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Effects of the menstrual cycle on the vibratory characteristics of the vocal folds

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EFFECTS OF THE MENSTRUAL CYCLE ON THE VIBRATORY CHARACTERISTICS OF THE VOCAL FOLDS

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ABSTRACT

The purpose of this study was to obtain preliminary data on several factors that may influence the vibratory patterns of the vocal folds in addition to the hormonal fluctuations 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 prior to each evaluation. Ten subjects who did not experience complaints of their voice participated in the study. Data from four subjects who were not on birth control and four on birth control were analyzed for the first cycle, which included self-perception, acoustic analysis, and stroboscopic images. Four subjects not on birth control and two on birth control participated in a second cycle.

Results demonstrated increased perturbations during the premenstrual phase followed by the ovulation phase for subjects who were not taking birth control. These subjects reported elevated reflux symptom and vocal hygiene values as well.

The results of this preliminary study did not show a definite trend towards a certain phase the menstruation cycle on the vocal fold vibratory characteristics. However, a study with a larger subject number would aid in determining whether the trends that were seen in this study will reach a significant level and whether acid reflux and vocal hygiene issues could influence vocal quality as much as the hormonal fluctuations occurring during the different phases of the menstruation cycle.

CHAPTER ONE
INTRODUCTION

Voice production is achieved by the vibration of the vocal folds. A subtle change in the vocal fold structure can cause alterations of the vibratory characteristics during phonation. The neurological (Rahn, Chou, Jiang, & Zhang, 2007; Perez, Ramig, Smith, & Dromey, 1996), myogenic (Rubin, et al., 2005), structural (Shin, Nam, Yoo, & Kim, 2002), and cytological changes (Colton, Woo, Brewer, Griffin, &Casper, 1995) in the laryngeal and vocal fold structure can result in changes in vocal fold vibratory characteristics and vocal quality. The natural aging process has also been shown to negatively affect the voice (Verdonck-de Leeuw & Mahieu, 2004; Sataloff, Rosen, Hawshaw, & Spiegel, 1997). Endocrine disorders such as thyroid dysfunctions have also been found to alter the vocal fold vibratory characteristics (Altman et al., 2003).

The vocal folds have often been described as hormonal targets (Chae, Choi, Kang, Choi, Jin, 2001; Abitbol, Brux, et al., 1989). The physiologic effects of the menstrual cycle on the voice have been researched for more than 40 years; however, the degree of changes on vocal fold vibratory characteristics has not been determined.

The menstrual cycle is a naturally occurring event resulting from hormonal changes. Most women of childbearing age experience menstruation approximately every twenty-eight days. The menstrual cycle is regulated by the interactions of hormones and other chemical messengers, of which estrogen and progesterone are the principle sex steroids (Doria, 1999). Estrogen causes hypertrophy and proliferation on mucosa which creates abundant, watery, thin, clear, and stretchable mucus. Progesterone, on the other hand, decreases the estrogen receptors, thus resulting in an antiproliferative effect (Abitbol, Abitbol, & Abitbol, 1999). Through vocal

fold staining, it was found that hormone receptors are also found in the nucleus and cytoplasm of cells in the vocal folds (Newman, Butler, Hammond, & Gray, 2000).

Since a fluctuation and influence of hormones have been shown to occur in the larynx (Altman et al. 2003, Abitbol, et al., 1989), it is reasonable to assume that the hormones regulating the menstrual cycle could create a transient change of the true vocal fold vibratory characteristics before, during, or after menstruation; however, it is not known to what extent this will affect the voice quality. If this phenomenon occurs, it is also possible that some populations can perceive these effects while others cannot. For example, professional voice users, such as female singers, may detect slight changes during their cycle considerably more than individuals who are not professional voice users and who do not use their voice to this degree (Smith Frable 1962, Abitbol et al. 1999, Chae et al. 2001). Professional voice users require this organ to perform optimally at all times; therefore, a subtle change may result in difficulty managing a performance.

Further reason to propose that hormones influence the vibratory behaviors of the vocal folds exists due to several studies demonstrating that birth control improved the vocal quality (Amir & Shental, 2004; Amir & Rabin 2004; Amir, Shental, Muchnik, & Rabin, 2003; and Amir, Shental, Tzenker, & Barer, 2005). This occurs through the elimination of hormonal fluctuations by creating a stable hormonal balance throughout the menstrual cycle (Amir & Shental, 2004).

The vocal folds vibrate on an average of 224 times per second in females (Stoicheff, 1981). This incredibly rapid vibratory rate requires precise equipment to assess the vibratory characteristics. Self-perception is typically the first method in identifying a change in the vocal quality (Behrman, 2005). Although, in order to be clinically useful, a standardized method is needed for quantification of the severity of the self-perceived consequences. One method is

acoustic analysis of a sustained vowel, which quantifies several parameters of an individual's voice quality. Although this is the golden tool in voice analysis, the studies investigating the variability in fundamental frequency (f_o) (Murry, Brown & Morris, 1995; Brown, Murry, Hughes, 1976; Garret& Healey, 1987) demonstrated f_o could change as much as four semitones within a day (Brown, Murry, & Hughes, 1976). Also, acoustic analysis of voice is an indirect way of analyzing vocal fold vibratory characteristics because the vibratory characteristics of the true vocal folds are only inferred.

Another method is videostroboscopy, which allows the investigator to visualize the laryngeal cavity and evaluate the movement of the vocal folds. This procedure gives the examiner a high-quality image; however, it only captures 36 frames per second revealing a slow-motion effect, and it does not capture each cycle (Yan, Ahmad, Kunduk, & Bless, 2005).

Several studies that have investigated the effects of the menstrual cycle on the vocal fold vibratory characteristics report using methodology such as perception, acoustic analysis, and laryngeal videostroboscopy (LVS); however, not only are there inherent limitations of this methodology, but also the majority of the studies that have used this tool did not account for several underlying factors that may contribute to alterations in the vibratory cycle during menstruation. These include vocal hygiene, reflux symptoms, and severity of premenstrual symptoms. Failure to include these aspects may result in difficulty determining whether increased perturbation measures were a result of hormonal fluctuations or a result of reflux, improper vocal hygiene, or severe premenstrual symptoms.

One of the latest technological advances for viewing the vocal fold vibrations is high-speed digital imaging (HSDI). HSDI acquires images at 2,000 frames per second, allowing for further analysis of the true vocal fold vibratory characteristics (Kay Pentax). This methodology provides direct data on the vibrations of the vocal folds and can display subtle changes in true

vocal fold vibratory patterns that may not be evident through self-perception, videostroboscopy, or acoustic analysis.

The purpose of this study was to collect preliminary data in order to determine if vibratory behaviors correlate with one of three phases of the menstrual cycle. The factors will consist of obtaining subjects' typical severity of premenstrual symptoms during the initial evaluation as well as vocal hygiene, reflux symptoms, and self-perception in each evaluation. A follow up study will include the preliminary data as well as data from HSDI to obtain more objective analysis on the vibratory patterns of the vocal folds during the different phases of menstruation.

CHAPTER TWO
REVIEW OF LITERATURE

For more than 40 years, research on the menstrual cycle as related to the voice in females has been conducted, which has resulted in a debate on whether the vocal fold vibratory behaviors change during the menstrual cycle (Smith Frable, 1962; Silverman & Zimmer, 1978; Abitbol et al., 1989; Higgins & Saxman, 1989; Abitbol et al., 1999; Chae et al., 2001; Amir & Shental, 2004). The menstrual cycle is regulated by the interactions of hormones and other chemical messengers, with estrogen and progesterone being the most predominant. Due to the changes of the hormonal levels during the menstrual cycle, researchers have investigated its effects on vocal fold vibratory characteristics.

The concentration of estrogen decreases for a period of time after the twenty-first day of the menstrual cycle (Markee & Berg , 1944). Consequently, a decrease in the concentration of estrogen results in swelling of the tissues (Schiff & Berg, 1960). Due to these findings Smith Frable (1962) investigated the presence of hoarseness as an unrecognized symptom of premenstrual tension. The author reported that upon premenstruation, the study's three subjects complained of premenstrual hoarseness, lowered vocal pitch, and vocal instability. He postulated that this was due to the decrease of estrogen concentration after the peak on twenty-first day of the menstrual cycle, causing a mucinous edema. In 1989, Abitol et al. completed a study involving 38 female vocalists between 21 and 40 years of age to investigate whether changes in voice accompanied biological and/or hormonal changes. They found that during ovulation and premenstruation significant similarity existed between laryngeal and cervical smears. It was stated that 22 of 38 women experienced changes during the premenstrual phase, as evidenced by voice and dynamic vocal exploration (DVE) changes.

In 1999, Abitol et al. reinvestigated his findings by including 97 women while using the methodology employed in the initial study; however, the study's subjects presented with complaints of premenstrual dysphonia prior to the investigation. The authors reported that the prevalence of vocal syndromes associated with the premenstrual syndrome starts approximately 4-5 days prior to the onset of menses and is estimated to occur in about 33% of women, with vocal professionals being particularly affected. Their symptoms included congestion, microvarices, edema of the posterior third of the vocal folds and a loss of its vibratory cycle.

