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THE FEMALE SINGING VOICE: PERCEIVED CHANGES DURING THE
MENSTRUAL CYCLE

by Shirley Guerreiro

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Master of Music Education in
The Department of Music, Theatre, and Dance
The Faculty of Arts and Sciences
Rhode Island College

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ABSTRACT

THE FEMALE SINGING VOICE: PERCEIVED CHANGES DURING THE MENSTRUAL CYCLE

By

Shirley Guerreiro

Most recent studies and literature show that there is some evidence of possible vocal change that is associated with the menstrual cycle.

The purpose of this research was to examine factors that may affect women's voices. The problem of this study was to examine if there is a change in vocal quality occurring in the female singing voice during the premenstrual phase of the menstrual cycle.

Journals and questionnaires of premenstrual vocal and physiological symptoms of seven female voice students, aged 18 to 35, were used during two menstrual cycles to examine the relationship between the female singing voice and premenstrual vocal symptoms throughout the menstrual cycle. Teacher journals for each participant were also used to see if further relationships could be found. The median score for various variables in the study were calculated to produce graphs for visual comparison looking for relationships between days of the menstrual cycle, physiological symptoms, and vocal symptoms.

The results of this study showed that there was no change to the female singing voice within the menstrual cycle.

ACKNOWLEDGEMENTS

There is a Chinese proverb that quotes, “A journey of a thousand miles begins with one small step.” As I look upon the completion of this project, I think about how a year ago I sat in front of this same laptop wondering which direction to take. This project has certainly been a journey for me in which I have developed a deeper appreciation for research and have become a more critical reader and writer. This journey would not have been possible if were not for the support of my family, friends, and colleagues along the way. I would like to thank my friend and colleague Tara Thomas for the inspiration for this project. It was her initial inquiries into this topic that led me into this research. My appreciation also goes to my voice teacher colleagues who gave up some of their lesson time to help with this study. Thank you also to all the voice students for participating in my study. This study would not have been possible without you. A special thanks goes to Dr. Edward Markward and Dr. Robert Franzblau for their advice and insight with this document. An even more special thanks goes to Dr. Denise Guilbault, my academic advisor. Thank you for your enthusiasm for research; it is truly an inspiration to me. Thank you for your expertise, guidance and patience with me and for all the questions, comments, and advice that has made me realize that research is never truly done, it just keeps evolving. Finally, I thank my parents and friends for their understanding and support as I have been in stealth mode for the past year. Thank you for inspiring me and uplifting my spirits along the way.

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CHAPTER ONE

RESEARCH BACKGROUND

Introduction

The human voice is different from other instruments. It cannot be put away in a case, cleaned, or tuned. Various parts of the body may affect singing. The vocal folds are but a small part of a larger mechanism that works around the clock and is influenced and affected by its internal and external environment (Gates, 2002). The human vocal tract is part of the respiratory system which is divided into two parts: upper and lower (see Figure 1). The lower part is made up of the trachea, the bronchi and the lungs. The upper part is made up of two nasal cavities, the nasopharynx, oral cavity, oropharynx, laryngopharynx, and pharynx (Crelin, 1987). The vocal apparatus operates in an intricate way that involves physical forces and includes two different systems: the breathing apparatus and the vibratory apparatus. The flow of air is supplied by the lungs, driven through the bronchi to the trachea terminating in the vibratory system. The vibratory system contains the pharynx, mouth, and nose. The energy needed for sound is produced by variations in air pressure through the use of muscular action which utilizes the ribcage, intercostal, diaphragm, and abdominal muscles. These are the main muscles responsible for breathing. During inhalation the lungs expand which makes the intercostals and the diaphragm contract making the abdominal wall move outward. During exhalation the diaphragm gets pulled upward as the abdominal wall moves inward expelling the air. The

process by which singers control their breathing is called diaphragmatic breathing (La, 2004).

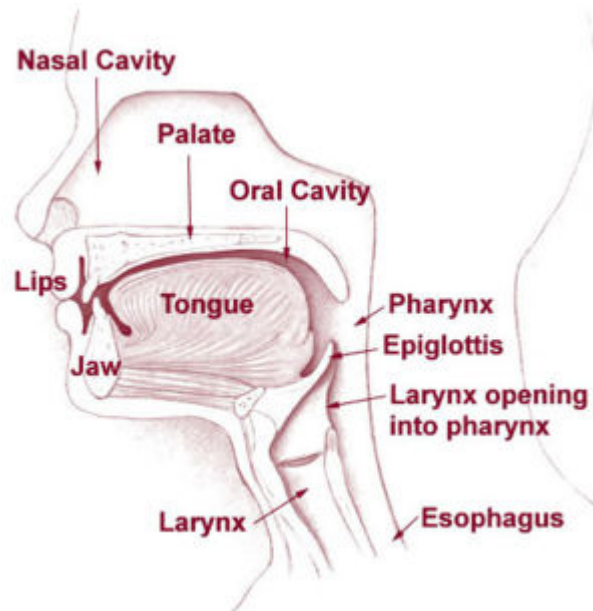


Figure 1. The human head and neck (internal). Adapted from http://en.wikipedia.org/w/index.php?title=Vocal_apparatus&oldid=342197602.

The vibratory apparatus is the set of structures that vibrate during phonation. The air passing through the vocal folds causes them to come together and vibrate producing a buzzing sound, which is then modified by the resonating chambers: pharynx, mouth, and nose, amplifying certain frequencies and turning the buzzing sound produced by the vocal folds into a pleasant, projected and rich singing sound. A tissue that is full of mucous glands which maintains moisture covers the vocal folds. This tissue is sensitive to infections and diseases such as upper respiratory infections, the flu, irritant substances, stressful emotional states, and hormonal variations such as those that occur during the menstrual cycle (La, 2004).

The singer's instrument is comprised of her entire body and mind, and premenstrual symptoms that affect the body may have adverse effects on a singer's vocal performance (Davis & Davis, 1993). The vocal folds are sensitive to its internal and external environment, (Gates, 2002) and the human voice is extremely sensitive to hormonal changes (Sataloff, 1993). Some examples of hormonal changes are those that occur before and after the menstrual cycle (Emerich, 2000). A hormonal change, such as the drop in estrogen which occurs during the menstrual cycle, may cause changes in the vocal folds, such as fluid build-up beneath the mucous tissue covering the vocal folds thus affecting its vibratory characteristics (Chernobelsky, 1998).

The menstrual cycle is a naturally occurring event resulting from hormonal changes in the female body. Most women of child bearing age experience menstruation approximately every 28 days. A woman's first menstruation usually occurs on average at the age of 12. The end of a woman's reproductive cycle is called menopause, normally occurring between the ages of 45 and 55. The menstrual cycle is commonly divided into three phases: the follicular phase, ovulation, and the luteal phase. The length of the menstrual cycle varies from woman to woman, but the average cycle is 28 days. Menstrual cycles are counted from the first day of menstrual bleeding or menses. The flow of menses can last anywhere from two to seven days (Menstrual Cycle, 2010).

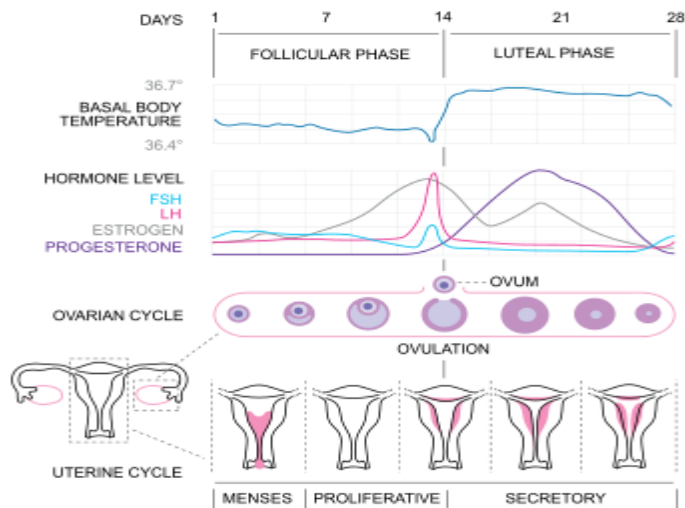


Figure 2. Illustration of the menstrual cycle. Adapted from http://en.wikipedia.org/w/index.php?title=Menstrual_cycle&oldid=351462009.

Premenstrual symptoms may occur specifically during the luteal phase of the menstrual cycle (Asso, 1983; Ismail, KM.K. & S. O'Brien, 2005). Premenstrual symptoms are most severe during the interval that begins on approximately day twenty-four of the menstrual cycle prior to the onset of menstruation and ends on day four of the menstrual period (Davis & Davis, 1993). Ninety-five percent of women have regular premenstrual symptoms. Five percent of women suffer from severe premenstrual syndrome (PMS), also known as premenstrual dysphoric disorder (PMDD), which can range from mild symptoms to severely debilitating ones (Ismail & O'Brien, 2001). Ismail & O'Brien (2005) suggest that in most menstrual cycles five or more symptoms are present: 1) Markedly depressed mood, feelings of hopelessness, or self-depreciatory thoughts, 2) Marked anxiety, tension, feeling of being "on edge," 3) Marked affective lability (feeling suddenly sad or tearful with increased sensitivity to rejection), 4) Persistent and marked anger or irritability, 5) subjective sense in difficulty concentrating,

6) decreased interest in usual activities (work, school, friends, hobbies), 7) lethargy, easy fatigueability, or marked lack of energy, 8) marked change in appetite, overeating, or specific food cravings, 9) hypersomnia or insomnia, 10) a sense of being overwhelmed or out of control, 11) other physical symptoms, such as breast tenderness or swelling, headaches, joint or muscle pain, a sensation of 'bloating' or weight gain. In most menstrual cycles at least symptoms one, two, three, or four are present.

Some premenstrual symptoms can also affect the vocal folds. Chae, Choi, Kang, Choi, & Jin (2001) found that participants with PMS were more prone to voice changes in the premenstrual phase and that the presence of PMS is an important contributing factor of change in the woman's voice. During the luteal phase of the menstrual cycle, the changes in hormonal levels of estrogen and progesterone may lead to fluid retention or edema of the vocal fold tissue. This swelling changes the mass of the vocal folds, thus changing the nature of their vibration. The voice quality may be slightly breathy or hoarse, the singer may feel that singing requires more effort. As a result, the singer may experience fatigue and therefore begin to engage muscles in the head, neck, throat, jaw, or tongue-base to help compensate; however, this behavior can lead to injury to the vocal tissue in which case the singer might experience a sudden voice change, usually hoarseness or laryngitis (Emerich, 2000). In some European opera houses, singers are offered grace days in which they are excused from singing during the premenstrual and early menstrual days. This practice is not followed in the United States (Sataloff, 1993). The physiological effects of the menstrual cycle on the voice has been studied for over 40 years, yet Gackle (1991) states that although there is no conclusive research that links

female voice change to menstruation, the beginning of the menstrual cycle and the lowering of pitch in the female voice seems to be simultaneous. The menstrual cycle may produce transient changes in the coordination of the voice during singing including loss of high tones and uncertainty of pitch (Brodnitz, 1971). Ryan and Kenny's (2009) findings supported the hypothesis that the voice may be affected by the menstrual cycle and its inherent physiological changes. However, not all women experience the same symptoms all the time. Chernobelsky (1998) suggests that because the muscular tension in the larynx decreases during the premenstrual and menstrual period, the singer requires extra effort for vocal function which may be a reason for beginning vocal disorders. This is why professional singers should be informed about the condition of the laryngeal muscular tension during the menstrual cycle.

