray, Dove, Kirchner, & Heras, 1997).

In 1998, Russel, Oates, and Greenwood investigated the prevalence of self reported voice problems in teachers. They mailed a survey to 1, 168 school teachers. Teachers were asked to report any voice problems on the day of the survey, during the current teaching year, and throughout their careers. Their results reveal that on the day of the survey, 16% of teachers reported voice problems, during the current teaching year, 20% of teachers reported voice problems, and during their careers 19% of teachers reported voice problems at some point in time. Russel et al also found that females were twice as likely to report a voice problem (Russel, Oates, & Greenwood, 1998).

Smith, Kirchner, Taylor, Hoffman, & Lemke (1998) studied voice problems among teachers, specifically differences in gender and teaching characteristics. They mailed a questionnaire out to participants. There were male (n=274) and female (280) who participated in the questionnaire. The study's results reveal that over 38% of the teachers complained that teaching had a negative impact on their voice and 39% of teachers had to cut back teaching activities as a result. The researchers also found that females when compared to males reported a voice problem more frequently; however, there were no gender differences in the perception of voice problems. Smith et al found that for all types of courses taught, females also had a higher probability of reporting voice problems when compared to males except in teaching physical education (Smith, Kirchner, Taylor, Hoffman, & Lemke, 1998).

In recent literature, there have been a few studies on the prevalence of voice disorders among teachers. In 2000, Simberg, Laine, Sala, & Ronnemaa investigated the prevalence of voice disorders among students who were going to be teachers. All subjects participated in a questionnaire about vocal symptoms and a perceptual assessment of voice quality was performed by a speech-language pathologist. Those who had abnormal voice quality or reported two or more vocal symptoms during the previous year were referred to laryngologist for a clinical examination. Results of the study revealed that during the previous year 20% of future teachers reported two or more vocal symptoms and 19% had an organic voice disorder.

Roy, Merrill, Thibeault, Parsa, Gray, & Smith (2004) investigated the prevalence of voice disorders in teachers and the general population. Using a voice disorder questionnaire, teachers (1,243) and non-teachers (1,288) were interviewed by phone. The study's results found that the prevalence of reporting a voice disorder was significantly higher in teachers (11%) than in non-teachers (6.2%), and the prevalence of reporting a voice disorder during one's lifetime was also significantly higher in teachers (57.7%) than in non-teachers (28.8%). Teachers as compared to non-teachers were more likely to consult with a physician or a speech-language pathologist concerning a voice disorder (14.3% vs. 5.5%).

In a later study, Roy and colleagues (Roy, Merrill, Thibeault, Gray, & Smith, 2004) investigated voice disorders in teachers and the general population, specifically exploring the effects on work performance, attendance, and future career choices. The results revealed that teachers as compared to non-teachers were significantly more likely to have experienced multiple voice signs and symptoms. These signs and symptoms included hoarseness, discomfort, increased effort while using their voice, tiring, or experiencing a change in voice quality after short use, difficulty projecting their voice, trouble speaking or singing softly, and a loss of their singing range.

Additionally, Roy and colleagues (Roy, Merrill, Thibeault, Gray, & Smith, 2004) found that teachers consistently blamed their voice signs and symptoms on their occupation. As a result, teachers were significantly more likely to suggest that their voice limited their ability to execute specific tasks during work, and that they had to reduced other activities and/or interactions. During the preceding year, teachers had also missed more days of work and were more likely to consider changing their careers and would adversely affect their career options due to their voice problems.

The purpose of this study was to examine the effects of vocal abuse in school teachers and teacher's aides pre and post one academic term. In the course of this study, the following research questions were investigated:

1. Was there a statistically significant difference in the acoustic measures of fundamental frequency, jitter, and shimmer in vocal quality of teachers and teacher's aides in the short term group pre and post term.
2. Was there a statistically significant difference in the acoustic measures of fundamental frequency, jitter, and shimmer in vocal quality of teachers and teacher's aides in the long term group pre and post term.

CHAPTER III

METHODOLOGY

Participants

The participants of the study included fifteen teachers and five teacher's aides from the Red Lake Madsen Public School and the Golden Learning Center in Red Lake, Ontario, Canada. Out of the 20 participants, seven teachers and three teacher's aides were randomly assigned to the daily term which was referred to as the short term group. In the short term group, all participants were female except one. The remainder of participants (eight teachers and two teacher's aides) were assigned to the academic term which was referred to as the long term group. In the long term group, all participants were female except one.

Participation Requirements

In order for teachers and teacher's aides to participate in this study, they had to work full time, pass a hearing screening, currently have no voice disorders, and were willing to participate. All participants passed the hearing screening and at the time of data collection no one had a voice disorder, therefore, nobody was excluded from the study.

Instrumentation

All testing procedures were administered in a spare quiet classroom at either the Red Lake Madsen Public School or the Golden Learning Center. At the time of testing, only the participant and the experimenter were present in the classroom. The experimenter screened all the participants' hearing using an audiometer (Maico, model MA27 series 103) and headphones (TDH-39 Eartone-3A), while following the American Speech-Language-Hearing Association (ASHA) standards for a hearing screening (ASHA, 1997). The hearing screening procedure confirmed that all participants had hearing within normal limits. All the participants were given a consent form regarding the purpose and procedures of the study (See Appendix C) and a participant questionnaire regarding the history of their voice (Modified from Brandel, 2002, see Appendix D) to be completed.