On the other hand, several investigators have reported contradictory or alternate findings (Chae et al., 2001; Higgins & Saxman, 1989; Silverman & Zimmer, 1978). Silverman and Zimmer (1978) completed a perceptual hoarseness analysis and fundamental frequency analysis on a total of 47 subjects at ovulation and premenstruation. The authors concluded that hoarseness is not a feature of the premenstrual syndrome for the typical woman due to insignificant findings between hoarseness and fundamental frequency during the two phases. Higgins and Saxman (1989) collected voice recordings of ten young women and five young men every other day for thirty-three days with the use of a throat contact microphone. The only notable change in voice was at the time of ovulation; however, it was not significant.

Chae et al. (2000) evaluated the relationship between voice change and premenstrual syndrome (PMS) through comparison of acoustic measurements during the follicular and premenstrual phase in 28 women. The diagnostic criteria for confirming PMS [*Diagnostic and Statistical Manual of Mental* Disorders, 4th ed. (DSM-IV)] examined emotional components as well as other diagnostic criteria such as fatigue, weight gain, and sleep disturbance. The women were divided into PMS-negative and PMS-positive groups. The authors found that when all the subjects were considered as one group there was an increase in jitter, shimmer, and normalized glottal noise energy (NNE) values and a decreasing tendency in fundamental frequency during

the premenstrual phase; however, it was not statistically different. The most significant finding was the PMS-positive group showed an elevated jitter value when compared to the PMS-negative group.

Vocal fold vibratory characteristics have not only been investigated during the menstrual cycle, but also with subjects using oral contraceptives. A series of recent studies investigated the effects of birth control pills on voice quality by means of acoustic analysis (Amir & Shental, 2004; Amir & Rabin 2004; Amir, Shental, Muchnik, et al., 2003; and Amir, Shental, Tzenker, et al., 2005). Each study revealed that vocal stability among the women was typically or significantly better than among those who did not use oral contraceptives. It was suggested that because hormonal fluctuations are eliminated by birth control pills, it creates a stable hormonal balance; therefore, related vocal changes are reduced or eradicated.

Studies investigating the changes that occur in the larynx during the menstrual cycle have demonstrated inconsistent findings; however, these studies fail to provide individualized data on several underlying factors that may contribute to the influence in the changes of the larynx, such as information on the subjects' self-perceived reflux symptoms, severity of premenstrual symptoms, and recent vocal hygiene. Including this data into the analysis may provide an explanation for the inconsistent findings. Furthermore, a number of studies included women aged 40 years or older, which is relatively close to the early onset of menopause (Cramer and Xu, 1996).

The purpose of this investigation was to obtain preliminary data to learn more about the vibratory characteristics and structure of the vocal folds as a function of the hormonal changes that are expected during the menstrual cycle. The data included a rating of the subjects' self-perceived reflux symptoms, severity of premenstrual symptoms, and recent vocal hygiene at three phases of the menstrual cycle: premenstrual, menstrual, and ovulation. A self-perception

rating, acoustic, and stroboscopic data was included as well to assess the correlation with the underlying factors and determine if consistencies are observed between these measures. In future studies, this data will be incorporated into an analysis of high-speed digital imaging.

The following was hypothesized:

1. Increased perturbation measures would be present before menstruation due to vocal fold edema.
2. There would be increased edema on the true vocal folds prior to menstruation.
3. The group using birth control pills would have decreased perturbation measures than the group not using oral contraceptives.
4. Subjects with increased acid reflux would have increased perturbation measures.
5. Subjects with increased negative vocal hygiene behaviors would have increased perturbation measures.

CHAPTER THREE
METHODS

Subjects

Ten post-pubescent females between 20 and 28 years of age participated in the study. All subjects had no history of smoking, no complaints of premenstrual dysphonia, and were not professional voice users. This study consisted of two groups: six subjects not using birth control and four subjects on birth control. The subjects met the birth control criterion for at least three months prior to the first day of investigation. All subjects were evaluated three times within one month or one menstrual cycle to obtain stroboscopic, perceptual, and acoustic measurements. Six of the subjects participated in a second cycle, which assessed the same parameters.

Equipment

The Kay/Pentax Videostroboscope for visualization of the larynx, and the Computerized Speech Lab Model 4400 (CSL) for acoustic analysis of vocal quality were used in this study.

Visualization was approached by means of videostroboscopy, in which a rigid endoscope was passed through the oral cavity and into the posterior oropharynx so that the laryngeal cavity could be visualized. The subject was then asked to vocalize /i/ as in “meet” while using their normal pitch and loudness. These stroboscopic images were used to determine true vocal fold edema, erythema, closure, mucus, and vocal fold edges (Appendix A).

The CSL developed by Kay Elemetrics was used to analyze vocal acoustics. The CSL, a computer interfaced system contains both hardware and software designed to analyze components of the speech signal. Client data were collected by means of a pressure microphone held one inch to the side and in front of the mouth. The software, Multi-Dimensional Voice Profile (MDVP), was used to analyze sustained phonation of /a/ as in “father” in order to quantify the acoustic correlates of the voice.

Perceptual Analysis

The subjects and the author completed the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) (Appendix B) during each session in order to describe the severity of auditory-perceptual attributes of the voice quality. The attributes assessed in CAPE-V are overall severity, roughness, breathiness, strain, pitch, and loudness.

The subjects also completed a questionnaire designed to assess their recent vocal hygiene and the Reflux Symptoms Index (RSI) (Appendix C) prior to each evaluation. The RSI consists of nine questions and was devised to monitor the severity of self-perceived laryngopharyngeal reflux (LPR) symptoms (Belafsky, Postma, & Koufman, 2002).

In addition to the RSI, a vocal hygiene (VH) protocol (Appendix D) was completed prior to each evaluation to assess the subjects' vocal abuse and/or misuse.

A premenstrual syndrome checklist (Appendix E) was completed during the initial evaluation to assess the subjects' perceived discomfort, which included typical affective and somatic symptoms (Kessel, 2000).

Subject Recruitment

All of the subjects were recruited from the campus of Louisiana State University (LSU) in Baton Rouge, Louisiana. The author distributed the information regarding the purpose, procedures, and subject criteria of the study to undergraduate and graduate students of LSU majoring in Communication Sciences and Disorders. The volunteers were then contacted by telephone or e-mail to obtain more information regarding the evaluations and to schedule the appointments. All subjects signed the consent form prior to data collection.

Setting

Evaluations were conducted individually by the author, accompanied by a doctor of speech-language pathology with a specialty in voice sciences. Each participant was seen in a

therapy room prior to the evaluation for completion of paperwork, including a consent form (APPENDIX F), a case history form, a vocal abuse checklist, and a PMS severity rating scale, as well as to address any questions the participant may had regarding the study. The participant was then taken into the diagnostic room for perceptual, visual, and acoustic evaluations.

Data Collection

For the first cycle, the subjects reported the expected date for the onset of menstruation prior to initiating the evaluations and the investigator called the subjects to schedule appointments accordingly and later confirmed the onset. The subjects were evaluated once 3 – 5 (mean 4.4) days post-onset of menstruation, which is when PMS symptoms are typically subsided and estrogen and progesterone levels are typically low (Kessel , 2000), once during ovulation, between days 13 – 15 (mean 14.1) of the menstrual cycle, when hormone levels fluctuate dramatically and rapidly (Higgins & Saxman, 1989), and 1 – 5 (mean 3.6) days prior to the expected onset of menstruation, a time at which PMS usually starts (Abitbol et al., 1999). High fluctuations on the number of days of the premenstrual evaluation were due to patients expected menstruation date based on their typical cycles. For the second cycle, patients who were not taking birth control recorded their basal body temperature and were evaluated the day or the day after a peak was noticed, indicating ovulation. Methods for determining the premenstrual and menstrual phase remained the same. This data collection was completed three times within two menstrual cycles.

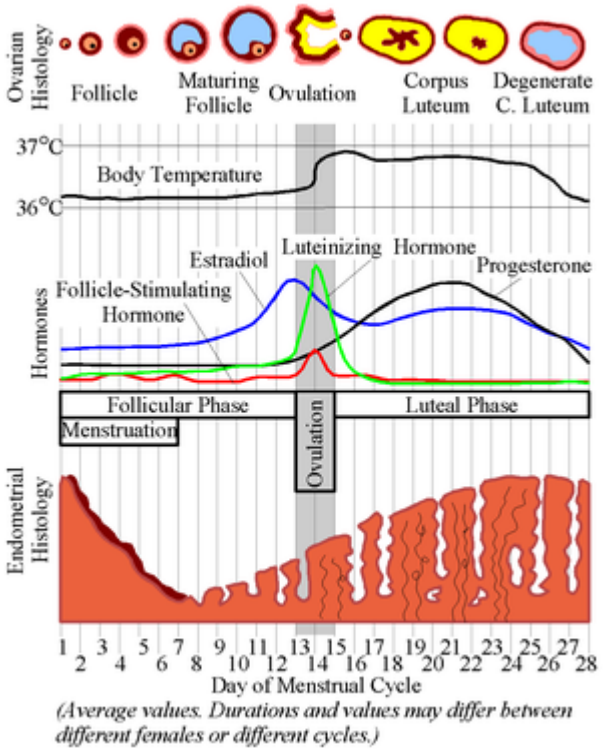

Figure 1. Illustration of typical hormonal fluctuations during the menstrual cycle. Adapted from http://en.wikipedia.org/wiki/Menstrual_cycle.