Summary

Gates (2002) suggests the human voice is an instrument sensitive to change both in its internal and external environments. The vocal apparatus involves two different systems: the breathing apparatus and the vibratory apparatus. The vocal folds are found in the vibratory apparatus. A tissue that is full of mucous glands maintaining moisture all the time covers the vocal folds. This tissue is sensitive to infections, diseases and hormonal variations such as those that occur during the menstrual cycle (La, 2004). The menstrual cycle is a naturally occurring event resulting from hormonal changes in the female body. Premenstrual symptoms (PMS) may occur in some women specifically

in the luteal phase of the menstrual cycle and resolve by the end of menstruation. Chae, Choi, Kang, Choi & Jin (2001) found that participants with PMS were more prone to voice changes in the premenstrual phase, possibly an important contributing factor of change in the woman's voice. These changes affect the quality of the singing voice, and the singer may feel that singing requires more effort. As a result, the singer may experience fatigue and begin to use muscles in the neck, head, throat, jaw, or tongue-base to overcompensate, leading to vocal injury (Emerich, 2000).

The Focus of this Research

Most recent studies and literature show that there is some evidence of possible vocal change that is associated with the menstrual cycle (Amir, Biron-Shental & Shabtai, 2006; Bonnette, 2007; Chernobelsky, 1998; Davis & Davis, 1993; De Figueiredo, et al., 2004; Hoover, 1991; Lã, 2004; Meurer, et al., 2009; Pipitone & Gallup, 2008; Ryan & Kenny, 2009). Even slight changes are problematic for the professional singer or voice teacher. Some researchers dismiss these findings as psychological (Hoover, C. A., 1991), but when commonalities exist between female singers why is this phenomenon so difficult to explain or measure?

The purpose of this research is to examine factors that affect the female voice.

The problem of this study is to examine the following:

Is there a change in vocal quality occurring in the female singing voice during the premenstrual phase of the menstrual cycle?

This study will examine the changes that happen to several women within two menstrual cycles and see if commonalities of symptoms exist between women and where those commonalities occur within the menstrual cycle. The median score of the participants' ratings of the severity of premenstrual symptoms will be used to determine if commonalities exist within those women to see if specific vocal symptoms affect vocal quality on specific days and if similar results can be observed in a consecutive menstrual cycle. Median scores will also be used to determine if the participant's voice teacher could also observe a change in the voice quality during the participant's weekly lesson and if those results would be similar throughout two consecutive menstrual cycles. This information could then be shared with colleagues in the educational field so that more research can be done and so that educators may know more about factors that may affect the voice during the premenstrual period.

Need for the Study

From an educational perspective, it is important to understand the voice as an instrument. Educators need to know more about changes such as decreased vocal efficiency, loss of the highest notes in the voice, vocal fatigue, slight hoarseness, and some muffling of the voice. Understanding these changes is important so that teachers can teach female voice students more effectively. Vocal teachers may seek to understand how certain days of the menstrual cycle may or may not limit the female singing voice within the menstrual cycle. Knowledge of how these changes may affect the voice will

help the student and teacher to develop symptom management strategies to avoid damage to the voice. The results of this study may show whether or not there are commonalities among women, meaning that women may share the similar symptoms on a given phase of the menstrual cycle. A female singer may seek to understand why her voice behaves a certain way on a certain day of the menstrual cycle and be able to plan accordingly based on her vocal abilities for that day. A vocal teacher may be able to understand that there is a relationship between his/her female student's voice and her menstrual cycle and be more sensitive to those changes, thereby developing teaching methods to address those changes that are occurring and implement those methods into the classroom and vocal studio.

Definitions

Cytology- The branch of biology that studies the structure and function of cells.

Diadochokinesis- The normal power of alternating diametrically opposite muscular actions (a flexion and extension of a limb)

Edema- A local or generalized condition in which the body tissues contain an excessive amount of tissue fluid; swelling.

Frequency perturbation- A fluctuation or disturbance of motion in the rate at which a sound wave is repeated per unit of time. See "jitter".

Formants- The resonant frequencies of the vocal tract that emphasize particular voice harmonics near in frequency to the resonance, or turbulent non-periodic energy

(i.e.noise) near the formant frequency in the case of whispered speech. The formants tell a listener what vowel is being spoken.

Fundamental frequency- The rate at which a sound wave is repeated per unit of time; also known as pitch.

Jitter- Also known as frequency perturbation; a measurement of how much a given cycle differs from the period that immediately follows it.

Laryngopathia premenstrualis- A vocal dysfunction which occurs in the immediate premenstrual period and is characterized by decreased vocal efficiency, loss of the highest notes in the voice, vocal fatigue, slight hoarseness, and some muffling of the voice.

Luteal phase- The latter phase of the menstrual cycle.

Menses- Monthly flow or bloody fluid from the uterine mucous membrane.

Neutral phase- Days 6-9 following the onset of menses.

Non-professional voice user- A person with no formal speech or singing training and with no special demands upon the voice.

Passaggio- Passage or transition between vocal registers of chest voice and head voice.

Premenstrual/menstrual phase- The period of time including the last three days before the onset of menses as well as the first day of menses.

Premenstrual dysphonia- vocal premenstrual syndrome which includes changes in voice, characterized by hoarseness, fatigue, and decrease in range.

Professional voice user- People who depend upon their voices for their livelihood such as singers, actors, clergy, teachers, television and radio announcers, etc.

Shimmer- Also known as amplitude perturbation; random cycle-to-cycle variations in amplitude.

Vocal cycle- One complete opening and closing of the vocal folds. The number of times such a cycle occurs in a given period of time (usually 1 second) is called f frequency and is recorded in cycles per second (cps) or hertz (hz).

Limitations

1. The lack of time to perform a longitudinal study.
2. The lack of access to equipment such as laryngoscopes, sonographs, spectographs and software to record and analyze the voice to record observable changes in voice quality.
3. The inability to address the fluctuation of hormone levels during menstruation through drawing blood, and using urine samples to measure actual hormone levels.
4. Small sample size

CHAPTER TWO

REVIEW OF LITERATURE

Most recent studies and literature have shown that there is some evidence of possible vocal change associated with the menstrual cycle (Abitbol, et al., 1989; Amir, Biron-Shental & Shabtai, 2006; Bonnette, 2007; Chernobelsky, 1998; Davis & Davis, 1993; De Figueiredo, et al., 2004; Higgins & Saxman, 1989; Hoover, 1991; Lã, 2004; Meurer, et al., 2009; Mussi, 2007; Pipitone & Gallup, 2008; Ryan & Kenny, 2009; Tarman & Imamoglu, 2008; Wicklund 1996). Gates (2002) suggested that during the premenstrual period, many women suffer side effects triggered by a decline in estrogen and progesterone levels. Often, tissues in the body retain water and cause bloating. Vocal folds that swell or thicken with PMS are likely retaining fluid. The excess fluid weighs down the vocal folds and impedes efficient vibration. Side effects may include hoarseness, sluggish laryngeal movement, uncertainty of pitch, vocal fatigue, submucous fold hemorrhage, and loss of high notes. Amir, Biron-Shental & Shabtai (2006) found that voice changes may be perceived in the days close to ovulation. They also examined how the synthetic hormones in the birth control pill modified the hormonal balance and found women did not experience natural menstrual cycles. Their study suggested that the voices of women on birth control pills are more stable throughout the menstrual cycle. My study will examine commonalities in change of voice quality among women's voices within the menstrual cycle. My study will include a question on the participant questionnaire asking if the participant uses birth control pills.

Sataloff (2005) suggested that even though vocal changes connected to the normal menstrual cycle are difficult to measure with current experimental techniques, they undoubtedly occur. Most of the symptoms are apparent in the immediate premenstrual period and are known as laryngopathia premenstrualis, most often referred to as vocal premenstrual syndrome (Sataloff, 2005). Sataloff suggested that symptoms of decreased vocal efficiency, loss of the highest notes in the voice, vocal fatigue, slight hoarseness, and some muffling of the voice are often more apparent to the singer than to the listener. Pipitone & Gallup (2008) found that females who experienced premenstrual syndrome symptoms were more prone to vocal changes during the menstrual cycle than women who did not experience premenstrual symptoms. The changes, characterized by hoarseness, fatigue, and decrease in range, have been identified as being clinical signs of vocal PMS. Pipitone & Gallup (2008) and Higgins & Saxman (1989) also indicated that the fundamental frequency in female voices was higher at ovulation as compared to other times during the cycle. Evidence also suggested that the impact of hormones across the menstrual cycle might drive vocal changes and perceptual features of the voice, but more research is needed.

Abitbol, et al. (1989) suggested that the human larynx is a hormonal target organ. The purpose of their study was to examine whether changes in the voice accompanied hormonal changes during the menstrual cycle. Abitbol stated that a singer with technical mastery of her voice normally uses seventy percent of her capabilities while singing. In the premenstrual phase right before menstruation, the singer has to exert more force using ninety percent of her capabilities to produce the same timbre as produced after

menstruation. Objective evidence through cytology and Dynamic Vocal Exploration (DVE) confirmed hormonal influences on the voice. DVE offered three kinds of data synchronized: acoustical, visual, and glottographic. The study included thirty-eight female participants, who were professional voice users between 21 and 40 years of age. The participants made three recordings of “Frere Jacques” The samples required the second song to be one tone above the first, and the third song one tone above the second with no rest in between songs. Participation began at ovulation. All subjects recorded their basal body temperature. A low measurement preceding a rise in temperature was assumed to indicate ovulation. The premenstrual samplings were scheduled one to three days before menstruation. Samples were taken at these two phases of the menstrual cycle for two successive cycles. Each singing sample was videotaped and a DVE was performed. Also, cytological smears of vocal cord epithelium were collected through a fiberscope with a micro-brush. Recently, estrogen target cells were found in the larynx. The investigators found that in the thirty-eight women examined, twenty-two women with premenstrual syndromes presented a hoarse voice and an increase in voice fatigue. These twenty-two women all had luteal insufficiency as confirmed by the vocal smear. The luteal phase is time in a woman’s cycle between ovulation and menstruation in which the luteinizing hormone peaks and then drops. Sixteen of the women did not have any voice change in the premenstrual phase although two of them had luteal insufficiency. The investigators concluded that ovulation inhibitors had been shown to lessen some of the premenstrual vocal symptoms, but they may also cause voice changes. The investigators suggested that management of premenstrual vocal syndrome should be a

topic for further research. The study included the use of video and sound recording, videostroboscopy, and cytology which I will not be able to incorporate into my study. However, like this study I will use female participants who are singers to see if commonalities exist among women throughout the menstrual cycle which may lead to further discussion on the management of premenstrual vocal symptoms.

De Figueiredo, Gonçalves, & Pontes (2004) examined whether or not there were vocal quality variations between the ovulation period and the first day of the menstrual cycle and used self-reporting, acoustic analysis and spectrography. The study included thirty female speech and language pathology students, non-smokers and non-users of birth-control pills all with regular menstrual cycles. The method included recording the students sing “happy birthday” twice during the menstrual cycle, during the first day of menstruation and on the thirteenth day when ovulation usually occurs. The voice was recorded and then analyzed through the use of the GW instruments Soundscope program. The program analyzed the fundamental frequency, jitter, and shimmer, of the voice. A questionnaire about PMS was used in which the students answered objective questions about: 1) pre-menstrual tension 2) symptoms experienced before menstruation such as: muscular pain, sensitivity, irritability, and nervousness 3) the length of the menstrual cycle 4) changes in the voice 5) loss of voice, fatigue, or hoarseness 6) duration of premenstrual symptoms 7) use of voice as a professional or non-professional.