Voice recordings were produced by speaking into a lavalier microphone (audio-technica, model ATR35s) and the vowel productions were recorded in PRAAT (4.214) on a Lab-top computer (make Dell, model Inspiron I 8200). All voice recordings were saved using the computer software program Multi-Dimensional Voice Program (MDVP) (Multi-Dimensional Voice Program, model 5105). Recordings were saved on the hard drive on a computer in addition to floppy disks and compact disks as back-up.

Procedures

All the participants attended two testing sessions, and each testing session was approximately 10 minutes in length. For the short term group, the pre-testing was conducted prior to the beginning of the teaching day and the post-testing was administered at the end of the same teaching day. For the long term group, the pre-testing was conducted prior to the start of the school year and post-testing was administered at the end of one academic term.

Prior to testing, all the participants received a consent form (See Appendix C), which explained the purpose and procedures of the study and a participant questionnaire (See Appendix D), which addressed the history of their voice. They were asked to come to their appointments with both forms filled out. At that time, any additional questions the participants had were addressed. The questionnaire helped the experimenter identify any voice disorders that might have been present among participants, and if so, that participant was excluded from the study.

Hearing screenings were performed by the experimenter on each participant to determine if their hearing was within normal limits. Headphones used were connected to the audiometer. The headphones were placed on the participants' ears and tones were presented at 1000, 2000, and 4000 Hz at 20 dB to one ear at a time. Each participant was given instructions to follow during the hearing screening. Each participant was told that she/he will hear tones in an ear. Participants were then instructed to raise their hand when they heard the tone or believed they heard the tone and lower their hand once the tone stopped.

Prior to data collection, the participants read the Rainbow Passage (See Appendix E) out loud as a warm-up (Shipley & McFee, 1998). During the testing conditions, the participants produced three vocalizations of the vowels /a/ into the lavalier microphone while seated 10 cm away from the microphone. Each of the vowel productions lasted 5 seconds and was recorded on the computer. All vowel productions were saved on a computer. For back-up, all recordings were copied on floppy and compact disks. After data collection, acoustic measures of fundamental frequency, jitter, and shimmer were obtained by using the computer software program MDVP.

Method of Analysis

Results of the short and long term groups were compared using a paired samples *t*-test. The group of participants (teachers vs. teachers' aides) was the independent variable and the acoustic measures were the dependent variables. The study's results were considered significantly different if they were significant at a *p* value of 0.05. Two comparisons were made within the study. Comparisons were as follows:

1. Comparing the acoustic measures of short term group pre and post.
2. Comparing the acoustic measures of long term group pre and post.

CHAPTER IV

RESULTS

The purpose of the study was to investigate any changes in vocal quality of school teachers and teacher's aides over one day (short term) and one academic term, (long term). Initially, the short term group consisted of seven school teachers and three teacher's aides. The long term group consisted of eight school teachers and two teacher's aides. However, six participants (three from each group) were excluded from the study. Reasons for exclusion were: three participants' audio recordings could not be analyzed because of low intensity; two participants were not regular classroom teachers; one participant missed the end of the term appointment. In the end, the short term consisted of five school teachers and two teacher's aides. The long term group consisted of six school teachers and one teacher's aides. For both groups, short and long term, there were not enough teacher's aides that participated, therefore, their questionnaire and acoustic data were not analyzed.

All the participants in the study participated in a hearing screening, reading of a passage, and produced six vowel recordings (three each for the pre and post condition). In addition, all participants completed a consent form and a questionnaire regarding their history of voice, which determined if any participant(s) had a voice disorder.

Questionnaire Data Analysis

According to the questionnaire that was completed by the participants prior to examination, all participants described their voice as normal. There were 27% (3/11) of teachers who reported that their voices became hoarse at the end of the day. Half of the participants described their voice as hoarse after talking for extended periods of time and that their throat is usually dry when waking up in the morning. There were 73% (8/11) of teachers who reported that they use their voice for longer than 4 hours without rest. There was 100% (11/11) of teachers that stated that while they teach they talk the majority of the time. All eleven teachers also reported that they do not whisper while teaching. While teaching, nobody stated that they yell majority of the time.

All the participants (11/11) reported that they had no previous speech, language, or voice therapy in the past. There was only one teacher who reported a family history with voice difficulties. She reported that her sister, a music teacher, had vocal nodules 2 years ago and required intensive therapy as well as two months off from work. There were 55% (6/11) of teachers reported getting sore throats one time per week as well as one teacher reported getting sore throats a few times a year. There were 82% (9/11) of teachers stated that they participate in extra curricular activities such as coaching, choir, several committees, etc.

Acoustic Data Analysis

The participants' raw scores for all three acoustic measures are presented in Appendix F-H. For all three acoustic measures, descriptive statistics were obtained using the computer program SPSS 10.1 for Windows (2000). The descriptive statistics are shown in Tables 1-6 and Figures 1-6 for the short and long term group, pre and post. Table 1 displays the means, standard deviations, and standard errors of fundamental frequency for the short term group pre and post. Figure 1 shows boxplots of fundamental frequency (Hz) for the short term group pre and post. Table 2 displays the means, standard deviations, and standard errors of fundamental frequency for the long term group pre and post. Figure 2 shows boxplots of fundamental frequency for the long term group pre and post. Table 3 displays the means, standard deviations, and standard errors of Jitter for the short term group pre and post. Figure 3 shows boxplots of Jitter (%) for the short term group pre and post.

Table 4 displays the means, standard deviations, and standard errors of Jitter for the long term group pre and post. Figure 4 shows boxplots of Jitter (%) for the long term group pre and post. Table 5 displays the means, standard deviations, and standard errors of Shimmer for the short term group pre and post. Figure 5 shows boxplots of Shimmer (%) for the short term group pre and post. Table 6 displays the means, standard deviations, and standard errors of Shimmer for the long term group pre and post. Figure 6 shows boxplots of Shimmer (%) for long term group pre and post.

