

THE EFFECT OF THE BREATH BUILDER™ ON VARIOUS LUNG FUNCTIONS
AND MUSICAL PERFORMANCE ABILITIES OF CLARINET PLAYERS

by

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SIGNED: _____
Wendy E. Mazon

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DEDICATION

To my husband Marco Bustamante, with love.

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ABSTRACT

The purpose of this study was to focus on the efficacy of a dynamic breath exerciser called the Breath Builder™ and its effects on clarinet players' performance abilities and/or lung functions. The study sample consisted of 15 clarinetists, a combination of undergraduate and graduates from the clarinet studio at the University of Arizona, ages 18 – 27. The eight-week study consisted of two phases. During Phase 1, subjects in experimental group 1 used the Breath Builder™ three times a day, five times a week. The control group was not given Breath Builders™ and continued with their normal practice routine. In Phase 2, the control group was given Breath Builders™ and relabeled as experimental group 2. Experimental group 1 stopped using the Breath Builder™ and was relabeled as experimental group 3. Following this cessation, the subjects in experimental group 3 were measured to note any change in lung function or performance. Some of the pulmonary lung function measurements used for this study were, Forced Vital Capacity (FVC), Maximal Inspiratory Pressure (MIP), Maximal Inspiratory Pressure in 1 second (MIP₁), and Maximal Expiratory Pressure (MEP). Musical abilities measured were tone, note duration and phrase duration. A significant interaction effect was found regarding MIP and MIP₁.

CHAPTER 1

INTRODUCTION

Managing airflow is a fundamental skill for all wind musicians. “Wind instrument players are concerned with the creation and maintenance of a moving column of air, which is the responsibility of the respiratory muscles alone” (Kelly, 1983, p. 7). In response, many different exercises and devices have been invented to train breath control, yet little research exists on the effectiveness of such devices and methods. Harold Hansen, inventor of the Breath Builder™¹ originally created the device to aid his bassoon students in their breathing technique.

The Breath Builder™ (See Appendix A) is made of a plastic cylinder, closed off at the bottom with the top containing four holes: one raised hole, one large hole, and two smaller holes. Inside, at the bottom of the closed cylinder of the Breath Builder™ sits a ping-pong ball. The device comes with two different breathing tubes, (both tubes are the same length, but differ in diameter). Only one tube is used at a time; i.e., using the smaller breathing tube will increase the resistance. There are various methods for using the Breath Builder™, but the general concept is as follows (See Appendix B): A breathing tube is inserted in or around the raised hole on the top of the Breath Builder™. When the subject blows a sufficient amount of air into the Breath Builder™, the ping-pong ball will rise to the top of the cylinder. The general goal is to breathe in and blow out through the Breath Builder™ the precise amount of air needed to sustain the ping-pong ball at the top of the Breath Builder's™ cylindrical body, no more, no less. If there

¹ The Breath Builder™ was invented by bassoonist, Harold Hansen, in the 1970s to help his students learn to breath properly without tension.

is not enough air movement during either inspiration or expiration to sustain the ping-pong ball, the ball will drop. Again, this occurs as the subject breathes continuously through the breathing tube, during both inhalation and exhalation, creating a flowing cycle. The ping-pong ball acts as visual feedback to the subject, since it falls or sinks with diminished airflow. Resistance can be increased by either using the smaller breathing tube or by covering one or two of the three open holes at the top of the Breath Builder™.

Many pedagogues prescribe to the Breath Builder™ and believe in its ability to help their students. The late Arnold Jacobs, tubist with the Chicago Symphony Orchestra for 44 years and a master teacher famous for his clinics on breathing and motivation, was a great advocate for the Breath Builder™. He believed they were “excellent devices,” recommended them “very highly,” and maintained they were “marvelous little devices for anybody who’s all tied into knots with respiration” (Wind Song Press Limited, 2008). Brian Fredrickson, founder of Wind Song Press Limited, sells the Breath Builder™ and other breathing devices on his website. When asked specifically about the Breath Builder™, Fredrickson said he believes musicians should be interested in the exhalation aspect, but even more in the inspiration aspect of the Breath Builder™. This is because he believes it can assist musicians in taking advantage of their entire lung capacity.