The results indicated that during the menstrual cycle there were changes in vocal quality, but the majority of the students in the study were unaware of these variations during the menstrual cycle. One element of this study that I will be able to utilize in my

study is the questionnaire with questions about premenstrual symptoms such as the ones above. I will not be able to utilize the recording and analyzing of the voice. My study will include subjects that are on the birth control pill to see if there are differences in symptoms between women who are on the pill and those who are not. Also, I will include women who are singers in my study because of the assumption that they will be more accustomed to the way their voice works and sounds, and be aware of any vocal variations.

Meurer, Garcez, von Eye Corleta & Capp (2009) studied the menstrual cycle influences on voice and speech in adolescent females. Their study suggested that during the reproductive years, fluctuations in hormone levels can reduce verbal efficiency and cause temporary lowering of the voice in the premenstrual phase. The participants included twenty-three adolescent females without any history of voice training and use of birth control. The participants were recorded twice during two menstrual cycles and a questionnaire was also used providing information about the participants' voice, speech, oral health, diet, habits, gynecological health, and other associated factors. The study did not state which specific questions were asked on the questionnaire. The recordings of the voice analyzed voice intensity, stability of fundamental frequency, formants, diadochokinesis, vocal modulations, rhythms, and speed of speech during the follicular and luteal phases of the menstrual cycle. The use of the prolonged vowel "a" was used to check the fundamental voice frequency, higher frequency, lower frequency, and standard frequency. Five repetitions of the vowel combination "iu" were recorded for variations, minimum formant frequency and maximum formant frequency. Five repetitions of

diadochokinesis “pa ta ka” were recorded. The diadochokinesis rhythm, speed, and their variation as well as the intensity patterns and their intensity variations were analyzed. The sentence “irei a Gramado nas férias de inverno” (I will go to Gramado during my winter vacation) was recorded several times and was produced with six intonation variations: neutral, exclamation, interrogative, angry, sadness, and happiness. The variables studied were speech fundamental frequency, the highest frequency, the lowest frequency, and the standard deviation of the frequency. A nonsense sentence was analyzed with a meaningful sentence for analytical comparison. The nonsense sentence was used because it included all the consonant sounds of the Portuguese language. The Portuguese language was used because the researchers conducted the study in Brazil. For the analysis of the two sentences, the average time of syllable patterns per second, their duration in milliseconds and pauses in milliseconds were measured. Data were analyzed using the participant’s paired sample t test. The results from the recordings were similar in the two phases of the menstrual cycle and did not show any influence of cyclic hormonal fluctuations on the voice. In conclusion, the adolescents showed similar voice fundamental frequency and intensity, formants, rate of speech, and suprasegmental speech parameters. One element from this study that I found to be useful to the current study is the use of a questionnaire. I will ask specific questions about the participants’ voice including habits such as smoking, drug use, or excessive consumption of alcohol. I will also ask if the participants have any other health issues such as allergies or acid reflux that would affect their voices. I will also ask questions about medications that the participants might be taking that may affect their voice negatively. The study included

twenty-three participants. I would like to use a large number of participants in my study because it would produce more data. However, I will not use adolescent participants or perform voice recordings. I prefer to use adult women as the participants in my study because their voices have matured and stabilized, and they may be more self aware of changes in their bodies and voices since my study will use more self-reflective measures. I will also try to use participants with voice training and include participants who are on the birth control pill.

The Tarman & Imamoglu study (2008) aimed to reveal possible effects of menstruation on singing performance. The investigators stated that during the menstrual cycle many changes occur in a women's body. These changes can have negative effects on the vocal folds just like the negative effects felt in other parts of the body such as bloating or water retention. The researchers suggested that singing is a whole body experience so it is important to know the effects of the menstrual cycle upon the voice. The investigators stated that there have been many studies that have examined the effects of menstruation on sportswomen. Studies investigating the effects of menstruation on singing have not been encountered in Turkey. The investigators suggested that menstruation has different effects on sportswomen and Olympic and world records have been broken by sportswomen despite their decreasing physical capabilities. Sportswomen have physically delayed their periods by taking birth control pills when they have important competitions. Similarly, singers may also use different painkillers and non-steroid anti-inflammatory tablets for several days to prevent premenstrual symptoms which may affect their vocal quality. A total of one hundred twenty women participated

in the study. Thirty-four women were professional chorus members, forty-six were B.A. students in the music education department and forty-six students were B.A. students in the department of art education. All groups stated that they experienced normal menstrual cycles. The chorus members were grouped as Test-I, the music students were grouped as Test-II and the art education students served as a control group. The study took place throughout one academic year.

The data was obtained from surveys made up of twenty-two questions related to the characteristics of menstruation from a study that was originally carried out on female athletes in Turkey. The specific study and questions used in the survey were not listed in the article. The investigators found that both singing groups were negatively affected by menstruation, particularly during intensive singing periods and concerts. Chorus members noted that they sang a minimum of five days a week and two hours a day. Music students sang four days a week and a minimum of one and a half hours a day. The negative effect was seen more among music students and caused them to feel worse and caused a decline in their performance. One of the strengths of this study was the way the investigators used a survey to collect information and used the art education students as a control group. Like this study, my study will include the use of a survey including female singers. My study will not include the use of a control group, because I will use the singers' voice teachers to correlate the information found from the singer surveys. The investigators made the comparison between the singer and the athlete and touched upon the use birth control pills to physically delay menstruation from occurring, and the

use of non-steroidal anti-inflammatory tablets to help manage premenstrual symptoms. This study could lead to further research in the management of premenstrual symptoms.

The Higgins & Saxman study (1989) examined if the magnitude of frequency perturbation varied systematically across the menstrual cycle. Previous research suggested that changes in frequency perturbation have been associated with mass changes in the vocal folds. Therefore, the investigators in this study examined if there were changes that occurred around the time of menstruation and also at other times during the menstrual cycle. The participants included ten women ranging in age from 19-25 years and five men ranging in age 19-26 years. The men were included in the study as a control to determine if perturbation was due to the influence of some other variable. All participants were non-smokers and had no professional voice training. The female participants had to have a history of regular menstrual cycles and a normal cycle length for about a year prior to the study. The female participants also could not be taking oral contraceptives or have taken them within three months prior to the study. Speech samples were recorded for each subject during a thirty-three day period and for the women, the results were analyzed in relation to ovarian hormone fluctuations inferred from basal body temperature data and the participants' reports of the onset of menstruation. The investigators found that there were no significant changes in the voice for most participants during the premenstrual and menstrual period. However, the time of ovulation produced a notable change in the magnitude of frequency perturbation. The investigators suggested that the ovarian hormone fluctuations altered neurotransmitter levels which resulted in changes in the processes involved with laryngeal control. The

investigators ran the study for a thirty-three day period. I plan on conducting my study during a two month period. My study will include women who are currently taking voice lessons. In addition, my study will not involve vocal recordings or recording of basal temperature. Like this study, my study will include the participant self-reporting the onset of menstruation and require that the women experience regular menstrual cycles.

Mussi (2007) investigated the quality of the voice during the premenstrual and menstrual cycle as compared to the quality after the menstrual cycle through the auditory perception of the voice teacher. The study took place in Brazil, and the participants included six female singers between the ages of 20 and 30 years of age, each experienced normal menstrual cycles and did not use birth control. The participants picked a piece of music from their repertoire and sang about forty seconds of the piece a cappella. The forty-second piece was recorded on tape on two different occasions: during the premenstrual period, and after menstruation on day seven through ten of the menstrual cycle. The recordings were then analyzed by five different vocal teachers with more than ten years of pedagogical experience. Each judge made his or her individual analyses and were blind to which recording they were listening to: premenstrual or postmenstrual. The following vocal qualities were evaluated: 1) breath support (coordinated or not), 2) brilliance (present or absent), 3) vibrato (regular or irregular), 4) resonance (nasal, laryngeal-pharyngeal, equal use of both), 5) use of vocal register (chest, head, or mixed), 6) intonation (in tune, or out of tune), 7) intensity of voice (strong or weak), 8) vocal quality (hoarse, tense, or soft), 9) projection (well projected, or with out much projection) 10) articulation (precise or not precise), 11) glottal attack (to much or just enough).

The judges then evaluated the twelve recordings from the six participants. The judges were able to hear significant differences in vocal qualities from four out of the six participants. The judges did not hear any change in vocal quality from two of the participants' recordings. The vocal changes that were most evident in the recordings were variations in vibrato, the use of more vocal force, phrasing with a high level of tension in the voice, lack of back support, problems with intonation, lack of resonance, and imprecise articulation.

In conclusion, the investigator stated that even though the judges heard some changes in vocal quality, the changes were not statistically significant and may not be valid because they did not have a specific format in which to rate the recordings. Also, the changes heard by the judges may be influenced by factors other than the menstrual cycle including an upper respiratory infection, allergies, or acid reflux. The investigator suggested that future research may include a larger number of participants and more recordings. Also, instead of having the participants pick their own piece, the results might have been more unified and precise if the singers recorded scales or vocalizes including determined vowel sounds. I felt that this was a good study, but I would have had the singers all perform the same task on the recordings because different factors might have influenced their performance such as their technical ability.

Ryan & Kenny (2009) examined the perceived effects of the female hormonal cycle on young female classical singers. The study was conducted in two parts. In the first part of the study, all twenty-seven participants recorded required information in daily diaries. The study also included male participants. Participants were asked to complete

one page per day over two noncontiguous months. The researchers felt that the participants might recall the information they had written in the previous month and duplicate it on the current month's diary. The daily diary included a questionnaire asking the participants to answer the following questions:

Thinking about your singing today, to what extent do you agree or disagree with the following:

- 1) my voice felt at its peak form, my voice felt fatigued
- 2) it took a lot of effort to sing
- 3) my ability to support my sound was affected
- 4) my voice seemed hoarse or husky
- 5) my voice felt muffled, weak or breathy
- 6) I could not extend to the top of my range
- 7) I was not able to control my voice as easily
- 8) my voice felt sluggish
- 9) my voice sounded flat in pitch

The *Profile of Mood States* was also used to assess mood. For each feeling the participants answered 0 (not at all), 1 (a little), 2 (moderately), 3 (quite a lot), 4 (very).

The question was: "How are you feeling right now?" The moods assessed were: relaxed, discouraged, annoyed/irritated, sad/depressed, unable to concentrate, energetic, forgetful/confused, tense/anxious, exhausted, cheerful, angry, fatigued, and happy.

The second phase of the Ryan & Kenny study (2009) included six female participants who reported being most affected by their hormonal fluctuations. The male

participants were used as a control group. These female participants recorded twenty seconds of the aria, *O Mio Babbino Caro* from the opera *Gianna Schicchi* by Puccini. Arpeggios and scale patterns were also recorded twice during the menstrual cycle: day one and between the tenth and fourteenth day. The taped samples were put on a CD and both expert pedagogues and the singers rated the vocal quality of the samples on a vocal quality scale to see whether or not there were discernible changes on the recordings. An unexpected result of the study was that mood had a strong effect on the voice. There was a wide rating of mood and voice quality among the same days for two cycles and worse moods were associated with greater variation in vocal quality. The findings of this study suggested that the voice is affected by the menstrual cycle. The voice quality of the singers tended to be significantly lower on days twenty-four through the first four of the next menstrual cycle when compared to the remainder of the cycle. Another interesting finding was that the singers were able to accurately identify the time of the month in which they were recorded. The singer recognized the extra effort needed for sound production during menstruation but discernible differences were not detected by expert listeners. My study will use a questionnaire similar to the one used in the first phase of the Ryan & Kenny study, to self-report premenstrual symptoms. I will not use the questionnaire on mood because my study will focus more on commonalities between vocal premenstrual symptoms during the menstrual cycle such as hoarseness, loss of high notes, loss of low notes, problems with passaggio and pitch. I will not use tape recordings in my study because of time constraints, and because without the proper equipment to

analyze the recordings, the voice samples might not produce enough discernible differences to be of significance to my study.