CHAPTER FOUR
RESULTS

Data from six non-birth control users (Group 1) and four birth control users (Group 2) with no complaints of premenstrual dysphonia were obtained for each acoustic and stroboscopic parameter during the premenstrual, menstrual, and ovulation phases of the menstrual cycle. Checklists or self-perceptual rating forms for severity of premenstrual symptoms, vocal hygiene, reflux symptoms, and vocal quality were obtained as well. Although ten subjects were able to participate, two of the subjects (1 and 2) were eliminated from the analysis of cycle one due to bilateral mid-vocal fold swelling. Due to subject reports of experiencing a "cold" at the time of the evaluation, certain phases were also eliminated as necessary. In the first cycle, subject 6's data were removed from the premenstrual analysis and subject 4 and 9's data were removed from the ovulation phase analysis due to an illness present at the time of the evaluation. Four non-birth control users and four birth control users' data were analyzed for the final analyses of the first cycle.

In addition, four of the non-birth control users and two of the birth control users participated in a second cycle. In the second cycle, subject 3's data from the premenstrual phase were removed due to a recent recovery of an illness and increased RSI score. Subjects whose data were eliminated were denoted by a "double strikethrough" (Ex: "~~~~") and were not included in the averages or figures. These results are presented in Tables 1-10 and Figures 2-30.

Premenstrual Syndrome Checklist

Average scores from the premenstrual syndrome checklist revealed that subjects who were not using birth control experienced more premenstrual symptoms (Average = 4.5) than subjects using birth control (Average = 2). Subject 5 reported the most premenstrual symptoms, with a score of eight. When subject 5 was eliminated from the average to determine her

influence on the results, the subjects who were not on birth control continued to experience more premenstrual symptoms (Average = 3.3). The highest score a subject could obtain was 10 and the lowest was 0. Subject data is presented in Table 1 and Figure 2.

Table 1. Premenstrual syndrome checklist scores obtained during the initial evaluation, based on typical premenstrual symptoms.

Group	Subject Number	PMS Values
Subjects not on Birth Control (Group 1)	~~1~~	~~4~~
	~~2~~	~~0~~
	3	3
	4	4
	5	8
	21	3
	Average:	**4.5**
Subjects on Birth Control (Group 2)	6	2
	7	2
	8	0
	9	4
	Average:	**2.0**

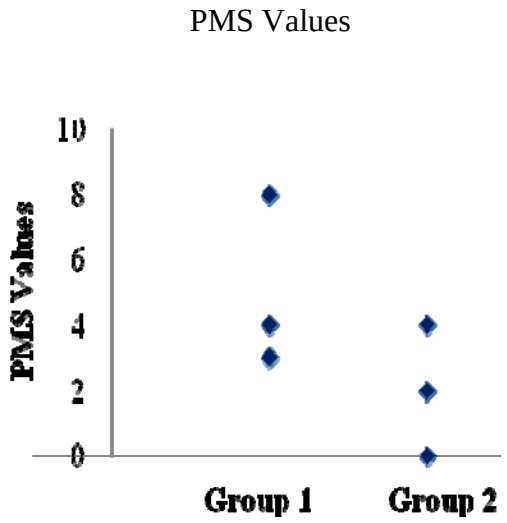

Figure 2. PMS severity ratings between non-birth control (Group 1) and birth control (Group 2) users.

Self- Perceptual Data

Analysis of the CAPE-V revealed most subjects detected changes in their voices when the subjects described themselves as "feeling sick" or "getting a cold." Although most changes were perceived when the subject was ill, subjects 3 and 5 detected a slight change in their voice during the premenstrual phase and ovulation phase, respectively, while not experiencing symptoms of a "cold." Group 1 reported changes during each phase of the menstrual cycle with slight differences between each phase and Group 2 perceived slight differences during the premenstrual phase. A combined analysis of Group 1 and Group 2 reveal minimal differences between the premenstrual (.17) and menstrual (.15) phases and the least values during ovulation. This data is illustrated in Table 2 and Figures 3 – 10.

Table 2: Subjects' self-perceived CAPE-V values obtained during each evaluation in non-birth control and birth control users.

Group	Subject Number	CAPE-V Values Premenstrual Phase		CAPE-V Values Menstrual Phase		CAPE-V Values Ovulation Phase	
		Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2
Subjects not on Birth Control (Group 1)	1	~~0~~	0	~~0~~	1	~~0~~	0
	2	~~N/A~~		~~0~~		~~N/A~~	
	3	1	~~1~~	0	0	0	0
	4	0	0	0	0	~~1.5~~	0
	5	0		N/A		.5	
	21	0	0	0	1	0	0
	Averages:	**.25**	**0**	**0**	**.5**	**.17**	**0**
Subjects on Birth Control (Group 2)	6	~~1~~	1	0	0	0	0
	7	0		0		0	
	8	0	0	0	0	0	0
	9	0		0		~~1~~	
	Averages:	**0**	**.5**	**0**	**0**	**0**	**0**

Premenstrual CAPE-V Values

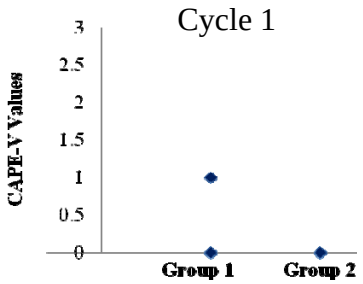

Figure 3. Pre-menstrual CAPE-V values for cycle 1 in non-birth control (Group 1) and birth control users (Group 2).

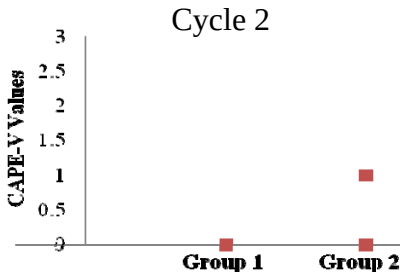

Figure 4. Pre-menstrual CAPE-V values for cycle 2 in non-birth control (Group 1)and birth control users (Group 2).

Menstrual CAPE-V Values

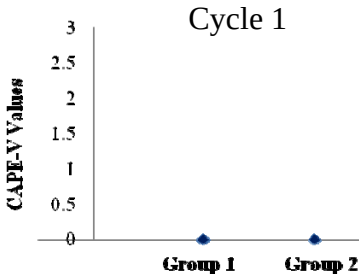

Figure 5. Menstrual CAPE-V values for cycle 1 in non-birth control (Group 1) and birth control users (Group 2).

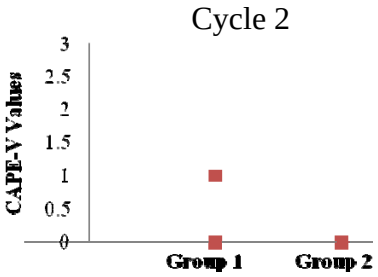

Figure 6. Menstrual CAPE-V values for cycle 2 in non-birth control (Group 1)and birth control users (Group 2).

Ovulation CAPE-V Values

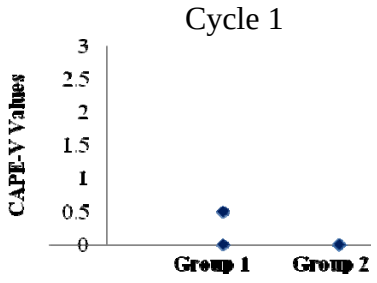

Figure 7. Ovulation CAPE-V values for cycle 1 in non-birth control (Group 1) and birth control users (Group 2).

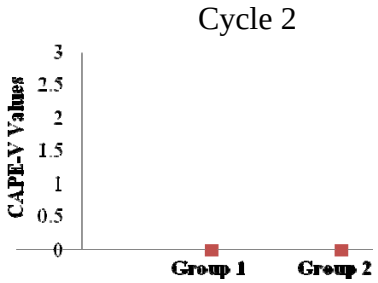

Figure 8. Ovulation CAPE-V values for cycle 2 in non-birth control (Group 1)and birth control users (Group 2).