Keith Johnson, Regents Professor of Trumpet at the University of North Texas, and Keith Underwood, Professor of Flute at NYU Steinhardt Department of Music, have both used the Breath Builder™ with their students for more than 20 years. Underwood asserts the Breath Builder™ helps musicians “get in touch” with their air and maintain an even airspeed by blowing the air very smoothly, sustaining the ping-pong ball (personal

communication, March 2, 2008). Johnson believes the Breath Builder™ focuses on motion and flow and he uses it to prompt individuals to take big flowing breaths, which helps them become aware of how they can play more efficiently with a flowing breath (personal communication, February 28, 2008)

Breathing Mechanism

Many muscles are involved in the processes of inspiration and expiration; however, the breathing technique for the average human being is different from the deep breathing technique utilized by wind musicians. In the past, many believed that the average human being utilized thoracic respiration² or ‘chest breathing’, as opposed to the deep diaphragmatic breathing used by musicians. Anthony Gigliotti, former principal clarinet of the Philadelphia Orchestra and former teacher of clarinet at the Curtis Institute, stated, “Up to a certain point in life everyone breathes correctly, but, for some reason, we change from the low diaphragmatic breathing³, which is correct and normal, to an upper chest manner of breathing” (Hegvik, 1970, p. 181). However, current medical research seems to dispute a portion of this widely held view on respiration. “During quiet breathing, the diaphragm is the principle muscle of inspiration with a tidal excursion in adults on average 1.5 cm. (*Lung Function*, 2006, p. 101).” However, Mr. Gigliotti was correct in his emphasis on the importance of low diaphragmatic breathing or deep breathing to musicians.

² Thoracic respiration- Respiration performed entirely by expansion of the chest when the abdomen does not move. (Taber’s Cyclopedic Medical Dictionary, 2005, p. 1884).

³ Diaphragmatic Breathing- A pattern of exhalation and inhalation which most of the ventilatory work is done with the diaphragm. Also called diaphragmatic respiration and abdominal breathing (*Mosby’s Medical Dictionary*, 2002, p. 517).

“During deep breathing, the diaphragm is also the primary muscle of inspiration, but Wade has shown that the excursion relative to the insertion of the diaphragm can be as much as 10 cm. Diaphragmatic movement is responsible for about 75% of the volume of gas that is inhaled; the remaining 25% is attributable to the movement of the ribs. (*Lung Function*, 2006, p. 101).

Therefore, the larger the diaphragmatic contraction the more air can be drawn into the lungs and thus utilized when playing a wind instrument.

Inspiration is the “act of drawing air into the lungs” (*Mosby's Medical Dictionary*, 2002, p. 899) through the involvement of several muscles. Listed in order of importance they are the diaphragm and the accessory inspiratory muscles: the external intercostals, scaleni, scapular elevators, and sternocleidomastoids (See Appendix C). The diaphragm is a dome-shaped muscle that separates the thoracic and abdominal cavities and is the primary muscle used for inspiration (*Mosby's Medical Dictionary*, 2002, pp. 517, 899). In the initial act of inspiration, the diaphragm flattens and the accessory muscles contract, expanding the thoracic cavity and the lungs. This movement creates a vacuum as the inside pressure of the body becomes lower than the outside pressure of the body. Air is then drawn into the lungs in an attempt to achieve balance by increasing the pressure inside the body. This movement of the diaphragm cannot be seen from outside of the body. The expansion that is perceived is actually the relaxing of the abdominal muscles, the rectus abdominus and external obliques, so that the diaphragm has room to contract, and the contraction of the external intercostals, located between the ribs, allows the thoracic cavity to expand outward. Therefore, the deeper the breath, the greater the diaphragmatic contraction, and thus the greater the need for relaxation of the abdominal muscles. The relaxation of the abdominal muscles is key to the inspiration process as

“controlled relaxation of the abdominal muscles, not a false sense of controlling the diaphragm itself, is essential to inspiration” (Lakin, 1969, pp. 48-49).⁴

With mild or shallow breathing⁵, the external intercostals become active with little diaphragmatic movement. This kind of inspiration only recruits the uppermost intercostal muscles diminishing the volume of air taken into the lungs. With deeper inspiration, the additional recruitment of lower and lower intercostal muscles occurs. This is why much shoulder movement with little expansion in the thoracic cavity is observed in “shallow” or “chest breathing” (Lakin, 1969, p. 49). Successful breathing for musicians requires deep inspirations and the recruitment of all muscles involved in the inspiratory process. “Musculature of the diaphragm, neck, chest wall, and abdomen all contributes to the production of the air column” (Gilbert, 1998, p. 24). Inspiration is followed by expiration in the breathing cycle.