Wicklund's study (1996) surveyed the level of severity of symptoms in women that were currently experiencing menstrual dysphonia and premenstrual syndrome symptoms. Wicklund also asked general questions to gain some insight regarding the general health of the participants and of the participants' voices. Twenty participants were surveyed with an age range of 20-57 years old and nine of the twenty women were in the age range of 38-42. The participants were asked questions in the following categories: premenstrual dysphonia symptom questions, premenstrual syndrome questions, and general health/health of voice questions. Results from the survey indicated that the severity levels of PMS and menstrual dysphonia symptoms may be linked given that all seventeen women experiencing dysphonia of a moderate or extreme nature also had PMS symptoms of a moderate or extreme nature. Wicklund stated that due to a small sample size, the effect of exercise on PMS symptoms could not be assessed in this study; however, various studies have shown the positive effects of exercise in the improvement of premenstrual symptoms. Wicklund also suggested that diet and exercise may help to alleviate premenstrual symptoms. Wicklund's study included a survey on menstrual dysphonia symptoms and premenstrual symptoms. My study will also include questions regarding menstrual dysphonia and premenstrual symptoms. Wicklund's survey was performed at a National Association of Teachers of Singing (NATS) winter workshop. My study will take place over the course of two months as to provide more data.

Davis & Davis's study (1993) examined factors concerning the range, frequency, severity, and specific effects of premenstrual symptoms on singers. The investigators developed a self-administered questionnaire to examine the degree to which a wide range of general symptoms and vocal changes associated with PMS are experienced by female singers during the premenstrual period. The investigators selected 67 physical and nonphysical symptoms of PMS and listed them in alphabetical order. The specific symptoms were not listed in the article. The participants were then asked to rate the degree of disturbance of these symptoms on a seven point scale in which zero meant "none," through six which meant "incapacitating." Another list included twenty vocal symptoms of PMS. The specific list used was not listed in the article. The participants were asked to circle the number that described the regularity of performance disruption caused by these symptoms. The scale ranged from one which meant "rarely," through five which meant "always." The participants were also asked to rate the number that best described the overall degree of perceived disruption on her life as a singer caused by general and vocal symptoms of PMS. The scale ranged from one which meant "not at all" through five which meant "severely."

The participants used in the study were female and had to participate in supervised singing activities for a minimum of two years, and have a minimum of a high school education. Between 1984 and 1987, the questionnaires were distributed through contacts in colleges, private voice studios, church choirs, and community choral groups throughout different geographical regions of the United States. The survey was dispensed to three hundred singers. One hundred fifteen surveys were returned but because eleven

supplied incomplete information, only one hundred and four were used. Eighty-four of the participants were between 21 and 42 years of age. According to medical literature, it is during these years of a woman's life that premenstrual symptoms seem to be most disruptive.

Davis and Davis found the eight most cited general symptoms affecting singers were abdominal cramping or bloating, breast swelling and tenderness, fluid retention, mood swings, irritability, general fatigue, backache, and tension. The most cited vocal symptoms were difficulty singing high notes, flexibility impairment, husky quality, fuzzy quality, decreased volume, breathy quality, difficulty bridging the passaggios, and intonation problems. The average singer experienced thirty-three general symptoms and three vocal symptoms of PMS. The overall average score for regularity of symptom disruption was "sometimes" and the average score for degree of life disruption was "moderately." At approximately age 35, respondents began to report fewer symptoms of PMS. The survey results verified that some singer's personal and professional lives have been disrupted by the effects of PMS. The researchers warned that the unpredictability, variety, and severity of vocal and general PMS symptoms adds anxiety to the already stressful life of the performer. The investigators concluded that the singer must realize that there will be physiological changes associated with the menstrual cycle that prevent her from realizing her full potential as an artist. At these times, the education and acceptance of PMS will help the singer to avoid the self-doubt and guilt that often accompanies a disappointing performance. Therefore, PMS symptom management is important to survive in the competitive world of vocal performance.

This study included the use of a questionnaire. My study will also use a questionnaire to evaluate general PMS and vocal symptoms. I think the investigators should have asked for participants in the 21-35 year old range, since this is the age range in which premenstrual symptoms seem to be most disruptive. My study will include participants in that age range.

Bonnette's study (2007) examined factors that influence the vibratory patterns present during the menstrual cycle. These factors included patient reports of severity of reflux symptoms, severity of premenstrual symptoms, and severity of negative vocal hygiene behaviors such as excessive clearing of the throat, coughing, yelling, or excessive consumption of alcohol or caffeinated beverages. In Bonnette's *Reflux Symptoms Index*, she asked the participants to rate how severely the following problems affect them: 1) hoarseness or a problem with your voice, 2) clearing your throat, 3) excess throat mucus or post nasal drip, 4) difficulty swallowing food, liquids, or pills, 5) coughing after you ate or after lying down, 6) breathing difficulties or episodes, 7) troublesome or annoying cough, 8) sensations of something sticking in your throat or a lump in your throat, 9) heartburn or chest pain.

In Bonnette's *Daily Vocal Hygiene Questionnaire* she asked the participants, "Have you experienced/demonstrated any of the following within the last three days?" Bonnette asked the participants to circle yes or no. The questions were: 1) symptoms of acid reflux, 2) significant stress related issues such as anxiety, 3) insufficient water intake (less than sixty-four ounces per day), 4) excessive yelling/screaming, 5) more than two

alcoholic beverages in one day, 6) less than seven hours of sleep, 7) increased caffeine intake, and 8) near or in noisy environments (bars/social events)?

In the *PMS Checklist*, Bonnette asked the participants to check all the symptoms that applied to them. An additional question at the bottom of the questionnaire asked if the participants were relieved of their symptoms on days four through thirteen of the menstrual cycle. The symptoms were organized into two categories affective and somatic. The affective symptoms were depression, angry outbursts, irritability, anxiety, confusion, and social withdrawal. The somatic symptoms were: breast tenderness, abdominal bloating, headache, and swelling of extremities.

The study included ten female participants who were non-professional voice singers. Some participants used the birth control pill and others did not. Her methods included using self-perception through various questionnaires, acoustic analysis, and videostroboscopy. The study took place during three phases of the menstrual cycle over the course of two menstrual cycles. The results from the Bonnette study indicated that it is difficult to determine whether the changes that occurred in the voice were due to negative hygiene behaviors, or reflux samples. Further research might include using a larger number of participants, high-speed digital imaging, and the use of participants who use their voice professionally as professional speakers or singers.

Bonnette's use of various questionnaires such as the *Reflux Symptoms Index*, *PMS Checklist*, and the *Vocal Hygiene Questionnaire* is interesting. I will implement these in my study to see if the participants are experiencing other symptoms as well during the premenstrual cycle. Symptoms such as acid reflux, allergies, or asthma might be linked to

changes occurring with the menstrual cycle or might just be normal daily symptoms for the participant. I would not be able to use the videostroboscope or record and analyze vocal samples because of the lack of access to equipment such as laryngoscopes, sonographs, spectographs and software to record and analyze the voice to record observable changes in voice quality. Another thing I would do differently is try to get a larger number of participants who use their voice professionally for my study. Bonnette used ten participants in her study; I would feel more comfortable using a larger number of participants in case a participant drops out of the study. Also, a study using a larger sample number would provide more reliable data.

The Hoover (1991) study investigated possible changes in vocal function associated with the menstrual cycle. Hoover suggested that even the smallest change in vocal function due to fluctuations in hormones and changes occurring within the menstrual cycle could be problematic for the professional singer. Researchers continue searching for some relationship between hormonal change and alteration in vocal function. Each subject's singing voice was recorded twice during the menstrual cycle using the Kay DSP sonograph measuring jitter and shimmer. Hoover's study also included self-reporting of vocal symptoms among trained singers in a daily symptom diary for four complete menstrual cycles. Hoover's *Self-Rating Symptom Diary* was a modified version of the *Smith & Schiff (1989) Menstrual Symptom Diary*. The Hoover *Self-Rating Symptom Diary* uses a five point rating scale, and space was also provided at the bottom of the chart for subjects to add any additional comments regarding symptoms or illness. The symptoms listed were anxiety, irritability, decreased morale, difficulty

concentrating, fatigue, bloating/swelling, breast tenderness, headaches, abdominal cramps, skin problems, food cravings (sugar and salt), lack of sleep (previous night), cold/respiratory infection, loss of high notes, loss of low notes, problem with passaggio, hoarseness, harsh/edgy/shrill tone, loss of flexibility, pitch problems, difficulty with breath support, voice breaks/cracking, excess mucous, throat feels “swollen”, throat feels “tight”, and clearing of the throat more often.

Vocal examples were recorded twice a week for at least four complete cycles in the speech spectrograph lab at the Ohio State University Division of Speech and Hearing Science. Hoover stated that data collection was interrupted due to problems with the equipment and scheduling conflicts with the lab. Therefore not all participants had both a premenstrual and neutral recording for each cycle. The participants in Hoover’s study were required to meet the following criteria to participate in the study: 1) must be singers with at least three years of voice training to facilitate accuracy in self-evaluation of voice change throughout the study, 2) not have been pregnant in the two years prior to the start of the study which would eliminate the effects of extreme hormonal change during pregnancy and subsequent months, and 3) have a normal menstrual cycle (beginning every twenty-seven days and lasting more or less than seven days.) Hoover’s study included ten female participants some of whom used birth control pills. Some participants were undergraduate and graduate students of the School of Music at Ohio State University; one participant was a singer and voice teacher and another was a private voice student of Hoover. Hoover concluded from her research that there were no significant findings in the acoustical analysis, but the self-reported data from the

symptom diary suggested a possible connection between hormonal fluctuation and reported vocal symptoms. Results of the self-reporting revealed that none of the three participants on the pill reported significant differences of any vocal symptoms for either phase (premenstrual or neutral), while six of the seven non-pill subjects with regular hormonal fluctuations reported at least one symptom which was significantly higher in the premenstrual phase. Four of the seven non-pill subjects reported two or more significantly higher premenstrual symptoms. Recommendations for future research include identifying women who show some type of effect first and then studying to see what the effect is, effects of pregnancy and menopause upon the voice. Future research should also involve measuring hormone levels through blood and urine samples, more long-term speech and singing samples, and examining the effect of contraceptives upon the voice.

Hoover conducted a preliminary screening of her participants. I will do the same with the addition of the following questions: 1) do you have acid reflux; 2) do you smoke, 3) do you have allergies or asthma? I will also use the self-reporting symptom diary with most of the questions from Hoover's modified *Menstrual Symptom Diary of Smith & Schiff* (1989) which I will modify. I will use the symptom diary to examine commonalities between women on specific days of the menstrual cycle. The participants that I will use will include voice teacher colleagues and private voice students of colleagues. I prefer to include these participants in my study because these women are trained to use their voice and may be more sensitive to changes that may alter their vocal function. These women might be better able to self-report premenstrual symptoms

accurately and identify some of the vocal changes they are experiencing. I will also compare self-reported commonalities between birth control pill users and non-users because the pill may present a confounding influence in investigations of menstrual effects on the voice. As mentioned before, women not on the pill demonstrated some significant premenstrual symptoms, while women on the pill did not demonstrate any increase of symptoms.

Some elements from this study that I will not use include the use of a sonograph; however, this will not be a great disadvantage in my study. Hoover herself stated how she had problems with equipment and scheduling, and the acoustical analysis did not show any significant findings. I will not be able to implement any hormone measurements through blood work or urine samples and will not be able to perform a long-term study because of time constraints for the completion of my study. I will have to evaluate the results over the course of two menstrual cycles.

Summary

The research reviewed in this chapter focused on recent studies and literature that showed evidence of possible vocal change associated with the menstrual cycle. Studies that were closely related to the female voice and the menstrual cycle were presented to provide the foundation for the present study.