Table 1: The Means, Standard Deviations, and Standard Errors of Fundamental Frequency (F0) for the Short Term Group Pre and Post.

Acoustic Measure	Mean	Std. Deviation	Std. Error
F0 (Pre)	193.31	42.98	19.22
F0 (Post)	201.11	42.72	19.11

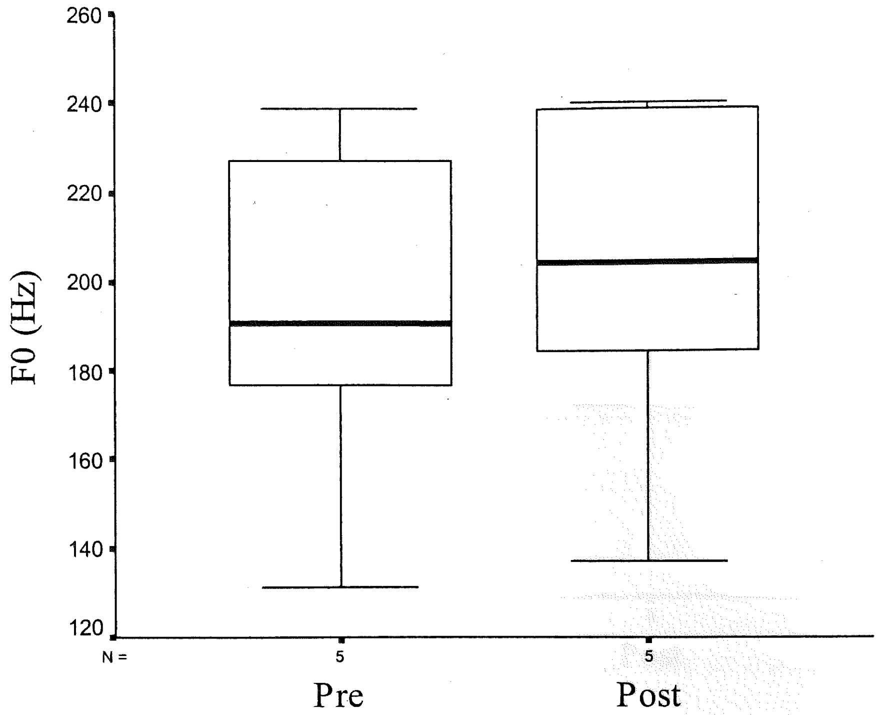

Figure 1: Boxplots of Fundamental Frequency (F0) Values for the Short Term Group.

Table 2: The Means, Standard Deviations, and Standard Errors of Fundamental Frequency (F0) for the Long Term Group Pre and Post.

Acoustic Measure	Mean	Std. Deviation	Std. Error
Fo (Pre)	202.55	66.60	27.19
Fo (Post)	217.71	61.93	25.28

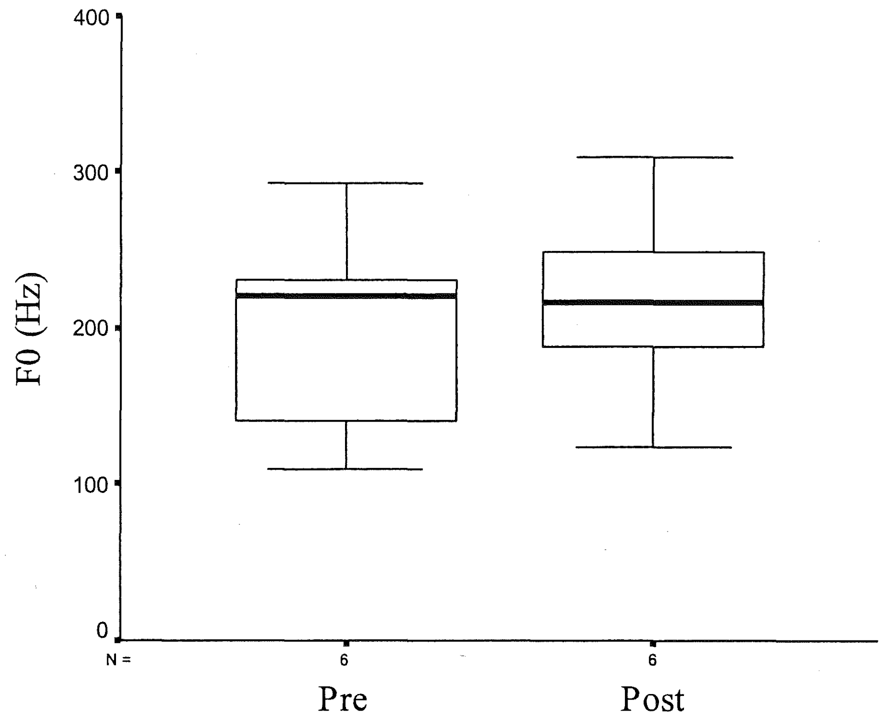

Figure 2: Boxplots of Fundamental Frequency (F0) Values for the Long Term Group.

Table 3: The Means, Standard Deviations, and Standard Errors of Jitter (Jitt) for the Short Term Group Pre and Post.