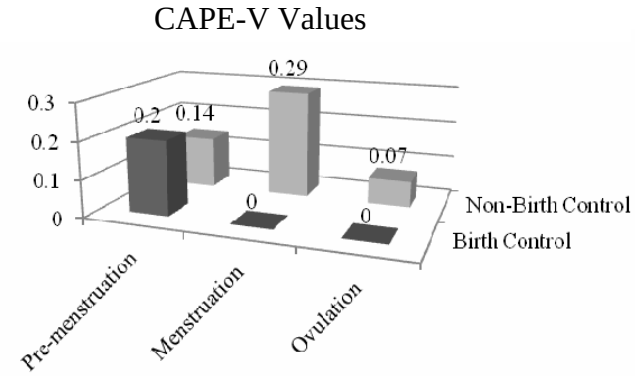

Figure 9. Average CAPE-V scores of cycle 1 and cycle 2 for non-birth control (Group 1) and birth control (Group 2) users.

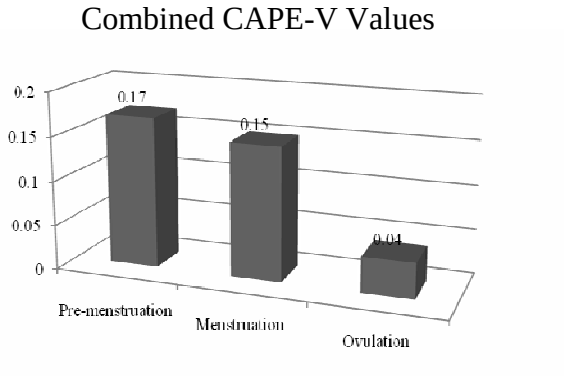

Figure 10. Combined analysis of Group 1 and Group 2 CAPE-V values.

Reflux Symptoms

An detailed analysis revealed that, 21% of the subjects reported the highest RSI score for the premenstrual phase, 29% reported the highest RSI score for the ovulation phase, only 14% during the menstrual phase, and 36% did not report any changes. Although the majority of the subjects reported their most elevated score during the ovulation phase or did not report any changes, premenstrual values maintained the highest averages. A combined analysis reveals the most reflux symptoms were experienced during the premenstrual phase followed by the ovulation phase. The lowest average score for both groups was during the menstrual phase. The

highest value a subject could receive was “45” and lowest was “0.” Individual subject data is presented in Table 3 and Figures 11 – 18.

Table 3: RSI scores at premenstrual, menstrual, and ovulation phase as rated by subjects prior to each evaluation.

Group	Subject Number	RSI Score Premenstrual Phase		RSI Score Menstrual Phase		RSI Score Ovulation Phase	
		Cycle 1	Cycle 2	Cycle 1	Cycle 2	Cycle 1	Cycle 2
Subjects not on Birth Control (Group 1)	~~1~~	~~4~~	2	~~3~~	1	~~2~~	3
	~~2~~	~~20~~		~~6~~		~~4~~	
	3	7	~~16~~	3	4	8	3
	4	4	0	4	0	~~13~~	0
	5	7		~~N/A~~		2	
	21	8	7	4	11	12	3
	Averages:	**6.5**	**3**	**3.67**	**4**	**7.33**	**2.25**
Subjects on Birth Control (Group 2)	6	~~11~~	10	1	0	1	0
	7	5		3		2	
	8	0	0	0	0	0	5
	9	0		0		~~3~~	
	Averages:	**1.67**	**5**	**1.0**	**0**	**1.0**	**2.5**

Premenstrual RSI Values

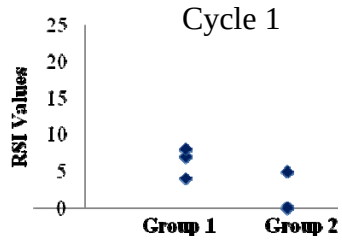

Figure 11. Pre-menstrual RSI severity ratings for cycle 1 in non-birth control (Group 1) and birth control (Group 2) users.

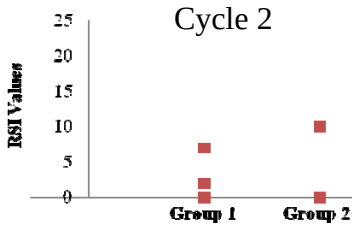

Figure 12. Pre-menstrual RSI severity ratings for cycle 2 in non-birth control (Group 1) and birth control (Group 2) users.

Menstrual RSI Values

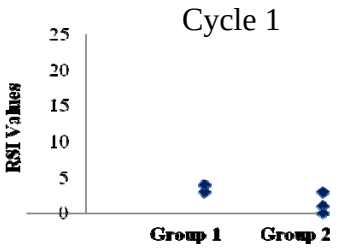

Figure 13. Menstrual RSI severity ratings for cycle 1 in non-birth control (Group 1) and birth control (Group 2) users.

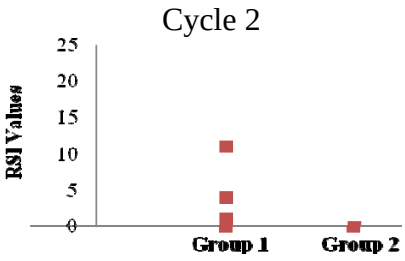

Figure 14. Menstrual RSI severity ratings for cycle 2 in non-birth control (Group 1) and birth control (Group 2) users.

Ovulation RSI Values

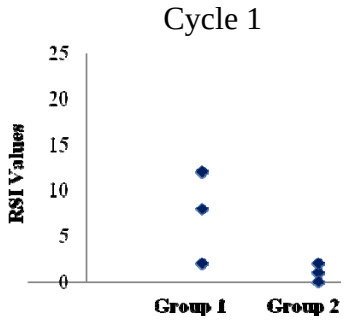

Figure 15. Ovulation RSI severity ratings for cycle 1 in non-birth control (Group 1) and birth control (Group 2) users.

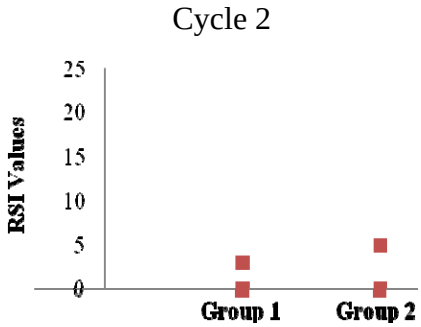

Figure 16. Ovulation RSI severity ratings for cycle 2 in non-birth control (Group 1) and birth control (Group 2) users.

RSI Summary Values

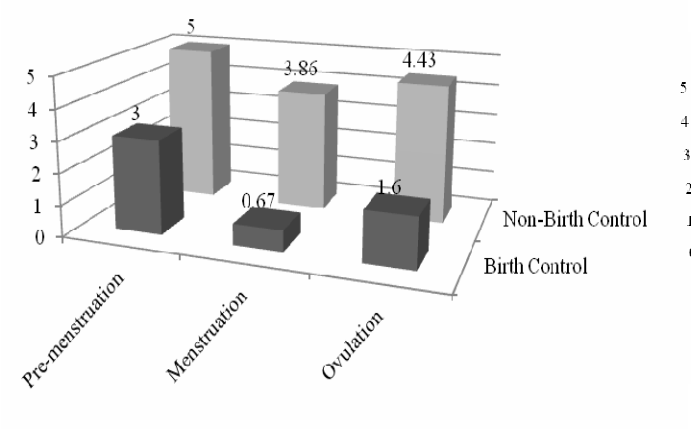

Figure 17. Average RSI scores of cycle 1 and cycle 2 for non-birth control (Group 1) and birth control (Group 2) users.

Combined RSI Values

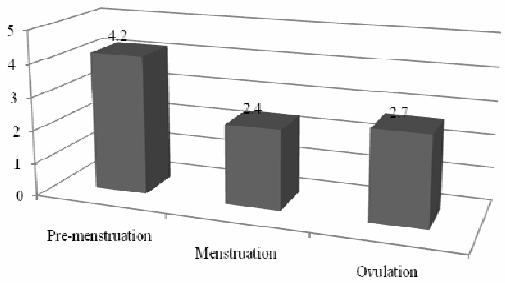

Figure 18. Combined analysis of Group 1 and Group 2 RSI Values.

Vocal Hygiene

The highest scores for vocal hygiene (VH) values were observed to be in the premenstrual phase for Group 1 and in the menstrual phase for Group 2. A combined analysis of Group 1and Group 2 reveal the highest VH scores during the premenstrual phase followed by the menstrual and ovulation phases. The highest score a subject could obtain was 9. The subjects' ratings are presented in Table 4 and Figure 19.

Table 4: Vocal hygiene values obtained during each session as rated by the subjects prior to each evaluation.