The researchers reviewed in this study concluded the following: 1) during the premenstrual period, many women suffered from side effects that affected the voice

(Abitbol, et al. 1989; Bonnette, 2007; Chernobelsky, 1998; Davis & Davis 1993; Hoover, 1991; Lã, 2004; Meurer, et al., 2009; Pipitone & Gallup, 2008; Ryan & Kenny, 2009); 2) voice changes may be perceived in the days close to ovulation; (Abitbol, et al. 1989; Amir, Biron-Shental & Shabtai, 2006; De Figueiredo, et al., 2004 Higgins & Saxman, 1989 Tarman & Imamoglu, 2008); 3) voice changes connected to the menstrual cycle are difficult to measure with current experimental techniques, but they undoubtedly occur (Hoover, 1991); 4) it is difficult to determine whether the changes that occurred in the voice were due to premenstrual symptoms or other vocal problems (Bonnette, 2007); and 5) self-reported data from symptom diaries suggested a possible connection between hormonal fluctuation and reported vocal symptoms (Bonnette, 2007; De Figueiredo, et al., 2004; Hoover, 1991; Meurer, et al., 2009; Ryan & Kenny, 2009).

Some studies used equipment to record and analyze the singing voice to see if the frequency of the voice changed during the menstrual cycle (Abitbol, et al 1989; Bonnette, 2007; De Figueiredo, et al., 2004; Higgins & Saxman 1989; Hoover, 1991; Meurer, et al., 2009; Mussi, 2007; Ryan & Kenny, 2009). The Ryan & Kenny (2009) study found that the voice was significantly lower on days twenty-four through four of the menstrual cycle. Other studies used diaries with daily questionnaires in which the participants could self-report information about premenstrual symptoms and questions about the voice (Bonnette, 2007; Davis & Davis, 1993; De Figueiredo, et al., 2004; Tarman & Imamoglu, 2008; Hoover, 1991; Meurer, et al., 2009; Ryan & Kenny, 2009).

The present study seeks to fill some of the gaps in the above studies by investigating commonalities among women's singing voices within the menstrual period.

The study will investigate premenstrual symptoms and possible vocal changes are taking place during certain days of the menstrual cycle. Various studies have included a daily symptom diary in which participants will self-report both vocal and premenstrual symptoms. No studies to date have a partner questionnaire which is filled out by a singer's vocal teacher to cross-reference with the student's journal entries.

CHAPTER THREE

DESIGN AND ANALYSIS

Sample

Post-pubescent females (N=7) between the ages of 18 and 35 participated in this study. All participants were nonsmokers who study voice privately. The study included participants from the New Bedford and Dartmouth areas who were from different economic backgrounds. Two of the participants reported an economic background/average annual household income of \$30,000-50,000. Two participants reported an economic background of \$70,000 and above. Three participants preferred not to state their income. Of the seven women, all experienced regular menstrual cycles, six out of the seven experienced premenstrual symptoms, and four out of the seven women used birth control pills. All women took private voice lessons once a week for a half hour over the course of eight weeks. Three out of the seven participants suffered from allergies. None of the participants suffered from acid reflux. All participants were Caucasian.

This study also included the vocal instructors of the participants (N=3). All instructors had least ten years of experience in vocal pedagogy. The teachers completed a partner questionnaire to cross-reference with the voice students' journal entries. I scheduled a meeting to train the participants and address any questions regarding the instructions. The participants all stated that they took lessons once a week for a half hour and they stated their teacher's name. The participants were blind to the study and did not

have specific information about what I was doing because it may skew the results. All participants signed the consent form prior to data collection.

Design

This non-experimental descriptive study examined the relationship between the female singing voice and premenstrual vocal symptoms throughout the menstrual cycle. The following variables were rated for days one through twenty-eight throughout cycles one and two for each participant: 1) loss of high notes, 2) loss of low notes, 3) hoarseness, 4) voice breaks/cracking 5) difficulty with passaggio, and 6) pitch problems. The same variables were examined using a teacher journal for each participant over the course of four weeks for two cycles. The teachers were unaware of the beginning of the students' menstrual cycle.

Data analysis will include the calculation of median scores of the above symptoms to produce graphs and use visual comparison of the singers' and teachers' graphs looking for relationships between days of the cycle, physiological symptoms, and vocal symptoms.

Procedure

I contacted various vocal instructors in the Providence, Dartmouth, and New Bedford area. They were emailed a copy of the recruitment flyer (see Appendix B) and

asked to forward the information regarding my study to their students. A meeting was set up to explain what the requirements for the study were and to explain what the participants had to do. The participants had to be female nonsmokers between the ages of 18 and 35 who study voice privately. The research participants must have experienced regular menstrual cycles and had time to complete a daily journal for two complete cycles. Teachers were asked to fill out one sheet reporting their observations of each student's voice quality once a week during their student's weekly lesson. Participating teachers and students signed the consent form (see Appendix A) and completed the participant questionnaire. All participants were given my email address and phone number as a contact if there were any further questions.

The study lasted for two menstrual cycles. Each participant received a hard copy of the vocal behavior journal which included a questionnaire providing information about the participant, a 28-day checklist of symptoms for two menstrual cycles in a folder, and a consent form. The participants each completed a page of the vocal behavior journal and additional open response section every day of their menstrual cycle. Participants began the study on day one of their menstrual cycle which was the onset of menstruation. At the completion of each menstrual cycle, the participants returned the completed journal entries to me through their teachers and began a new journal with the checklist for the consequent menstrual cycle.

Research Instruments

The participant questionnaire (see Appendix C) was used to gather information about the participants such as their name, email, phone number, age, voice teacher name, and phone number. The questionnaire required the participants to circle yes or no for the questions below: Do you experience a regular menstrual cycle? Do you use birth control pills? Do you experience premenstrual symptoms? Do you suffer from acid reflux? Do you suffer from allergies? Do you smoke? Do you take voice lessons? The questionnaire also asked the student to indicate how often they take lessons and how long is their lesson. The participant questionnaire also asked questions about the participant's ethnic and economic background.

The participant symptoms journal (see Appendix D), was used to rate the severity of the participants' premenstrual and vocal symptoms for each day. The participants were asked to rate each symptom on a scale of zero through four. The participants rated the following symptoms every day: anxiety, irritability, decreased morale, difficulty concentrating, fatigue, bloating/swelling, breast tenderness, headaches, abdominal cramps, skin problems, food cravings sugar or salt, lack of sleep previous PM, cold/respiratory infection, loss of flexibility, pitch problems, difficulty-breath support, voice breaks/cracking, excess mucous, throat feels "swollen", throat feels "tight", clear throat more often, harsh edgy shrill tone, hoarseness, difficulty with passaggio, loss of low notes, and loss of high notes. The symptom journal also included an open response

section to add any other relevant information or symptoms that may not have been included on the journal.

The study also included a voice teacher journal (see Appendix E). There was a space at the top of the journal for the voice student name, voice teacher name, date and email. The teacher was asked to rate their observation on a scale of zero to four of their student on the following qualities for today's lesson: anxiety, irritability, decreased morale, difficulty concentrating, fatigue, clearing their throat more often, hoarseness, loss of low notes, loss of flexibility, pitch problems, difficulty with breath support, voice breaks/cracking, excess mucous, harsh edgy shrill tone, difficulty with passaggio, cold/respiratory infection and loss of high notes. The journal also included an open response section in which the teacher could add any other relevant information or symptoms.

Data Analysis

The six variables were selected from the questionnaire because they were the most commonly cited symptoms in previous research. The variables were loss of high notes, loss of low notes, hoarseness, difficulty with passaggio, and pitch problems. Data analysis included the calculation of median scores of the above symptoms to produce graphs and use visual comparison of the singers' and teachers' graphs looking for relationships between days of the cycle, physiological symptoms, and vocal symptoms.

CHAPTER FOUR

RESULTS AND INTERPRETATIONS

The study took place over two menstrual cycles. The participants ranged in age from 18 to 31 years of age. Of the seven women surveyed, all experienced regular menstrual cycles, six out of the seven experienced premenstrual symptoms, and four out of the seven women used birth control pills. All women took private voice lessons once a week for at least a half hour. All of the participants were non-smokers, and three out of the seven suffered from allergies. None of the participants suffered from acid reflux. All participants were Caucasian. The following figures show the results of the scores obtained from the student symptom journals.

The median score was calculated for the loss of high notes over two 28-day cycles. The median scores ranged from zero to one, indicating that the menstrual cycles had no effect on the use of high notes during either of the menstrual cycles (see figure 3).

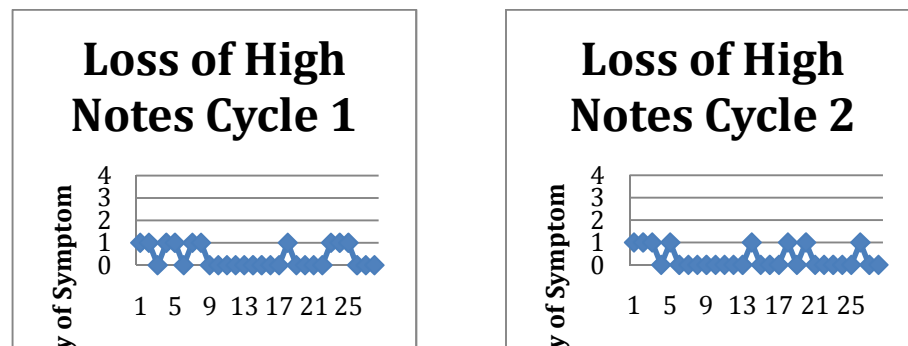


Figure 3. Loss of high notes.

The median score was calculated for the loss of low notes over two 28-day cycles. The median scores produced a score of zero which indicates that the menstrual cycles had no effect on the use of low notes during either of the menstrual cycles (see Figure 4).

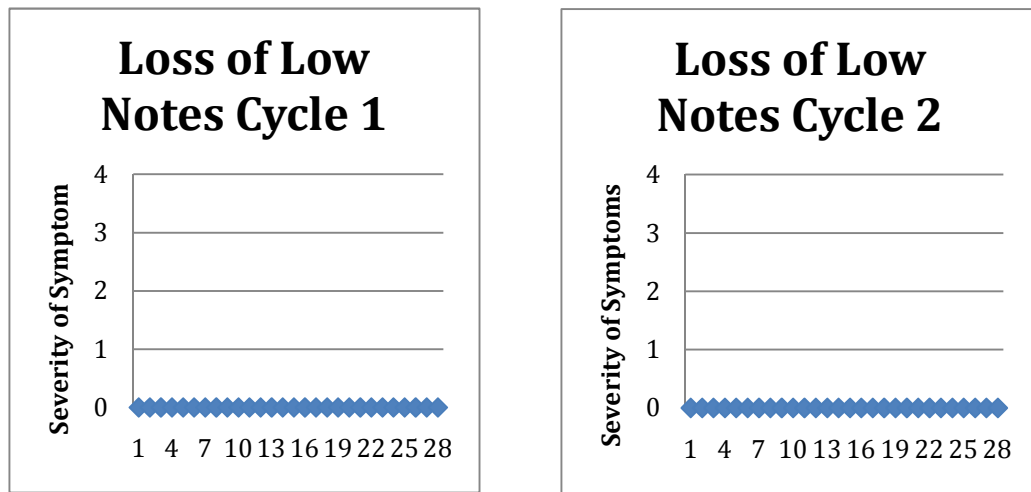


Figure 4. Loss of low notes.

The median score was calculated for hoarseness over two 28-day cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on hoarseness during either of the menstrual cycles (see Figure 5).