Acoustic Measure	Mean	Std. Deviation	Std. Error
Jitt (Pre)	0.97	1.28	0.57
Jitt (Post)	0.78	0.59	0.26

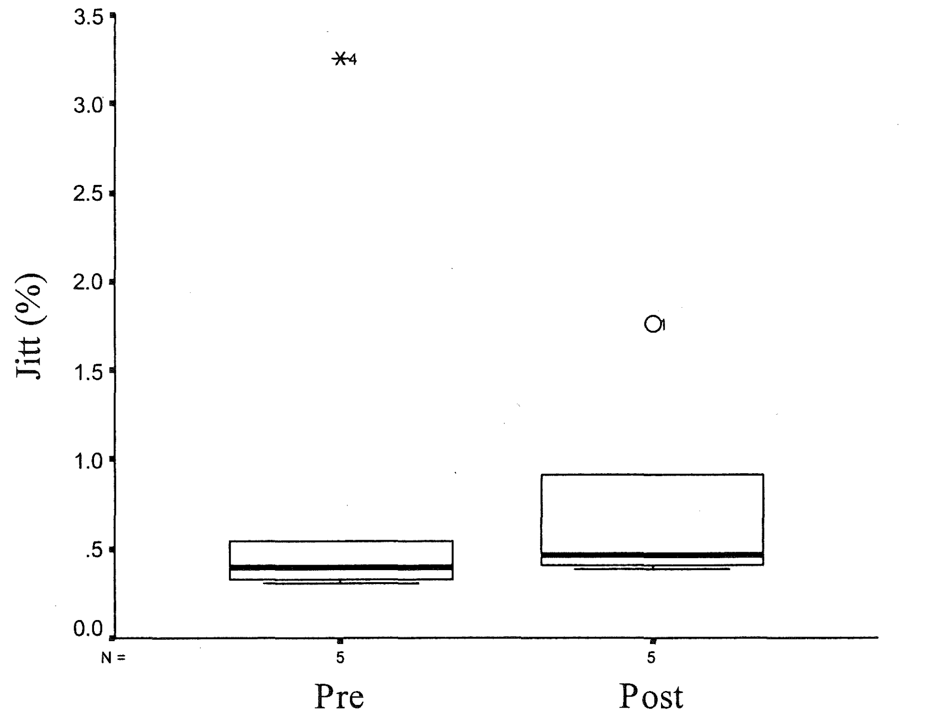

Figure 3: Boxplots of Jitter (Jitt) Values for the Short Term Group.
(*denotes an extreme value & O denotes an outlier)

Table 4: The Means, Standard Deviations, and Standard Errors of Jitter (Jitt) for the Long Term Group Pre and Post.

Acoustic Measure	Mean	Std. Deviation	Std. Error
Jitt (Pre)	0.87	0.39	0.16
Jitt (Post)	0.58	0.39	0.16

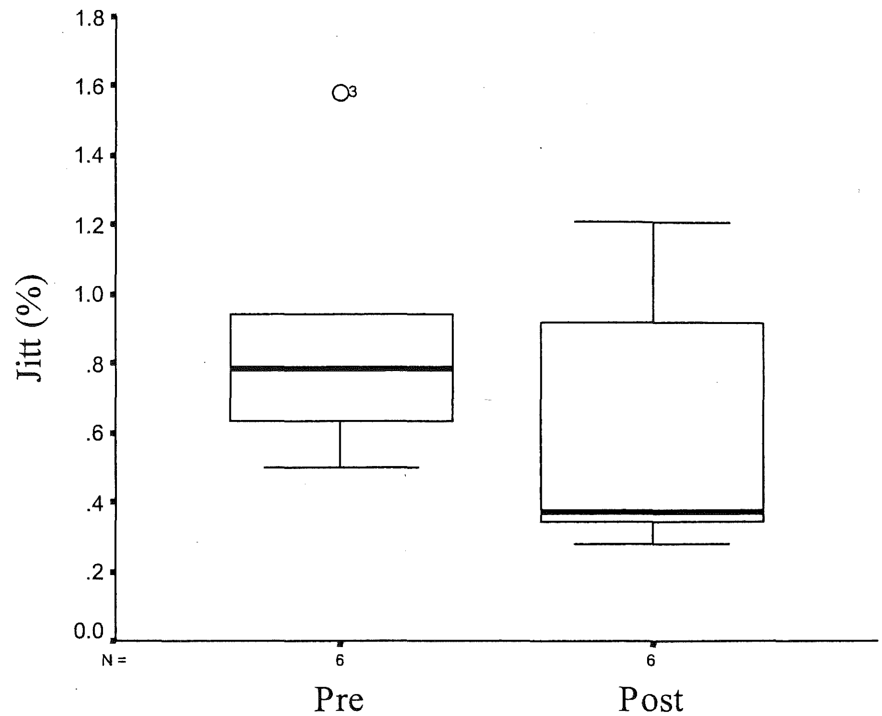

Figure 4: Boxplots of Jitter (Jitt) Values for Long Term Group.
(O denotes an outlier)

Table 5: The Means, Standard Deviations, and Standard Errors of Shimmer (Shim) for the Short Term Group Pre and Post.