Group	File Number	VH Value Premenstrual Phase		VH Value Menstrual Phase		VH Value Ovulation Phase	
		Cycle 1	**Cycle 2**	**Cycle 1**	**Cycle 2**	**Cycle 1**	**Cycle 2**
	1	~~5~~	2	~~5~~	1	~~1~~	3
Subjects not	2	~~1~~		~~2~~		~~4~~	
on Birth	3	1	~~0~~	0	0	2	0
Control	4	3	1	3	2	~~3~~	1
(Group 1)	5	2		~~N/A~~		2	
	21	1	1	0	1	0	1
	Averages:	**1.75**	**1.33**	**1.0**	**1.0**	**1.3**	**1.25**
Subjects on	6	~~2~~	2	2	3	2	1
Birth	7	0		0		0	
Control	8	1	0	1	0	0	0
(Group 2)	9	1		1		~~0~~	
	Averages:	**.67**	**1.0**	**1.0**	**1.5**	**0.67**	**.5**

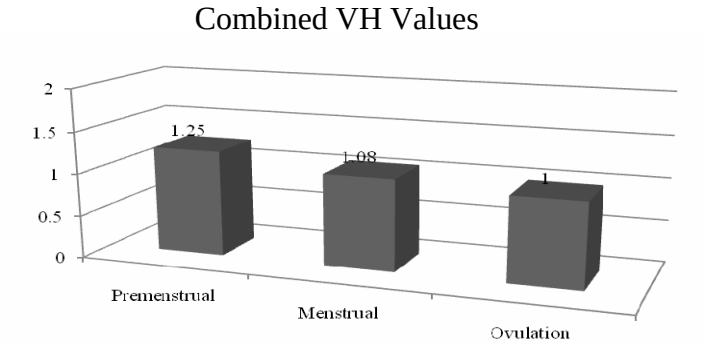

Figure 19. A combined analysis of vocal hygiene values for Group 1 and Group 2.

Acoustic Data

Average scores of jitter and shimmer percentage of perturbations from the CSL demonstrated an increasing tendency during the premenstrual phase in the non-birth control users, followed by the ovulation phase, and the least perturbation measures were seen during the menstrual phase; however, the ovulation and menstrual average differences were minimal. A decreasing tendency was seen in the birth control users during the premenstrual phase and the most elevated perturbations were seen during a time at which ovulation is expected. Combined analysis of Group 1 and Group 2 demonstrate the highest perturbation measures during the ovulation phase, followed by premenstrual and menstrual, respectively; however the differences

between all phases were minimal. Consistent tendencies to demonstrate a correlation between the time of the evaluation and the percentage of perturbations were not observed. Subject data is presented in Tables 5 – 7 and Figures 20 – 22.

Table 5. CSL pre-menstruation perturbations, fundamental frequency, and time of evaluation. Acoustic data was obtained with the sustained phonation of /a/ using the Multi-Dimensional Voice Profile (MDVP).

Group	File Number	CSL Score Premenstrual Phase				Fundamental Frequency		Time of Evaluation	
		Cycle 1		Cycle 2		Cycle	Cycle	Cycle	Cycle
		Jitter	Shimmer	Jitter	Shimmer	1	2	1	2
Subjects not	~~1~~	~~2.3~~	~~3.3~~	1.418	2.993	~~249.078~~	247.505	pm	pm
on Birth	~~2~~	~~1.75~~	~~3.196~~			~~197.552~~		pm	
Control	3	1.048	3.612	~~0.581~~	~~2.427~~	206.037	~~177.712~~	am	am
(Group 1)	4	0.568	1.684	0.333	1.817	241.899	228.462	pm	pm
	5	0.57	4.05			235.027		am	
	21	2.161	3.672	1.623	4.106	228.58	237.894	pm	am
	Averages:	**1.087**	**3.255**	**1.125**	**2.972**	**227.886**	**237.953**		
Subjects on	~~6~~	~~0.666~~	~~3.387~~	1.233	2.42	~~221.80~~6	230.699	am	am
Birth Control	7	0.451	1.994			241.95		am	
(Group 2)	8	0.616	1.756	1.468	3.799	259.83	232.482	am	pm
	9	0.865	3.225			271.671		am	
	Averages:	**.644**	**2.325**	**1.351**	**3.11**	**257.817**	**231.591**		

Table 6. CSL menstruation perturbations, fundamental frequency, and time of evaluation. Acoustic data was obtained with the sustained phonation of /a/ using the Multi-Dimensional Voice Profile (MDVP).

Group	File Number	CSL Score Menstrual Phase				Fundamental Frequency		Time of Evaluation	
		Cycle 1		Cycle 2		Cycle	Cycle	Cycle	Cycle
		Jitter	Shimmer	Jitter	Shimmer	1	2	1	2
Subjects not	~~1~~	~~0.491~~	~~2.433~~	1.138	2.528	~~262.082~~	239.459	pm	am
on Birth	~~2~~	~~3.155~~	~~2.638~~			~~214.078~~		pm	
Control	3	0.789	2.484	0.643	2.534	173.904	173.82	am	am
(Group 1)	4	0.362	2.411	0.302	1.641	239.632	177.847	am	am
	~~5~~	~~N/A~~	~~N/A~~			~~N/A~~		n/a	
	21	1.228	2.449	2.335	3.558	225.543	228.417	pm	am
	Averages:	**.793**	**2.448**	**1.105**	**2.565**	**213.026**	**204.886**		
Subjects on	6	0.469	2.148	0.938	3.398	228.207	243.868	pm	pm
Birth Control	7	0.388	1.863			235.375		pm	
(Group 2)	8	1.808	3.831	0.625	3.05	242.497	241.436	pm	pm
	9	0.337	3.764			247.926		am	
	Averages:	**0.7505**	**2.902**	**.782**	**3.224**	**238.501**	**242.652**		

Table 7. CSL ovulation perturbations, fundamental frequency, and time of evaluation. Acoustic data was obtained with the sustained phonation of /a/ using the Multi-Dimensional Voice Profile (MDVP).

Group	File Number	CSL Score Menstrual Phase				Fundamental Frequency		Time of Evaluation	
		Cycle 1		Cycle 2		Cycle	Cycle	Cycle	Cycle
		Jitter	Shimmer	Jitter	Shimmer	1	2	1	2
Subjects not on Birth Control (Group 1)	~~1~~	~~0.706~~	~~2.094~~	1.631	2.253	~~257.47~~	237.205	am	am
	~~2~~	~~N/A~~	~~N/A~~			~~N/A~~		pm	
	3	0.854	3.532	0.909	2.339	191.238	192.795	pm	am
	~~4~~	~~0.692~~	~~3.101~~	0.556	1.289	~~232.74~~	234.583	pm	pm
	5	0.532	3.326			220.468		am	
	21	1.613	3.246	0.857	2.136	231.569	246.698	pm	pm
	Averages:	**1.0**	**3.368**	**.988**	**2.004**	**214.425**	**227.820**		
Subjects on Birth Control (Group 2)	6	0.719	2.65	0.929	3.583	234.971	234.871	am	pm
	7	0.892	2.513			243.672		am	
	8	1.549	4.649	1.225	3.132	246.709	231.228	am	pm
	~~9~~	~~0.721~~	~~4.592~~			~~234.281~~		am	
	Averages:	**1.053**	**3.271**	**1.077**	**3.258**	**241.784**	**233.05**		

Average Perturbations for Group 1

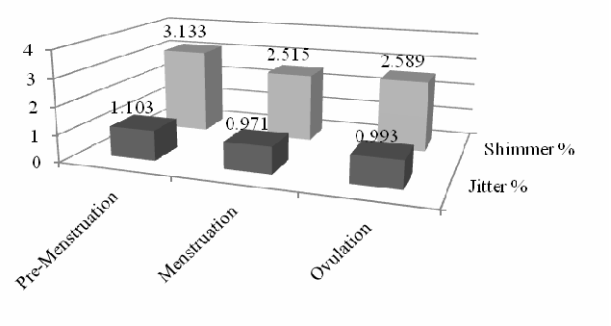

Figure 20. Average perturbation measures for non-birth control users (Group 1).

Average Perturbations for Group 2

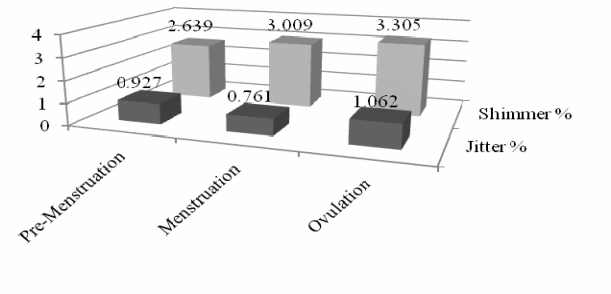

Figure 21. Average perturbation measures for birth control users (Group 2).

Combined Perturbations

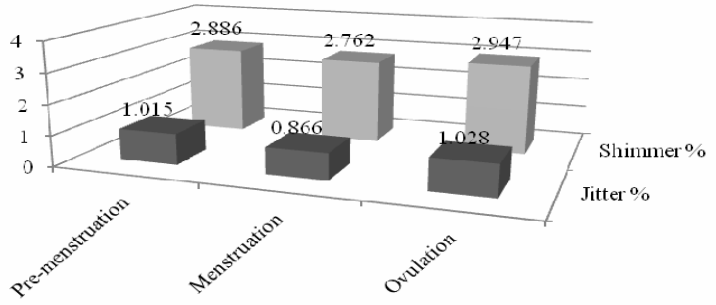

Figure 22. Combined analysis of acoustic perturbations obtained from CSL for non-birth control (Group 1) and birth control (Group 2) users.