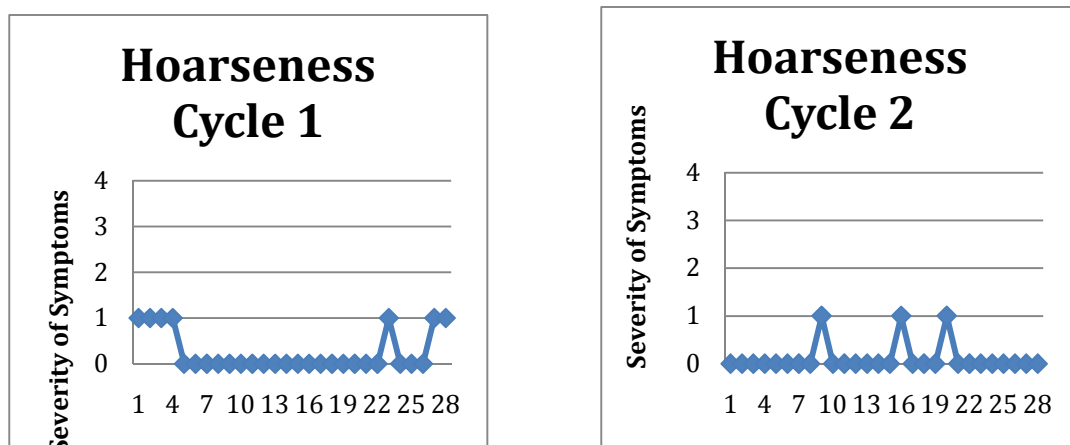


Figure 5. Hoarseness.

The median score was calculated for voice breaking/cracking over two 28-day cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on voice breaking/cracking during either of the menstrual cycles (see Figure 6).



Figure 6. Voice breaking/cracking.

The median score was calculated for passaggio over two 28-day cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on the use of passaggio during either of the menstrual cycles (see Figure 7).

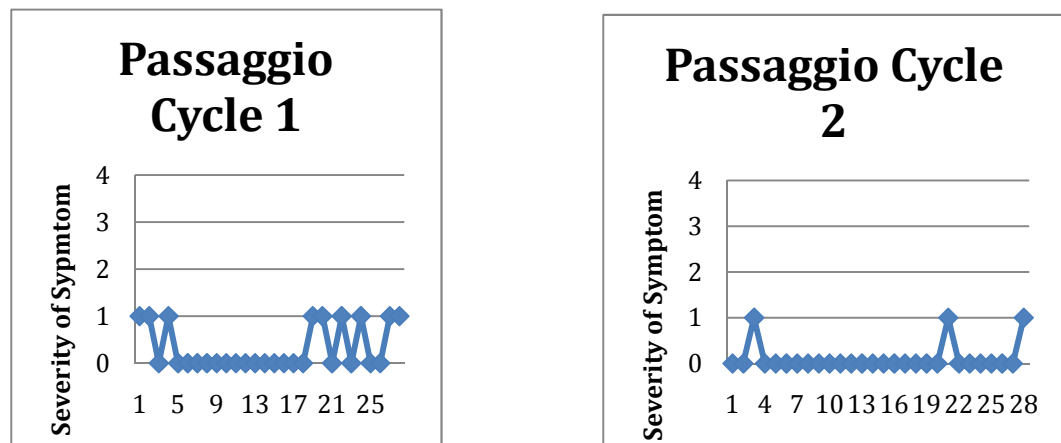


Figure 7. Passaggio.

The median score was calculated for pitch problems over two 28-day cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on pitch problems during either of the menstrual cycles (see Figure 8).

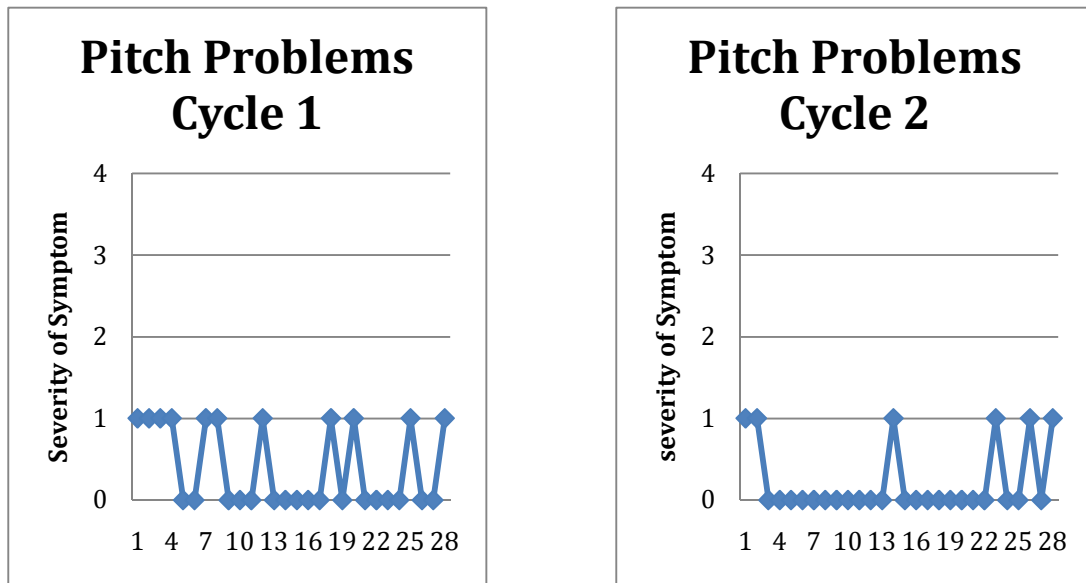


Figure 8. Pitch problems.

Figure 9 is a compilation of the median scores for the six symptoms that were rated on a scale of zero to four for each vocal cycle. The overall median score indicated a range of zero to one suggesting that a women's menstrual cycle has no effect on her singing voice.

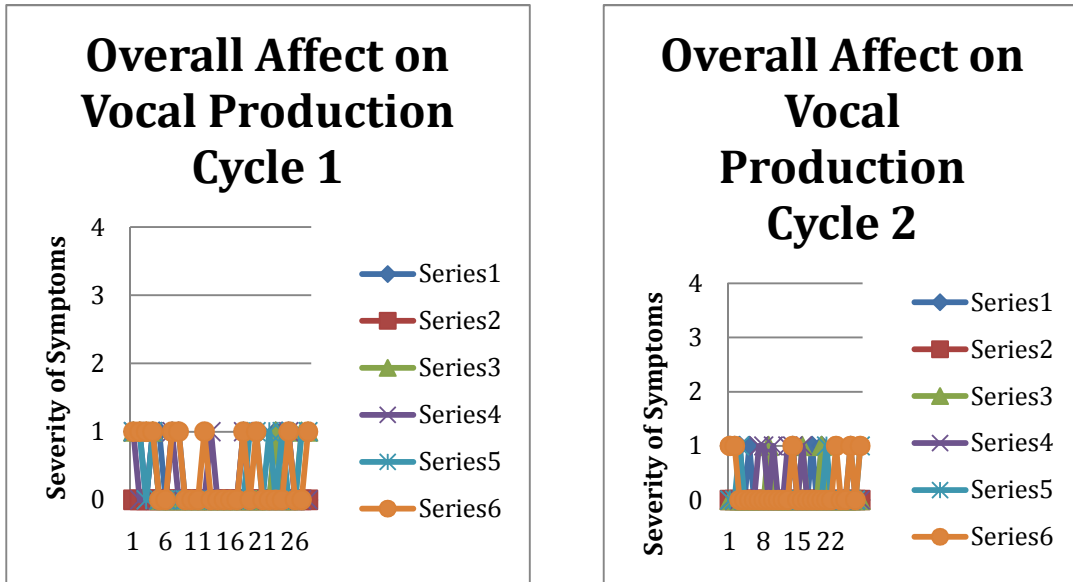


Figure 9. Overall effect on vocal production.

The following are the results of the teacher surveys. The teachers rated their observation of symptoms during their students weekly half hour lesson.

The median score was calculated for loss of high notes over two menstrual cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on the use of high notes during either of the menstrual cycles (see Figure 10).

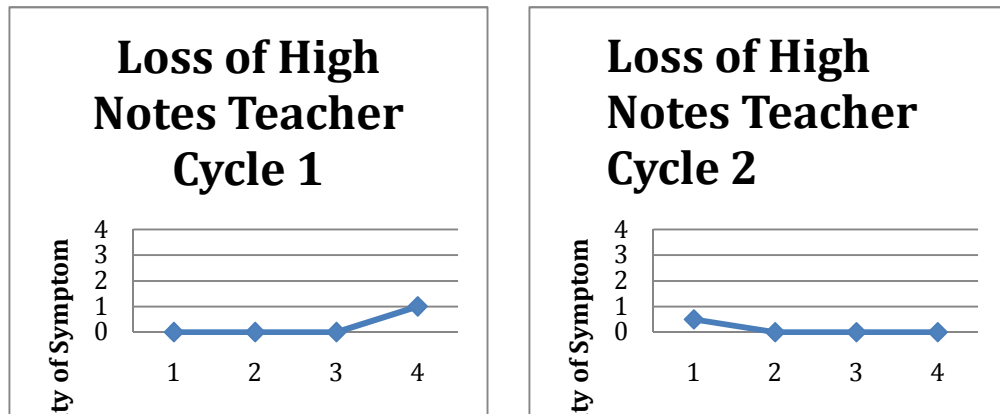


Figure 10. Loss of high notes teacher cycle.

The median score was calculated for loss of low notes over two menstrual cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on the use of low notes during either of the menstrual cycles (see Figure 11).

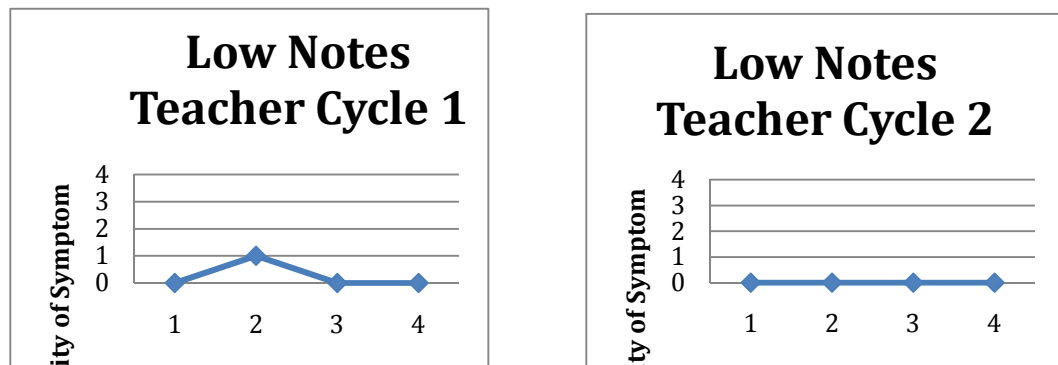


Figure 11. Low notes teacher cycle.

The median score was calculated for hoarseness over two menstrual cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on hoarseness during either of the menstrual cycles (see Figure 12).