Acoustic Measure	Mean	Std. Deviation	Std. Error
Shim (Pre)	3.04	1.85	0.83
Shim (Post)	2.94	1.47	0.66

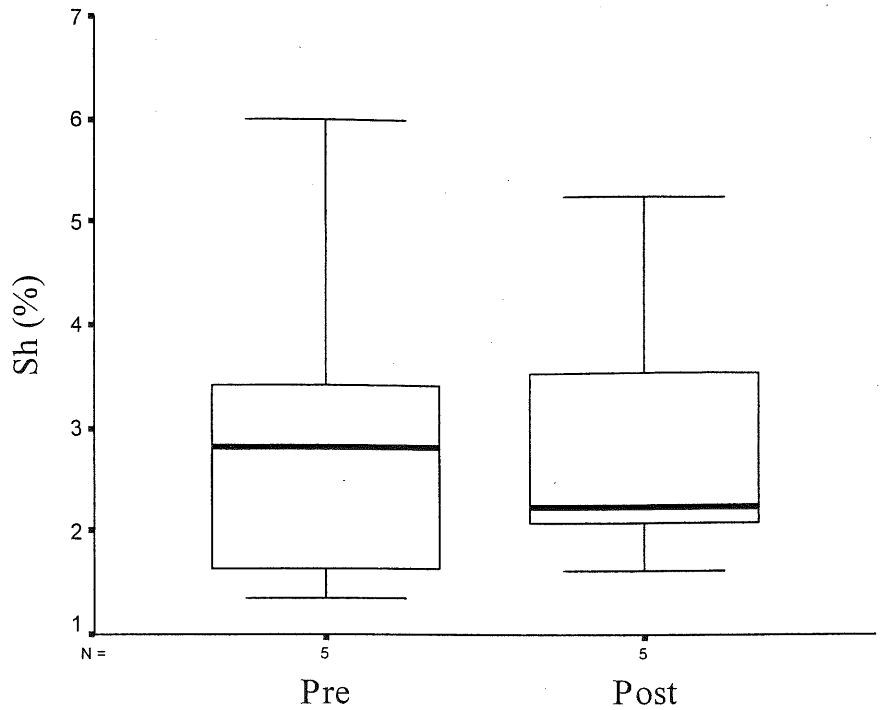

Figure 5: Boxplots of Shimmer (Shim) Values for the Short Term Group.

Table 6: The Means, Standard Deviations, and Standard Errors of Shimmer (Shim) for the Long Term Group Pre and Post.

Acoustic Measure	Mean	Std. Deviation	Std. Error
Shim (Pre)	3.27	0.81	0.33
Shim (Post)	3.26	1.40	0.57

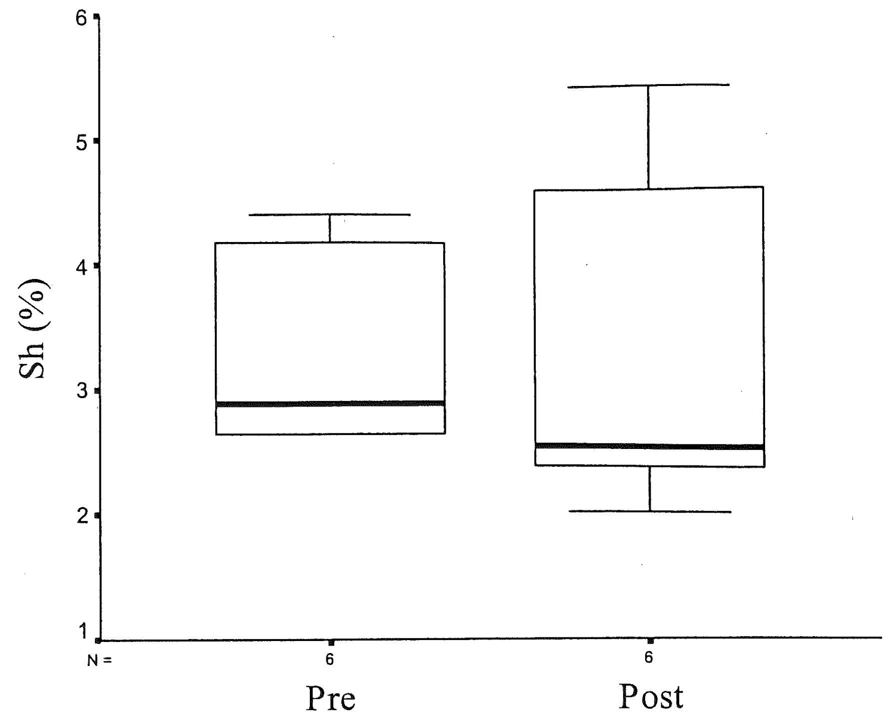

Figure 6: Boxplots of Shimmer (Shim) Values for the Long Term Group.

To analyze the pre and post results for fundamental frequency, jitter, and shimmer of the short term group and the long term group, a paired sample *t*-test was used. The inferential statistics was analyzed by using the computer program SPSS 10.1 for Windows (2000).

Short Term Group Data Analysis

A paired samples *t*-test ($p<.05$) was conducted to determine whether there was a statistically significant difference in the acoustic measures of fundamental frequency, jitter, and shimmer for the short term group pre and post. The only acoustic measure that was statistically significant was fundamental frequency (t=-3.524, p=0.024). Acoustic measures, jitter and shimmer were not significant. Table 7 displays the *t*-values and significant levels (two-tailed) for each of the three acoustic measures.

Table 7: *t*-values and Significance Levels (two-tailed) for the Short Term Group Pre and Post on the Three Acoustic Measures.

Acoustic Measures	*t*-value	Significance (two-tailed)
Fundamental Frequency	-3.524	0.024
Jitter	0.303	0.777
Shimmer	0.254	0.812

Long Term Group Data Analysis

A paired samples *t*-test ($p<.05$) was conducted to determine whether there was a statistically significant difference in the acoustic measures of fundamental frequency, jitter, and shimmer for the long term group pre and post. There were no statistically significant differences in any the acoustic measures in the long term group. Table 8 displays the *t*-values and the significance values (two-tailed) of the three acoustic measures.

Table 8: *t*-values and Significance Levels (two-tailed) for the Long Term Group Pre and Post on the Three Acoustic Measures.