Stroboscopic Data

Videostrobosopic data was taken only during the first cycle. The following parameters were assessed through videostroboscopy: closure of the vocal folds upon phonation, presence and/or severity of mucus, edema, and erythema, and status of the vocal fold edges. Due to the subjectivity of rating these parameters, the presence and severity of these parameters were rated *within* each subject by assigning a "0" for none present or normal, a "1" for being present or abnormal, a "2" when severity increased as compared to "1," or a "3" when severity increased as compared to "2." In other words, the ratings are based on an increasing level of severity on an individualized basis that cannot be generalized to the entire group. Ten percent of the data were re-analyzed by the author and differences varied by 1 point or less.

Only the data from cycle one was analyzed due to time constraints. Results demonstrate that subjects not on birth control, Group 1, received peak ratings during the menstruation phase and subjects on birth control, Group 2, received peak ratings during a time at which ovulation is expected. A combined analysis revealed minimal differences between the menstrual and ovulation phase and the lowest values during premenstruation. Subject data is presented in tables 8 – 10 and Figures 23 – 27.

Table 8. Videostroboscopy ratings during the premenstrual phase for subjects not on birth control (Group 1) and subjects on birth control (Group 2).

Group	File Number	Closure	Mucus	Edema	Erythema	VF Edges	Subject Total
Subjects not on Birth Control (Group 1)	~~1~~	~~1~~	~~2~~	~~3~~	~~1~~	~~3~~	~~10~~
	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~5~~
	3	0	1	0	1	0	2
	4	0	1	0	1	0	2
	5	0	1	n/a	0	n/a	n/a
	21	0	1	0	0	0	1
	Averages:	**0**	**1.0**	**0**	**.5**	**0**	**1.67**
Subjects on Birth Control (Group 2)	~~6~~	~~0~~	~~0~~	~~1~~	~~0~~	~~1~~	~~2~~
	7	0	1	1	0	1	3
	8	0	0	0	0	0	0
	9	0	2	0	0	0	2
	Averages:	**0**	**1.0**	**.33**	**0**	**.33**	**1.67**

Table 9. Videostroboscopy ratings during the menstrual phase for subjects not on birth control (Group 1) and subjects on birth control (Group 2).

Group	File Number	Closure	Mucus	Edema	Erythema	VF Edges	Subject Total
Subjects not on Birth Control (Group 1)	~~1~~	~~1~~	~~2~~	~~2~~	~~1~~	~~1~~	~~7~~
	~~2~~	~~1~~	~~2~~	~~1~~	~~1~~	~~1~~	~~6~~
	3	0	2	1	1	1	5
	4	0	2	1	2	1	6
	~~5~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~
	21	0	1	0	0	1	2
	Averages:	**0**	**1.67**	**.67**	**1.0**	**1.0**	**4.33**
Subjects on Birth Control (Group 2)	6	0	1	2	0	3	6
	7	0	1	0	0	0	1
	8	0	0	0	0	0	0
	9	0	1	0	0	0	1
	Averages:	**0**	**.75**	**.5**	**0**	**.75**	**2.0**

Table 10. Videostroboscopy ratings during the ovulation phase for subjects not on birth control (Group 1) and subjects on birth control (Group 2).

Group	File Number	Closure	Mucus	Edema	Erythema	VF Edges	Subject Total
Subjects not on Birth Control (Group 1)	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~5~~
	~~2~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~
	~~3~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~	~~n/a~~
	~~4~~	~~0~~	~~2~~	~~1~~	~~2~~	~~0~~	~~5~~
	5	0	1	1	0	1	3
	21	0	1	1	0	1	3
	Averages:	**0**	**1.0**	**1.0**	**0**	**1.0**	**3.0**
Subjects on Birth Control (Group 2)	6	0	2	1	0	2	5
	7	0	1	1	0	1	3
	8	0	0	0	0	0	0
	~~9~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	~~0~~
	Averages:	**0**	**1.0**	**.67**	**0**	**1.0**	**2.67**

Strobe Ratings – Premenstrual Phase

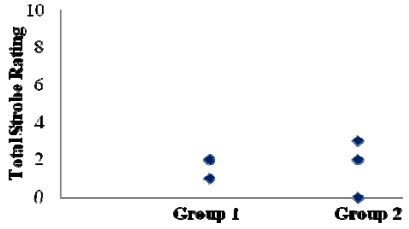

Figure 23. Average strobe ratings during premenstrual phase for subjects not on birth control (Group 1) and subjects on birth control (Group 2).

Strobe Ratings – Menstrual Phase

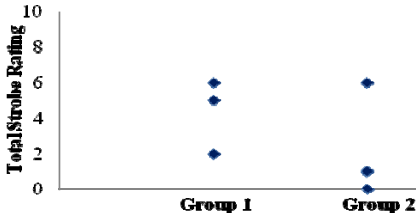

Figure 24. Average strobe ratings during menstrual phase for subjects not on birth control (Group 1) and subjects on birth Control (Group 2).

Strobe Ratings – Ovulation Phase

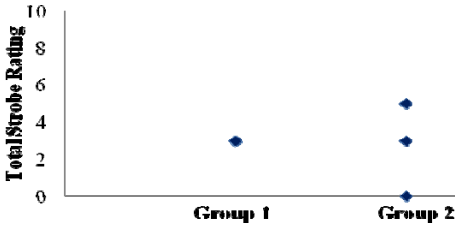

Figure 25. Average strobe ratings during ovulation phase for subjects not on birth control (Group 1) and subjects on birth control (Group 2).

Strobe Ratings for Group 1 and Group 2

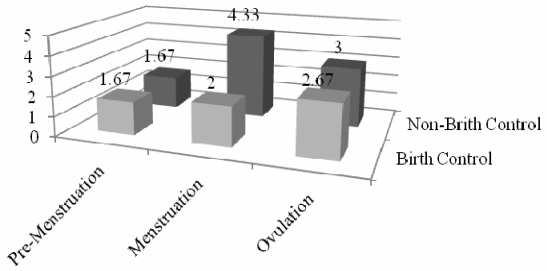

Figure 26. Average strobe ratings for each phase for subjects not on birth control (Group 1) and subjects on birth control (Group 2).

Combined Strobe Ratings

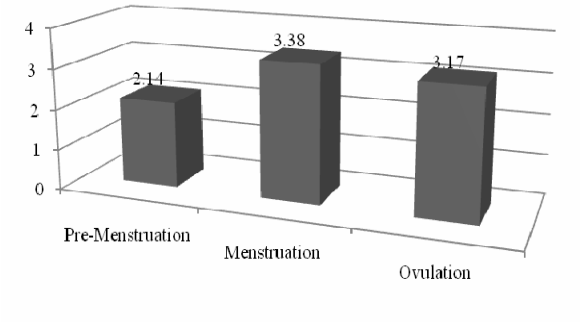

Figure 27. Combined strobe ratings for subjects not on birth control (Group 1) and subjects on birth control (Group 2).

Summary Analysis

The results obtained for Group 1 demonstrate increased perturbations ratings during the premenstrual phase, which also correlate with elevated scores for reflux symptoms and vocal hygiene behaviors. Self-perceptual ratings were most elevated during the menstrual phase and were followed by the premenstrual phase. Group 2 demonstrated inconsistent findings for all measures. Self-perception and reflux symptoms were increased during premenstruation, vocal hygiene scores were most elevated during the menstrual phase, and acoustic perturbations were most increased during ovulation. An overall analysis is presented in Figures 28 - 30.

Summary Analysis of Group 1

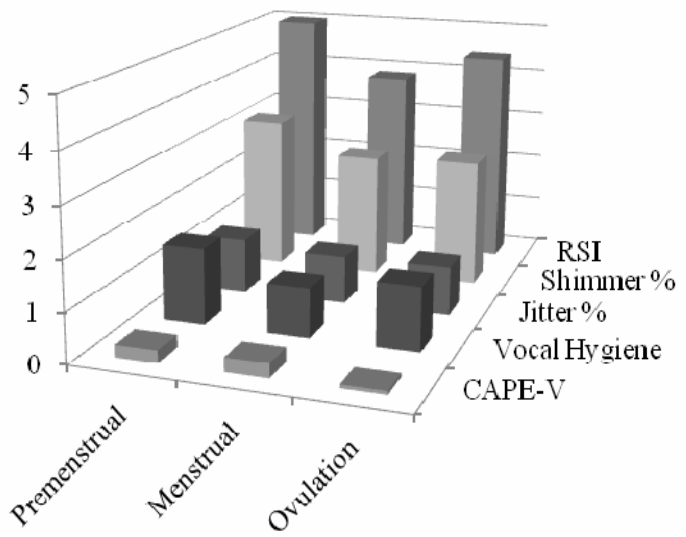

Figure 28. Average results from acoustic (Shimmer % and Jitter %), perceptual (CAPE-V), vocal hygiene, and reflux symptom data obtained during each evaluation for subjects not on birth control (Group 1).