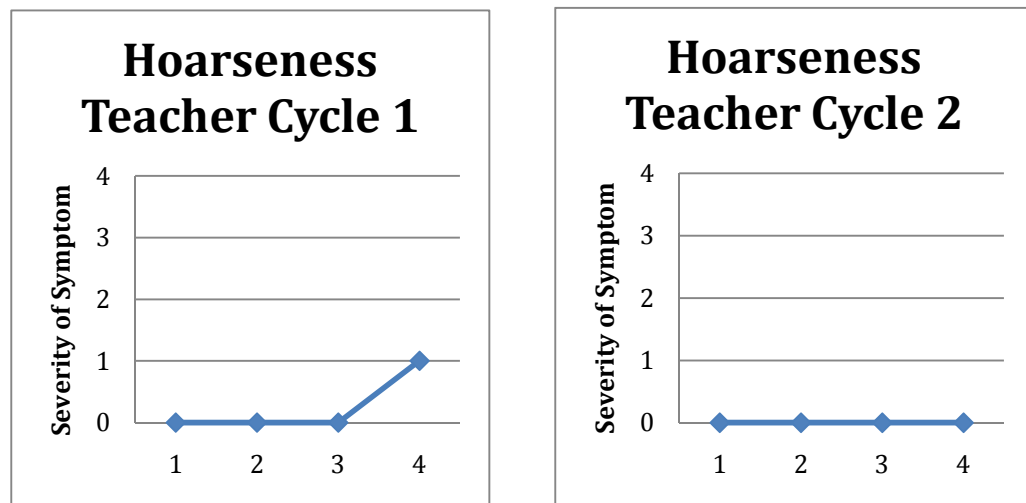


Figure 12. Hoarseness teacher cycle.

The median score was calculated for voice breaks/cracks over two menstrual cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on voice breaks/cracks during either of the menstrual cycles (see Figure 13).

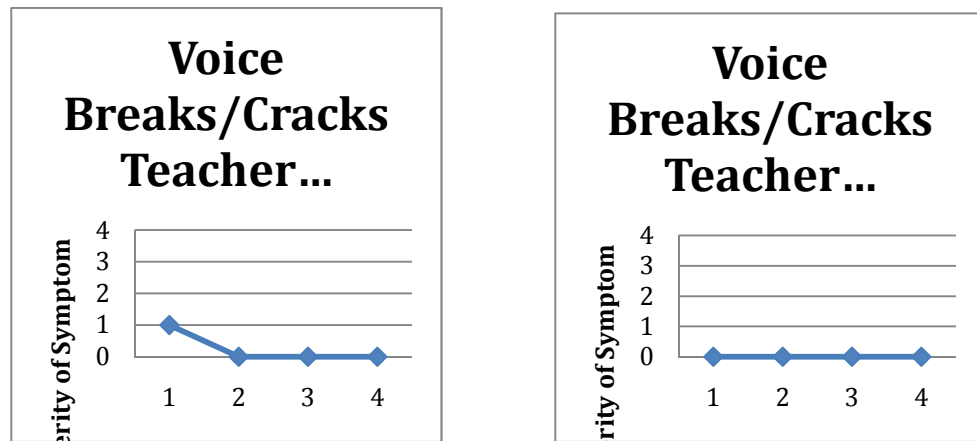


Figure 13. Voice breaks/cracks teacher cycle.

The median score was calculated for passaggio over two menstrual cycles. The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on passaggio during either of the menstrual cycles (see Figure 14).

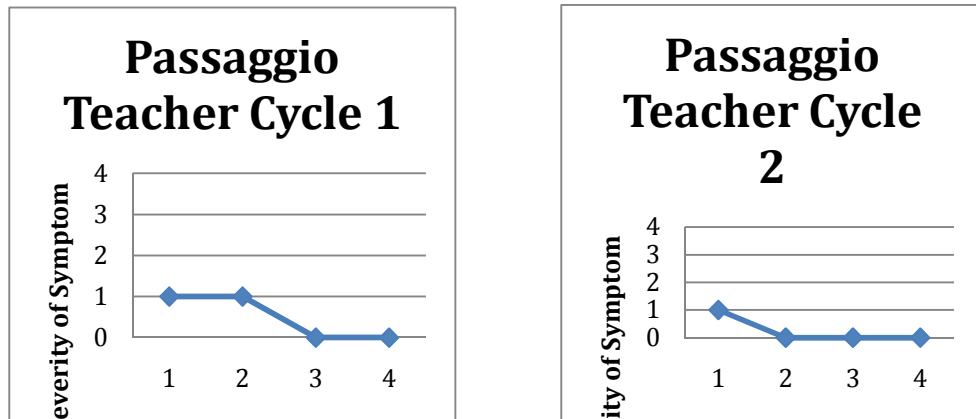


Figure 14. Passaggio teacher cycle.

The median score was calculated for pitch problems over two menstrual cycles.

The median scores ranged from zero to one which indicates that the menstrual cycles had no effect on pitch problems during either of the menstrual cycles (see Figure 15).

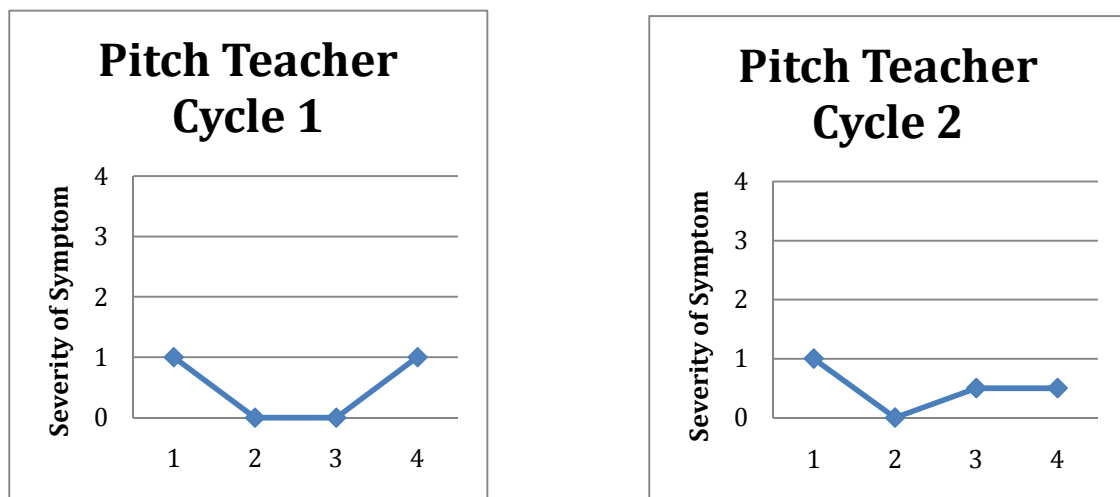


Figure 15. Pitch teacher cycle.

Figure 16 is a compilation of the median scores from the teacher journals for the six symptoms that were rated on a scale of zero to four for each vocal cycle. The overall

median score indicated a range of zero to one suggesting that a women's menstrual cycle has no effect on her singing voice.

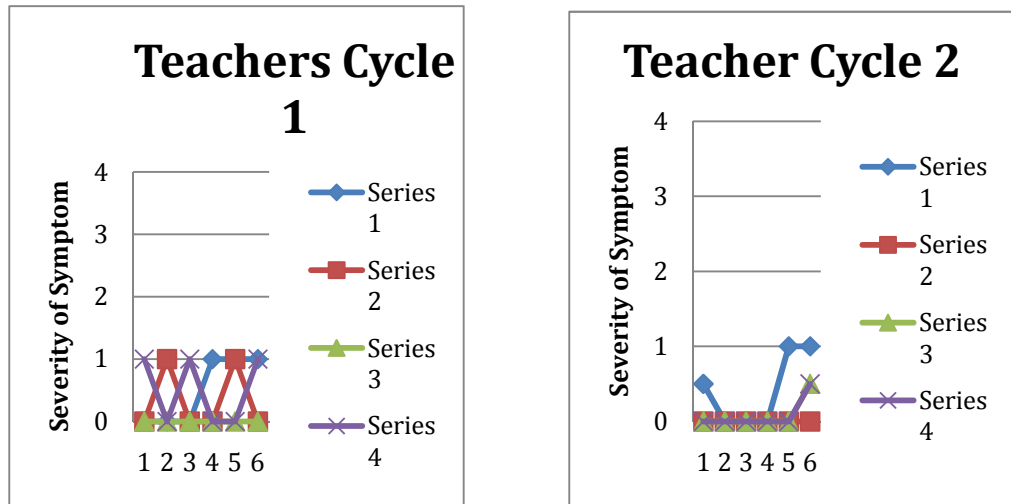


Figure 16. All teacher cycle.

CHAPTER FIVE

SUMMARIES, CONCLUSIONS, AND RECOMMENDATIONS

A summary of the study is presented in this chapter. Conclusions and implications for music education are also included, followed by recommendations for future research.

Purpose and Problems

The purpose of this research was to examine factors that affect the female voice.

The problem of this study was to examine the following:

Is there a change in vocal quality occurring in the female singing voice during the premenstrual phase of the menstrual cycle?

This study examined the changes that happened to seven women within two menstrual cycles to see if commonalities of symptoms existed between women and within the menstrual cycle.

Design and Procedures

Post-pubescent females (N=7) between the ages of 18 and 35 participated in this study. All participants were nonsmokers who study voice privately. The study included participants from the New Bedford and Dartmouth, MA area. The participants all experienced a regular menstrual cycle and took voice lessons every week for a half hour

for eight weeks with the exception of two participants who missed two voice lessons due to illness. This study also included the vocal instructors of the participants (N=3), as they also completed a partner questionnaire to cross-reference with the voice students' journal entries.

This non-experimental descriptive study examined the relationship between the female singing voice and premenstrual vocal symptoms throughout the menstrual cycle. The following variables were rated for days one through twenty-eight throughout cycles one and two for each participant: 1) loss of high notes, 2) loss of low notes, 3) hoarseness, 4) voice breaks/cracking 5) difficulty with passaggio, and 6) pitch problems. The same variables were examined using a teacher journal for each participant over the course of four weeks for two cycles.

Data analysis included the calculation of median scores of the above symptoms to produce graphs and use visual comparison of the singers' and teachers' graphs looking for relationships between days of the cycle, physiological symptoms, and vocal symptoms.

The study lasted for two menstrual cycles. Each participant received a hard copy of the vocal behavior journal which included a questionnaire providing information about the participant, a 28-day checklist of symptoms for two menstrual cycles in a folder, and a consent form. The participants each completed a page of the vocal behavior journal and additional open response section every day of their menstrual cycle. Participants began the study on day one of their menstrual cycle which was the onset of menstruation. At the completion of each menstrual cycle, the participants returned the completed journal

entries to me through their teachers and began a new journal with the checklist for the consequent menstrual cycle.

Results and Interpretations

It was the intent of this study to include more participants therefore requiring more statistical tools in the data analysis. However, the number of participants was unfortunately drastically reduced to seven because the study was conducted in the summer when many singers were unavailable which may have skewed the results.

In menstrual cycle one, all participants retained their high notes on days nine through seventeen of the menstrual cycle. This is around the time during the menstrual cycle in which ovulation is said to occur. In cycle two, all participants again retained their high notes between days six through thirteen. The results are not the same as in cycle one, but are similar in that the participants are not experiencing any loss of high notes.

In menstrual cycles one and two the median score calculated for the loss of low notes produced a score of zero. The menstrual cycle had no effect on the use of low notes throughout both menstrual cycles. All participants retained their low notes.

One participant rated experiencing “severe hoarseness” in cycles one and two. However, the median score produced showed that the participants did not experience any hoarseness in their voice on days five through twenty-two of menstrual cycle one. There is little common between these results and the results for cycle two. In cycle two,

participants did not experience hoarseness throughout different days of the menstrual cycle.

In cycle two, the women's voices were not affected by breaking and cracking in the latter part of the menstrual cycle days seventeen through twenty-eight.

Also, none of the women seemed to have any problems with the passaggio area of their voices in cycle one on days five through eighteen. In cycle two, the women did not experience any problems with the passaggio area on days four through twenty. This similarity is occurring around the middle of the menstrual cycle when ovulation is said to occur.

One participant rated experiencing "severe problems with pitch" for two days. The median score showed that pitch problems occurred randomly throughout both menstrual cycles. However, in cycle two, there appeared to be two times during the menstrual cycle in which all women experienced no problems with pitch: days three through thirteen and fifteen through twenty-two.