Acoustic Measures	*t*-value	Significance (two-tailed)
Fundamental Frequency	-2.00	0.102
Jitter	1.12	0.314
Shimmer	0.030	0.978

CHAPTER V

DISCUSSION AND SUMMARY

The purpose of this study was to examine any changes in vocal quality of teachers and teacher's aides during one day (short term) and one academic term (long term). Participants were randomly assigned to the short term group or the long term group. In the short term group, there were five teachers and two teacher's aides participants. In the long term group, there were six teachers and one teacher's aide. For both the short and long term group, since there were not enough teacher's aides that participated, their data were not analyzed. Each participant's vocal quality was examined in two ways. One way was by subjectively administering a questionnaire and analyzing the responses from the participants. Second way was by objectively measuring fundamental frequency, jitter, and shimmer from their production of the vowel /a/.

For the short term group, results indicated that there was one statistically significant difference within the three acoustic measures. The acoustic measure that was statistically significant was fundamental frequency (t =-3.524, p=0.024) when comparing the pre and post testing sessions. In this group, there was one male participant. When reanalyzing the data without the male's participant scores, the acoustic measure of fundamental frequency was not statistically significant (t=-2.978, p= 0.059). Therefore, the statistically significant difference was attributed to gender differences. For the long term group, results did not reveal any statistically significant differences in any of the acoustic measures.

Three reasons may be suggested as to why statistically significant differences might have not been observed in the acoustic measures in the short and long term group. One reason could be that there was adequate amount of time between testing sessions to allow the vocal folds of the participants to rest and/or recover from any possible abuse and/or misuse. Another reason could be that the duration from the beginning of one academic term to its end, may have allowed participants adequate opportunity to adjust to the high demands of their occupation. Yet another reason could be that the acoustic measures used in this study were not able to capture or quantify the subjective experiences of hoarseness by the participants. In the participant questionnaire, 27% of teachers reported that their voice becomes hoarse at the end of the day. Half of the teachers described their voice as hoarse after talking for extended periods of time and that their throat is usually dry when waking up in the morning. In the presence of such a disparity between the objective and subjective evaluation of voice, perhaps, a subjective evaluation procedure such as The Buffalo III Voice Profile System (Wilson, D. K., 1987) should be considered along with other acoustic measures such as soft phonation index, etc., which may capture the actual changes these teachers are experiencing.

Future studies would benefit by examining differences in gender, grades levels taught, and years of experience of participants as well as to increase the number of participants. Further research could attempt to test and analyze teachers' vocal quality before and after a lesson. In which case, the participant would not have any time to allow their vocal folds to rest or heal from any abuse and the results may identify the presence of actual vocal abuse, if any.

APPENDICES

APPENDIX A

EXTRINSIC MUSCLES OF THE LARYNX

Table 1: Extrinsic Muscles of the Larynx

Suprahyoid Muscles

- Stylohyoid Muscle
    - Origin: styloid process of the temporal bone
    - Insertion: body of the hyoid bone
    - Function: elevates the hyoid bone posteriorly
    - Innervation: cranial nerve X (vagus)
- Mylohyoid Muscle
    - Origin: mandible
    - Insertion: hyoid bone
    - Function: elevates the hyoid bone anteriorly and upward
    - Innervation: cranial nerve X (vagus)
- Geniohyoid Muscle
    - Origin: mandible
    - Insertion: anterior surface of the corpus of the hyoid
    - Function: draws the hyoid bone anteriorly and slightly upward
    - Innervation: cranial nerve X (vagus)
- Digastric Muscle [consists of anterior belly (A) and a posterior belly (P)]
    - Origin A: lower border of the mandible
      P: mastoid process
    - Insertion A: hyoid bone
      P: hyoid bone
    - Function A: pulls the hyoid bone anteriorly and upward
      P: pulls the hyoid bone posteriory and upward
    - Innervation: cranial nerve X (vagus)

Infrahyoid Muscles

- Thyrohyoid Muscle
    - Origin: thyroid
    - Insertion: border of the greater horn of the hyoid bone
    - Function: approximates the thyoid cartilage and the hyoid bone
    - Innervation: cranial nerve X (vagus)
- Sternothyroid Muscle
    - Origin: sternum
    - Insertion: thyroid
    - Function: lowers the thyroid cartilage
    - Innervation: cranial nerve X (vagus)
- Sternohyoid Muscle
    - Origin: sternum
    - Insertion: hyoid bone
    - Function: lowers the hyoid bone
    - Innervation: cranial nerve X (vagus)

Omohyoid Muscle

Origin: scapula
Insertion: hyoid
Function: lowers the hyoid bone
Innervation: cranial nerve X (vagus)

(Ferrand, 2001; Deem & Miller, 2000; Colton & Casper, 1996; Stemple, Glaze, & Gerdeman, 1995)

APPENDIX B

INTRINSIC MUSCLES OF THE LARYNX

Table 2: Intrinsic Muscles of the Larynx

- Cricothyroid (Tensor)
  - Origin: cricoid
  - Insertion: thyroid
  - Function: decreases the distance between the thyroid and the cricoid, which in turn increases the length the of the vocal folds
  - Innervation: cranial nerve X (vagus)
- Thyroarytenoid (Adductor, Tensor, or Relaxer)
  - Origin: posterior surface of the thyroid
  - Insertion: arytenoids
  - Function: decreases the distance between the thyroid and arytenoids, which in turn decrease the length of the vocal folds
  - Innervation:
- Lateral Cricoarytenoids (Adductor, Relaxer)
  - Origin: upper border of the cricoid
  - Insertion: arytenoids
  - Function: adducts the arytenoids, which in turn results in the closing of the glottis
  - Innervation: cranial nerve X (vagus)
- Posterior Cricoarytenoids (Abductor)
  - Origin: posterior lamina of the cricoid
  - Insertion: arytenoids
  - Function: abducts the arytenoids, which in turn opens the glottis
  - Innervation: cranial nerve X (vagus)
- Arytenoids (Adductors)
  - Origin: base of one of the arytenoids
  - Insertion: apex of the opposite arytenoid
  - Function: adducts the arytenoids
  - Innervation: cranial nerve X (vagus)