Summary Analysis of Group 2

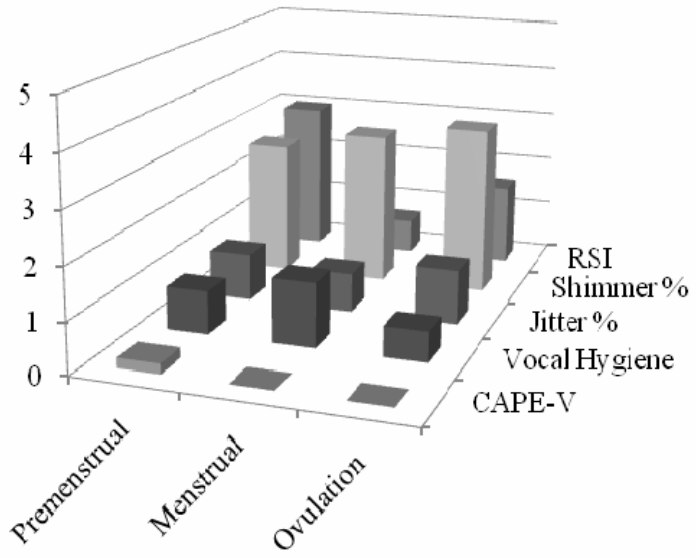

Figure 29. Average results from acoustic (Shimmer % and Jitter %), perceptual (CAPE-V), vocal hygiene, and reflux symptom data obtained during each evaluation for subjects not on birth control (Group 2).

Combined Analysis

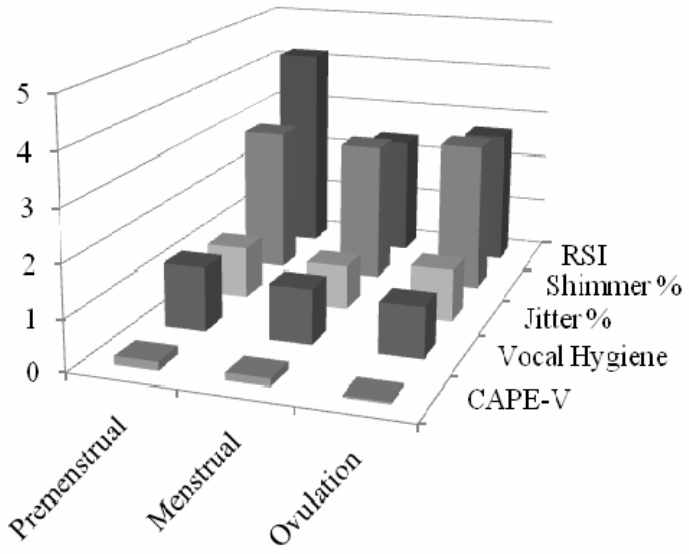

Figure 30. Combined analysis of Group 1 and Group 2 from acoustic (Shimmer % and Jitter %), perceptual (CAPE-V), vocal hygiene, and reflux symptom data obtained during each evaluation.

CHAPTER FIVE
DISCUSSION

The purpose of this study was to obtain preliminary data on the effects of menstruation on the vocal fold structure and function. Perceptual, acoustic and endoscopic images together with RSI, self evaluation and vocal hygiene data were collected from each subject. Evaluations were completed for three phases of the menstrual cycle: 1) the menstrual phase, when there are minimal levels of estrogen and progesterone and premenstrual symptoms have subsided, 2) the ovulation phase, when there is a peak in estrogen and minimal levels of progesterone, and 3) the premenstrual phase, when estrogen and progesterone levels are peaked and premenstrual symptoms are typically present. Ten post pubescent females between the ages 20 and 29 participated in the study. Six of the subjects were not on birth control (Group 1) and four were on birth control (Group 2). Four non-birth control users and four birth control users' data were analyzed for the final analyses. Two of the subjects were eliminated from the study due to bilateral mid-vocal fold nodule like swelling at the time of data collection. Four of the non-birth control and two of the birth control users participated in a second cycle. Data was obtained from three measures: perceptual, visual, and indirect acoustic.

Perceptual Findings

Self-perception was evaluated through the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) to quantify the self-perceived voice changes. Only two subjects reported slight changes in their voice at premenstruation and two during menstruation. The remaining subjects did not indicate any changes unless the subject reported experiencing an illness. These findings contradict the findings reported by Abitbol et al. (1999), Abitbol et al. (1989), and Smith Frable (1962). However, all of these studies reported that self perception was determined based on typical menstrual cycles and did not address other phases of the menstrual cycle.

Stroboscopic Findings

Abitbol et al. (1989 & 1999) employed dynamic vocal exploration (DVE) in both of their studies and found significant changes in the larynx during premenstruation, as noted by edema, presence of microvarices, asymmetric vocal fold vibration, and other less common symptoms. The present study concurs with evaluating these parameters, specifically the presence of mucus, edema, and erythema, to be the most perceptible in identifying changes in the larynx. Though Abitbol and his colleagues documented noticeable changes through DVE in nearly all of the subjects, it must be noted that their subjects experienced complaints of premenstrual dysphonia prior to the investigation. In the present study, subjects were recruited from a pool of young female students at Louisiana State University Communication Disorders Department who had no concerns about their voice. The results of the current study revealed that the least differences were seen in subjects during their premenstrual phase. Even though stroboscopic assessment is a golden clinical tool, the evaluation of stroboscopic images is not standardized. This makes the comparison of the expected subtle changes in vocal fold vibration, presence of edema and erythema in different studies very difficult. Therefore the follow up study with high speed digital imaging with larger subject numbers using an objective endoscopic image processing system might reveal more consistent results in the future.

Acoustic Findings

Acoustic data is another commonly used method in assessing vocal quality. It provides objective data by quantifying several parameters on a sustained phonation. Over seventy percent of the literature reports using acoustic data as at least one of the means in the assessment of voice quality; however, 40% report no significant findings at the premenstrual phase and 60% report significant perturbation increases or tendencies during the premenstrual cycle. Although this tool is efficient and easy to use, it has demonstrated inconsistent findings over time, including

the present study. This may be due to the changes being measured are not significant enough to assess in an indirect way. In addition, within and between sessions, variability in f_o values reported in the literature (Murry, Brown, & Morris, 1995; Brown, Murry, and Hughes, 1976; Garret & Healey, 1987) might have influenced the results. In the present study, Group 1 demonstrated an increase in perturbations during the premenstrual and ovulation phases, which could be attributed to the level of hormone fluctuations present at this time. These results concur with the findings of Abitbol et al. (1999), Abitbol et al. (1989), and Chae et al. (2001). Group 2 demonstrated increased perturbations during a time at which ovulation was expected. These findings support the studies by Amir and Rabin (2004) and Higgins and Saxman (1989) who speculated that an increase at the time around ovulation could be due to the fluctuating levels of hormones present at this time.

Reflux Symptoms

Laryngopharyngeal reflux (LPR) is present in 50% of individuals with voice disorders (Belafsky et al., 2002). Common symptoms include frequent throat clearing, increased mucus, hoarseness, coughing, and other abusive behaviors to the vocal folds. It was recently found that patients with objective LPR experienced higher frequency perturbations than patients not experiencing reflux symptoms (Oguz 2007). Because there are significant differences, it is necessary to include patient reflux symptoms as part of the protocol in assessing the vibratory characteristics of the vocal folds. Failure to include this aspect could result in finding changes in the vibratory patterns during a certain phase of the menstrual cycle, when in fact the patient also reports complaints of reflux. In the current study, it was noted that the most elevated perturbations were during the premenstrual phase, followed by the ovulation and menstrual phase; however, this correlated with the amount of reflux symptoms reported during this phase.

Therefore, a determination could not be made of whether the increased perturbations were due to LPR or premenstrual dysphonia.

While patients reported increased reflux symptoms during premenstruation, it cannot be determined if reflux symptoms are consistent with a certain phase of the menstrual cycle because subjects reported inconsistent patterns of reflux symptoms. Only three subjects were consistent in both cycles and five subjects were not consistent. Thus, reflux symptom scores during the menstrual cycle should be investigated to determine if there is a consistency by including more subjects or more cycles. Previous studies do not specifically address the severity of reflux symptoms during each evaluation; however, these findings support the results of Oguz (2007).

Vocal Hygiene

Vocal hygiene is an important aspect to include in the evaluation of the vibratory behaviors of the vocal folds as well. Fletcher, Drinnan, and Carding (2007) reported that patients who presented with dysphonia were less knowledgeable about proper vocal hygiene when compared to patients who did not experience vocal complaints. As with the importance of inclusion of reflux symptoms, failure to obtain recent vocal hygiene behaviors may prevent finding a clear definition of whether perturbations were induced by improper vocal hygiene or were caused by normal hormonal changes experienced as part of the menstrual cycle.

In the present study, increasing tendencies in the subjects not on birth control (Group 1) were noted during premenstruation; however, the subjects in this group reported more reflux symptoms and negative vocal hygiene behaviors as well. Conversely, findings for subjects on birth control (Group 2) did not demonstrate a tendency towards any phase.