In comparing the results from cycle one to cycle two, the only apparent commonality found was that all women retained their low notes throughout the menstrual cycle. Also, in cycle one there seemed to be a few days in the middle of the menstrual cycle in which women did not experience any adverse effects on the voice, this is around the time of ovulation.

The teachers observed that there was no loss of high notes between weeks two and three of the menstrual cycle in both cycles one and two. This observation suggests a

slight corroboration with the students' indication that they are not losing any high notes in the middle part of the the menstrual cycle days nine through thirteen.

The teachers observed a loss of low notes in week two of menstrual cycle one. However, the results for weeks one, three, and four agree with the students' indications of no loss of low notes. In cycle two, the teacher journal is in agreement with the students' reports in cycle two. The teachers reported that in cycle two the loss of low notes had no effect on their students' voices.

During weeks one through three of menstrual cycle one, the teachers observed that the students did not experience any hoarseness. This supported the students indications in cycle one that their voices were not affected on days five through twenty-one.

In cycle one, the teachers observed that there were no voice breaks and cracks occurring on weeks two through four of the menstrual cycle. However, in cycle one, the students report random voice breaks and cracking. In cycle two, the teachers observed that there was no voice breaking and cracking occurring, but the students reported random breaking and cracking throughout the menstrual cycle except for days one through seven and seventeen through twenty-eight, which is in slight agreement with the teachers' observations.

The teachers' observations indicated that they did not observe any passaggio problems in the students' voices between weeks three and four. This did not agree with the students indications because they indicated that they did not experience any problems on days five through eighteen in cycle one. In cycle two, the teachers reported that there

were no passaggio problems during weeks two and three which had a similarity to what the students reported in the middle of cycle two.

The voice teachers observed that there were no problems with pitch during week two of both menstrual cycles. The teacher observations had no corroboration with the results of the students' indications in cycle one or cycle two. In the student journal, pitch problems were random throughout cycle one and there was no commonality with cycle two as pitch problems happened randomly as well. However, in cycle two, there were two times during the student menstrual cycle in which none of the women experienced any problems with pitch: days three through thirteen and fifteen through twenty-one. The only teacher observation that was in agreement with the student journal was the observation made in cycle two regarding the retention of low notes. There was one teacher survey for cycle two that was not returned to me which might have skewed the results.

The question of this study was to find if there was a change in vocal quality occurring in the female singing voice during the premenstrual phase of the menstrual cycle. The results of this study showed that there was no change to the female singing voice within the menstrual cycle. The results may be due to the lack of time, (two menstrual cycles), and a small sample size. In addition, four women out of seven participants in the study were taking birth control pills and this may have skewed the results. Previous research has indicated that women who take birth control pills do not experience natural menstrual cycles (Amir, Biron-Shental & Shabtai, 2006).

This study examined the changes that happened to seven women within two menstrual cycles to see if commonalities of symptoms existed between women and within the menstrual cycle. All the participants in this study reported that there was no loss of low notes throughout the menstrual cycle in both cycles. Another commonality was that the women reported they did not lose any high notes around days nine through seventeen of the menstrual cycle. This is interesting because this happens to be the time of the menstrual cycle in which the woman is ovulating. Another interesting relationship in this study was that the women reported not having any problems with their passaggio during the middle part of the cycle, days seven through nineteen. This might indicate that the female singing voice might be at its peak performance level during ovulation time.

Conclusions and Implications for Music Education

From an educational perspective, it is important to understand the voice as an instrument. Educators need to know more about the factors that may affect the voice resulting in changes such as decreased vocal efficiency, loss of the highest notes in the voice, vocal fatigue, slight hoarseness, and some muffling of the voice. Understanding these changes may help teachers instruct female voice students more effectively. Vocal teachers may seek to understand how these factors may influence certain days of the menstrual cycle and may or may not limit the female singing voice within the menstrual cycle. Information about how these changes may affect the voice will help the student and teacher to develop symptom management strategies to avoid damage to the voice.

The results of this study suggest that there is no relationship between changes to the female singing voice and the premenstrual cycle. Women retained use of low notes, high notes, and the passaggio area of their voice throughout the menstrual cycle. Although many women complain about premenstrual symptoms occurring in their body in the premenstrual part of the menstrual cycle, researchers should be open to finding effects in other unexpected times of the menstrual cycle as well such as ovulation.

Recommendations for Future Research

Future research should include a longitudinal study to include more menstrual cycles and a larger number of participants. Actual hormone levels should also be measured throughout the menstrual cycle to increase the objectivity of the data. For future research, the participant and teacher journal entries should begin on the first day of the participant's cycle. The teacher journal results were not as beneficial as a correlational tool with the student journal because the teachers were unaware of the beginning of the students' menstrual cycle.

There may have been other factors that influenced the singer's voices such as a cold. For example, some of the students reported hoarseness in their voice and the teacher results only indicated hoarseness in one out of eight weeks. Future research might include a recording of a scale with a set range of notes from low to high, and have the participants practice that scale everyday of the study and report their vocal symptoms based on their performance of that scale. All of the women reported that they had retained

all their low notes throughout the menstrual cycle, but how low and how high in their vocal ranges were they actually practicing?

Future research might examine if participants who are on the birth control pill have fewer self-reported symptoms as a result of the modification of the hormonal balance, and researchers should try to look for effects in other times of the cycle as well such as during ovulation.

APPENDIX A:

CONSENT DOCUMENT
Rhode Island College

The Female Singing Voice: Perceived Changes During the Menstrual Cycle

You are being asked to participate in a research study about vocal health. You were selected as a possible participant because you study voice privately and you are a nonsmoker between the ages of 18 and 35 who experiences a regular menstrual cycle. Please read this form and ask any questions that you may have before agreeing to be in the research.

Shirley Guerreiro a graduate student at Rhode Island College is conducting this study. This study is being conducted in partial fulfillment of the requirements of the Master's of Music in Education.

Background Information

The purpose of this research is to examine factors that affect the female voice.

Procedures

If you agree to be a participant in this research, you will be asked to participate throughout two menstrual cycles. You will receive a hard copy of the vocal behavior journal which includes a questionnaire and a 28 day checklist of symptoms in a folder. You will each complete a page of the vocal behavior journal and additional open response section every day of your menstrual cycle. You will begin the study on day 1 of your menstrual cycle which is the first day of menstrual bleeding. At the completion of each menstrual cycle, you will return the completed journal entries to me in a self-addressed stamped envelope. Begin a new journal with the checklist for each consequent menstrual cycle.

Voluntary Participation

Your participation is completely voluntary. If you choose not to participate in this research, there will be no negative consequences to your private voice study. Also, you can change your mind about participating at any time with no negative consequences. Choosing not to participate or changing your mind will not affect your relationship or standing with your private instructor.

Risks and Benefits to Being in the Study

The risks of participating in this research are minimal, meaning that they are about the same as what you would experience in your normal daily activities. The main foreseeable risk is that you may feel some frustration when trying to remember the lists. If you feel too frustrated and want to stop your participation, you should tell the researcher.

There are no direct benefits to you, although the information collected may help us to understand how the voice is affected during various times throughout the menstrual cycle.

_____ Initial here to indicate that you have read and understood this page.

Confidentiality

The records of this research will be kept private. In any sort of report that might be published, the researcher will not include any information that will make it possible to identify you. Research records will be kept in a secured file, and access will be limited to the researcher, the Rhode Island College review board responsible for protecting human participants, and regulatory agencies. All data will be kept for a minimum of three years, after which it will be destroyed.

Contacts and Questions

The researcher conducting this study is Shirley Guerreiro. You may ask any questions you have now. If you have any questions later, you may contact her at sguerreiro@verizon.net or (508) 742-5464. You may also contact Dr. Denise Guilbault, the faculty advisor for this study, at dguilbault@ric.edu or (401) 456-951.

If the researcher cannot be reached, or if you would like to talk to someone other than the researcher about (1) your rights as a research participant, (2) research-related injuries or problems, or (3) other issues/concerns you have about your participation in this study, please contact the Chair of the Institutional Review Board at IRB@ric.edu, or by phone (401-456-8228), or by writing, Chair, IRB; c/o Office of Research and Grants Administration; Roberts Hall; Rhode Island College; 600 Mount Pleasant Avenue; Providence.

You will be given a copy of this form for your records.

Statement of Consent

I have read and understand the above information, and I agree to participate in this study. I understand that my participation is voluntary and can be withdrawn at any time with no negative consequences. I have received answers to the questions I asked, or I will contact the researcher with any future questions that arise. I am at least 18 years of age.

Print Name of Participant: _____

Signature of Participant: _____ Date: _____

APPENDIX B:

RESEARCH PARTICIPANTS WANTED

My name is Shirley Guerreiro and I am a graduate student working on my Master's Thesis at Rhode Island College. I am looking for females for a research study about vocal health. I need female nonsmokers between the ages of 18 and 35 who study voice privately. Research participants must also have a regular menstrual cycle and have the time to complete a daily journal.

If you are interested in participating in this study please contact me for more information. You may contact me via email at sguerreiro@verizon.net or by phone at (508) 742-5464.

APPENDIX C:

Participant No. ____

Participant Questionnaire

Name: _____

Email: _____

Phone number: _____

Age: _____

Ethnic Background: (please circle)

Caucasian African-American Hispanic Asian Prefer not to say

Economic Background/Average annual household income: (please circle)

\$30,000-50,000 \$50,000-70,000 \$70,000 and above prefer not to say

Please circle the correct answer for the questions below:

Do you experience a regular menstrual cycle? yes no

Do you use birth control pills? yes no

Do you experience premenstrual symptoms? yes no

Do you suffer from acid reflux? yes no

Do you suffer from allergies? yes no

Do you smoke? yes no

Do you take voice lessons: yes no

How often do you take lessons and how long is your lesson? _____

Voice Teacher Name: _____

Voice Teacher Phone Number: _____

APPENDIX D:

Participant Symptom Journal

Participant No. _____

Cycle No. _____

Day _____

Date: _____

Please rate your symptoms for today:

0= none 1=mild 2=moderate 3=severe 4=unable to perform

Anxiety _____ loss of flexibility _____

Irritability _____ pitch problems _____

Decreased morale _____ difficulty-breath support _____

Difficulty concentrating _____ voice breaks/cracking _____

Fatigue _____ excess mucous _____

Bloating/swelling _____ throat feels “swollen” _____

Breast tenderness _____ throat feels “tight” _____

Headaches _____ clear throat more often _____

Abdominal cramps _____ Harsh, edgy, shrill tone _____

Skin problems _____ Hoarseness _____

Food cravings sugar or salt _____ Difficulty w/passaggio _____

Lack of sleep previous PM _____ Loss of low notes _____

Cold/respiratory infection _____ Loss of high notes _____

Open Response: (Please add any other relevant information or symptoms you may use the back of this sheet)

APPENDIX E:

Voice Teacher Journal

Voice Student Name: _____

Voice Teacher Name: _____

Date: _____ Email: _____

Please rate your observations of your student on the following qualities for today's lesson:

0= none	1=mild	2=moderate	3=severe	4=unable to perform
Anxiety	_____	_____	loss of flexibility	_____
Irritability	_____	_____	pitch problems	_____
Decreased morale	_____	_____	difficulty-breath support	_____
Difficulty concentrating	_____	_____	voice breaks/cracking	_____
Fatigue	_____	_____	excess mucous	_____
Clear throat more often	_____	_____	Harsh, edgy, shrill tone	_____
Hoarseness	_____	_____	Difficulty w/passaggio	_____
Loss of low notes	_____	_____	Cold/respiratory infection	_____
	Loss of high notes	_____		

Open Response: (Please add any other relevant information or symptoms on the bottom of this page.)

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