(Ferrand, 2001; Deem & Miller, 2000; Colton & Casper, 1996; Stemple, Glaze, & Gerdeman, 1995)

APPENDIX C

CONSENT FORM

Title: The evaluation of vocal abuse in school teachers' pre and post academic term.

INTRODUCTION
You have been asked to participate in a research study being conducted by Jodi Franczak. Ms. Franczak, the principal investigator, is a second year graduate student in the department of Communication Sciences and Disorders.

PURPOSE AND DURATION
This study will evaluate the effects of vocal abuse in school teachers' pre and post academic term. The total duration of the study will be approximately two hours.

PROCEDURES
If you choose to volunteer for this study you will complete a pre and post academic term survey, provide a voice recording of three vowels and read a short passage. The voice samples will be analyzed and examined for the study. The samples will also inform the investigator of the characteristics of the voice that may change over the period of an academic term. You will also receive a standard clinical hearing screening at both testing sessions. All the testing will be done in Elementary Public Schools in Red Lake, Ontario. There will be rest periods provided between each vocal production or when needed.

BENEFITS
By participating in this study you will be supporting the University of North Dakota researchers as well as others to understand the effects of vocal abuse on the voice. This knowledge may assist in the prevention and management of voice disorders in teachers and benefit in the study of voice use and misuse. You will also benefit in receiving a free hearing screening as well as information about the status of your voice.

RISKS AND DISCOMFORTS
Although it is impossible to predict all potential risks or discomforts that the volunteer participants may experience in a research study, the investigator anticipates no major risks or discomforts will occur during this project. Participants will not be exposed to any harmful noise levels and rest periods will be taken as needed.

CONFIDENTIALITY
All records pertinent to this study will remain confidential. Participants' names will be alphanumerically coded to conceal identification for all scientific presentations, publications, or educational uses. Data and forms that are collected will be stored

Participant's Initials: _____ Page 1 of 2 separately in a locked cabinet in room 108 Montgomery Hall. The principal investigator, student advisor, and those who audit UND IRB procedures will have sole access to the data. Data will be kept for three years and after that time, will be destroyed by shredding.

COMPENSATION / MEDICAL TREATMENT
There are no physical risks involved in this study.

PERSONS TO CONTACT WITH QUESTIONS
The investigator will be available to answer any questions concerning this study. You may contact Jodi Franczak by calling 701-777-3232 or 701-746-6456 or by Email: jfranczak9@yahoo.com. You may also contact Dr. Manish Rami, 108 Montgomery Hall, University of North Dakota, 701-777-3724, or the Institutional Review Board, ORPD, Twamley Hall, Room 105, Grand Forks, ND 58202-7134, University of North Dakota, 701-777-4278 for any other concerns.

VOLUNTARY PARTICIPATION
You understand that the participation in this study is voluntary, and refusing to participate will not penalize you in any way. You may also decide to end your participation at any time throughout the study without penalizing you in any way. There will be no costs for participating in this research study. You may choose to receive a copy of the consent form as well as the findings at any time.

CONSENT TO PARTICIPATE
I certify that I have read all of the above, asked questions, and received answers relating to my areas of concerns. I willingly give my consent for participation in this research study.

Participant's Name (print): ____

Participant's Signature: ______________________________ Date: ____________

APPENDIX D

Participant Questionnaire
(Modified from Brandel, 2002)

Instructions: Please fill in the complete survey by either circling the appropriate responses or by writing in a response. Please answer the questions as they pertain to you at the present time. If you have any questions please ask the experimenter.

Date: ____________________

Date of birth (mm/dd/yy): ___________________

Gender: Male / Female

Please circle the correct response and provide details when appropriate:

1. I would describe my voice as **normal / hoarse**.
2. When I wake up in the morning, my voice is usually **normal / hoarse**.
3. At the end of the day, my voice remains **normal / becomes hoarse**.
4. After talking for extended periods of time, my voice is **normal / hoarse**.

Please answer yes or no to the following questions and provide additional details when appropriate.

1. When I wake up in the morning, my throat is usually dry. Yes / No

2. Throughout the day, I use my voice for longer than 4 hours without rest. Yes / No

3. While teaching, I am often talking the majority of time. Yes / No

4. While teaching, I am often whispering the majority of time. Yes / No

5. While teaching, I am often yelling the majority of the time. Yes / No

6. I have had speech, language or voice therapy in the past. Yes / No
   If yes, please explain in detail (what, where, when, & length of therapy).

7. There is a history of speech, language or voice difficulties in my family. Yes / No
   If yes, please explain in detail (parent, siblings, cousin, etc.).

8. I have had vocal nodules in the past. Yes / No
   If yes, when, what size, and diagnosed by whom.

   Also, my treatment was (vocal rest, medication, surgery, etc.

9. I get sore throats _______ times a week.

10. I use tobacco products (cigarettes, chewing tobacco) ________ times per day.
    (ie: frequency of smoking or chewing per week)

11. Do you participate in any extra curricular activities? Yes / No
    If yes, which activities are you involved in (ie: coaching) and how many times a week.