Due to these findings, it is difficult to determine whether the increase in perturbation measures were due to the reflux symptoms experienced and the negative vocal hygiene behaviors or the hormonal fluctuations present during premenstruation.

Clinical Implications

At this time, the present study can only provide a descriptive analysis of tendencies observed for birth control and non-birth control users and perturbations experienced during the premenstrual, menstrual, and ovulation phases of the menstrual cycle with the inclusion of self perceived reflux symptoms, vocal hygiene, and premenstrual symptoms. Although the group not on birth control demonstrated increasing tendencies in acoustic perturbations, reflux symptoms, and vocal hygiene (VH), due to the low number of subjects analyzed, generalizations cannot be made at this time. A clear-cut recommendation regarding the effects of any phases of the menstruation on a vocal performance is not possible until the study includes a larger number of subjects. Increasing the number of subjects will help to determine the normal variability of underlying factors that may attribute to the tendencies observed during different phases of the menstrual cycle.

Limitations

Limitations in this study involved the subject self-reporting the onset of menstruation and when menstruation was expected to occur. Subjects were not required to record daily basal body temperature, as the investigator attempted to place the least amount of demands on the subject because there was no compensation for participation. Ovulation was estimated to be 14 days after the onset of menstruation, although recordings of basal body temperature would have been more reliable. However, when a subject was willing to document the temperature change as a indication of the ovulation phase during the second cycle, this was used to document the time of ovulation and collect the data accordingly. Differences between first and second evaluations during ovulation for the four subjects recording their temperature varied from 1 to 9 days.

Even though every effort was made to see the patients at the same time during the day (ex: all evaluations occur between 8:00 and 10:00) this was not always achieved due to scheduling issues. How this is reflected in the results is unknown.

Implications for Future Research

Future research on measuring the effects of the menstrual cycle on the vibratory characteristics of the vocal folds should include the preliminary data in the present study as well as the use of high-speed digital imaging (HSDI). HSDI will provide an objective analysis on the vibratory patterns of the vocal folds during each phases of menstruation. In addition, inclusion of professional voice users could yield the presence of specific voice issues in this group during the menstruation cycle. The same study with a larger subject number would demonstrate true coexistence of acid reflux and contribution of vocal hygiene issues which further alter the voice production and quality.

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APPENDIX A
STROBE RATING FORM

Pt. Name: _____ Age:_____

Eval 1:

Closure:

Mucus:

Edema:

Erythema:

VF edges:

Notes:

APPENDIX B
CONSENSUS AUDITORY-PERCEPTUAL EVALUATION OF VOICE (CAPE-V)

Name: _____ Date:_____

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

1. Sustained vowels, /a/ and /i/ for 3-5 seconds duration each.
2. Sentence production:

a. The blue spot is on the key again. d. We eat eggs every Easter.
b. How hard did he hit him? e. My mama makes lemon muffins.
c. We were away a year ago. f. Peter will keep at the peak.

3. Spontaneous speech in response to: "Tell me about your voice problem." or "Tell me how your voice is functioning."

Legend: C = Consistent I = Intermittent
MI = Mildly Deviant
MO =Moderately Deviant
SE = Severely Deviant SCORE

Overall Severity _____C I /100
MI MO SE

Roughness _____C I /100
MI MO SE

Breathiness _____C I /100
MI MO SE

Strain _____C I /100
MI MO SE

Pitch (Indicate the nature of the abnormality): _____
MI MO SE

Loudness (Indicate the nature of the abnormality): _____
MI MO SE

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

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

Clinician:_____

APPENDIX C
REFLUX SYMPTOMS INDEX

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

0 = no problem 5 = severe problem

1. Hoarseness or a problem with your voice.	0	1	2	3	4	5
2. Clearing your throat.	0	1	2	3	4	5
3. Excess throat mucus or postnasal drip.	0	1	2	3	4	5
4. Difficulty swallowing food, liquids, or pills.	0	1	2	3	4	5
5. Coughing after you ate or after lying down.	0	1	2	3	4	5
6. Breathing difficulties or episodes.	0	1	2	3	4	5
7. Troublesome or annoying cough.	0	1	2	3	4	5
8. Sensations of something sticking in your throat or a lump in your throat.	0	1	2	3	4	5
9. Heartburn or chest pain.	0	1	2	3	4	5

APPENDIX D
DAILY VOCAL HYGIENE

Have you experienced/demonstrated any of the following within the last three days?

Symptoms of acid reflux	Y	N	Fill out Reflux Symptoms Index.
Significant stress related issues	Y	N	
Insufficient water intake (< 64oz/day)	Y	N	If yes, how many? _____
Excessive yelling/screaming	Y	N	If yes, how long? _____
More than 2 alcoholic beverages in one day	Y	N	If yes, how many? _____
Less than 7 hours of sleep	Y	N	If yes, how many? _____
Increased caffeine intake	Y	N	If yes, how many? _____
Near or in noisy environments (bars/social events)?	Y	N	If yes, how long? _____

APPENDIX E
PREMENSTRUAL SYNDROME (PMS) CHECKLIST

Check all that apply.

Affective Symptoms:
__ depression
__ angry outbursts
__ irritability
__ anxiety
__ confusion
__ social withdrawal

Somatic Symptoms:
__ breast tenderness
__ abdominal bloating
__ headache
__ swelling of extremities

Are symptoms relieved from days 4 through 13 of the menstrual cycle? Y N N/A

APPENDIX F
CONSENT FORM

Study Title: Effects of the Menstrual Cycle on the Vibratory Characteristics of the Vocal Folds

Performance Site: LSU-Department of Communication Disorders

Contacts: Aimee M. Bonnette, B.A.: (Contact Person) Available to answer questions about the research, M-F, 8:00 a.m. – 5:00 p.m. 318-359-1060

Melda Kunduk, Ph.D., CCC-SLP
M-F, 8:00 a.m. – 5:00 p.m.: 225 578 3930

Purpose of the Study: The purpose of this research project is to determine if there is a variation in the vibratory behavior of the vocal fold vibratory characteristics before, during, and after menstruation.

Subjects: *Inclusion Criteria*: Females, ages 18-29 who are experiencing a typical monthly menstrual cycle who may or may not be on oral contraceptives.

Exclusion Criteria: History of smoking.

Maximum Number of Subjects: 20

Study Procedures: Five forms will be filled out prior to the investigation. These will include a brief premenstrual syndrome (PMS) checklist, a vocal hygiene checklist, a reflux symptom checklist to assess presence of reflux, a voice self-perception rating scale, and a general health questionnaire. The evaluation will involve a small tube being placed into the mouth to visualize the vocal folds during vocalization. This procedure will be done twice using the same tube with two different camera attachments. The subject's true vocal folds will be examined before during and after menstruation for two consecutive menstrual cycles. Each evaluation should last approximately thirty minutes. Prior to each endocopic evaluation, the PI will ensure that the endocope used to capture laryngeal images has been cleaned and sterilized according to recommended KAYPENTAX factory standards.

Benefits: Subjects will receive a clinical evaluation free of charge on the function of the larynx accompanied by high quality color images. Education on proper vocal hygiene will be provided to all subjects free of charge. Information gained may provide early identification of at-risk individuals to whom prevention efforts can be directed.

Risks/Discomforts: Although there are no known risks of injury, a slight discomfort upon endoscopy may be experienced in some individuals with a sensitive gag reflex. Anecdotally, only less than 10% of the clinical population experiences this.

Injury/Illness: In the event of detecting an at-risk individual, the subject will be referred to Dr. Andrew McWhorter # 504-412-1570, or to the patient's own ENT for treatment; however, the expense of medical treatment will be your responsibility. No compensation is available in-case of study-related illness or injury.

Right to Refuse: Subjects may choose not to participate or to withdraw from the study at any time with no jeopardy to their treatment by their respective doctors or other penalty at the present time or in the future.

Privacy: The LSU Institutional Review Board (which oversees university research with human subjects) may inspect and/or copy the study records. Results of the study may be published, but no names or identifying information will be included in the publication. Other than as set forth above, subject identity will remain confidential unless disclosure is legally compelled.

Financial Information: There is no cost to the subjects, nor is there any compensation for participating in the study.

Signatures: The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of the consent form.

Subject Signature _____ Date_____

VITA

Aimee Michelle Bonnette was born and raised in Moreauville, Louisiana. After completing her freshman year at Louisiana State University in Alexandria, where she discovered her admiration and the importance of speech-language pathologists, she transferred to Louisiana State University and Agricultural and Mechanical College in Baton Rouge to pursue her degree in communication disorders.

In the spring of 2005, Ms. Bonnette was awarded a Bachelor of Arts in communication disorders, with a minor in French, from Louisiana State University. After completing her first year as a graduate student in communication disorders, Ms. Bonnette recognized her appreciation of the structure and function of voice and voice disorders, as well as swallowing disorders. She completed this thesis in partial fulfillment of the requirements for the degree of Master of Arts in the Department of Communication Sciences and Disorders. Upon completion of her master's degree in May 2007, she plans to complete her clinical fellowship year and specialize in the evaluation and treatment of voice and swallow disorders.