APPENDIX E

"THE RAINBOW PASSAGE"

(Shipley & McAfee, 1998, p. 124)

When the sunlight strikes raindrops in the air they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but on one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow.

APPENDIX F

RAW SCORES TABLE

Raw Scores of Acoustic Measure Fundamental Frequency (F0) for Pre and Post Short Term (ST) and Long Term (LT)

Subjects	F0 1(Pre)	F0 2(Pre)	F0 3(Pre)	F0 1(Post)	F0 2(Post)	F0 3(Post)
ST-1*	175.49	178.62	177.09	175.34	186.9	192
ST-4	220.87	222.95	239.23	235.12	236.02	245.8
ST-5	237.13	239.65	241.04	241.74	238.16	240.16
ST-6	190.56	186.48	196.13	198.89	203.67	211.06
ST-7	138.58	121.82	133.98	123.5	144.73	143.63
ST-8*	234.4	239.52	241.7	213.61	212.02	215.65
ST-10	211.57	236.76	233.42	215.5	228.76	214.5
LT-1	139.31	143.65	140.21	187.56	185.73	191.93
LT-2	231.24	256.34	207.11	240.81	247.06	259.96
LT-3*	110.11	108.25	109.15	124.46	122.58	125.93
LT-5	220.35	224.52	235.09	229.52	219.14	223.67
LT-6	268.08	293.57	316.23	291.77	295.39	342.61
LT-7*	213.57	210.87	218.34	219.33	198.29	213.06
LT-10	154.45	166.13	150.41	186.08	177.45	205.66

Short Term
*Subjects 2 & 3 audio recordings could not be analyzed because of low intensity.
*Subject 9 not included in the analysis since she was not a regular classroom teacher.
Long Term
*Subject 4 audio recordings could not be analyzed because of low intensity.
*Subject 8 not included in the analysis since she was not a regular classroom teacher.
*Subject 9 not included in the analysis because the individual missed the end of the term appointment.

APPENDIX G

RAW SCORES TABLE

Raw Scores of Acoustic Measure Jitter (Jitt) for Pre and Post Short Term (ST) and Long Term (LT)

Subjects	Jitt 1(Pre)	Jitt 2(Pre)	Jitt 3(Pre)	Jitt 1(Post)	Jitt 2(Post)	Jitt 3(Post)
ST-1*	0.4	0.38	0.41	0.74	0.39	0.63
ST-4	0.5	0.52	0.59	0.32	0.45	0.45
ST-5	0.41	0.33	0.24	0.38	0.39	0.37
ST-6	3.66	2.89	3.21	1.36	0.9	0.47
ST-7	0.31	0.34	0.28	0.49	0.45	0.45
ST-8*	0.48	0.55	0.36	0.68	0.34	0.3
ST-10	0.4	0.34	0.54	0.35	0.39	0.37
LT-1	0.5	0.43	0.58	0.83	0.64	2.17
LT-2	0.59	0.62	0.69	0.27	0.27	0.29
LT-3*	1.32	2.22	1.21	0.32	0.38	0.47
LT-5	0.71	0.54	0.68	0.35	0.31	0.38
LT-6	0.33	2.03	0.47	0.39	0.32	0.32
LT-7*	0.94	1.09	0.77	0.98	0.75	1.04
LT-10	0.57	0.3	0.48	0.25	0.56	0.18

Short Term
*Subjects 2 & 3 audio recordings could not be analyzed because of low intensity.
*Subject 9 not included in the analysis since she was not a regular classroom teacher.
Long Term
*Subject 4 audio recordings could not be analyzed because of low intensity.
*Subject 8 not included in the analysis since she was not a regular classroom teacher.
*Subject 9 not included in the analysis because the individual missed the end of the term appointment.

APPENDIX H

RAW SCORES TABLE

Raw Scores of Acoustic Measure Shimmer (Sh) for Pre and Post Short Term (ST) and Long Term (LT)

Subjects	Sh 1(Pre)	Sh 2(Pre)	Sh 3(Pre)	Sh 1(Post)	Sh 2(Post)	Sh 3(Post)
ST-1*	3.34	3.67	3.26	4.78	2.67	3.15
ST-4	2.42	3.53	2.49	1.69	1.63	1.52
ST-5	1.29	1.36	1.4	1.87	2.51	2.33
ST-6	6.85	5.45	5.68	6.16	5.06	4.5
ST-7	1.61	1.8	1.49	2.07	2.24	1.97
ST-8*	2.93	2.97	2.97	3.48	2.79	3.82
ST-10	2.12	1.49	2.46	1.83	1.69	2.02
LT-1	2.9	3.42	3.03	3.2	3.36	5.86
LT-2	2.54	2.61	2.79	2.04	2.62	2.5
LT-3*	4.18	4.29	4.05	2.62	2.8	2.49
LT-5	2.15	3.03	2.77	2.14	1.89	2.04
LT-6	2.29	3.69	1.94	2.98	2.34	2.08
LT-7*	3.67	5.62	3.94	8.06	3.86	4.36
LT-10	2.8	2.14	2.79	2.05	2.23	1.62

Short Term
*Subjects 2 & 3 audio recordings could not be analyzed because of low intensity.
*Subject 9 not included in the analysis since she was not a regular classroom teacher.
Long Term
*Subject 4 audio recordings could not be analyzed because of low intensity.
*Subject 8 not included in the analysis since she was not a regular classroom teacher.
*Subject 9 not included in the analysis because the individual missed the end of the term appointment.

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