Unlike inspiration, expiration – the act of breathing out – is considered a passive process (*Mosby's Medical Dictionary*, 2002, p. 642). The lungs, once expanded, diminish in size as the inspiratory muscles used to expand the lungs and the thoracic cavity relax. Passive expiration occurs in normal breathing, such as during sleep or quiet reading, and can be considered a recoil effect of inspiration (Lakin, 1969, p. 50). However, for musicians, expiration is an active process, as they need to control the output of air. One requirement for wind playing is to be able to “generate an air column with precise control of flow, duration, and pressure” (Gilbert, 1998, p. 24). Active expiration consists of

⁴ One of the first musical articles to address the kinesthetic aspects of breathing (Brian Luce, personal communication, March 9, 2009).

⁵ Shallow breathing- a type of breathing w/ abnormally low tidal volume (*Stedman's Medical Dictionary*, 2006 p. 267).

passive expiration with the additional use of muscles such as the lateral abdominal muscles, the external and internal obliques, and the internal intercostals— the muscles located between the ribs that allow them to be lowered (Lakin, 1966, p. 49). As a larger, more intense air stream is required for musicians, the lateral abdominals, intercostals, and other muscles contract to assist in the process of expelling air out of the lungs.

Factors of Lung Volume

Various factors affect lung volume such as age, gender, height and weight (McArdle, W., Katch, F.I., & Katch, V.L. 1996, p. 222). Lung capacity in children increases as they grow older, but there is a point in an adult's life where the lung tissue begins to lose its elasticity, thereby increasing residual volume (volume of air that remains in lungs even after a deep exhale) and decreasing vital capacity (total volume of air that a subject can move in one breath). Males generally have larger vital capacities than females with healthy young men averaging four and five liters and healthy young women averaging three and four liters (p. 222). Height and weight also affect lung volume. Larger volumes are found in taller subjects and smaller volumes in heavier subjects. This is because "fat can be laid down in the mediastinum, around the heart, in the pleural space and above the diaphragm. In many of these positions it occupies space that would otherwise be available for alveolar air (Coates, J. E., Chinn, D. J., & Miller, M.R., 2006, p. 321)." Larger lung values can also be found in athletes, but this "generally reflect[s] genetic influences on body size characteristics, because static lung volumes cannot be changed with exercise training to a great degree" (p. 222).

Standard and predicted values have been created to evaluate a subject's lung function performance as can be seen in Appendix D and Appendix E. These male and female vital capacity charts, created by Arnold Jacobs, are based on a formula from the American Thoracic Society. This information is crucial to musicians because the short female, age 24, with a smaller lung volume will have to be able to compete with the tall male, age 24, who has a larger lung volume based on genetics, during auditions and performances. In this regard, breathing exercises and devices can be helpful as the ability to sustain a breath until the end of a long phrase can mean the gain or loss of a job.

Breathing devices such as the Breath Builder™ were created to assist musicians in developing the respiration process, and although many musicians feel the Breath Builder™ improves their breathing abilities, no studies have been published regarding its effectiveness. This study focused on the efficacy of the dynamic breath exerciser called the Breath Builder™ and its effects on clarinet players' performance abilities and/or lung functions.

Intent and Scope of Study

This study examined whether the device known as the Breath Builder™ has any significant effect on a subject's lung functions and/or performance abilities. The performance abilities measured in the study included tone, note duration, and phrase duration. The lung function measurements taken into consideration were: (1) Forced Expiratory Volume in 1 second (FEV1), starting from the level of total lung capacity, the volume exhaled during the first second of a forced expiratory maneuver; (2) Forced Vital Capacity (FVC), the maximum breath volume or volume change of the lungs between a

full inspiration to total lung capacity and a maximal expiration to residual volume; (3) Maximal Inspiratory Pressure (MIP), the measure of the power of the inspiratory muscles; (4) Maximal Inspiratory Pressure in One Second (MIP₁), the measure of the power of the inspiratory muscles during the first second of the maneuver; (5) Maximal Expiratory Pressure (MEP), measuring the power of the expiratory muscles; and (6) Maximal Expiratory Pressure in One Second (MEP₁), the measure of the power of the expiratory muscles during the first second of the maneuver.⁶

Two research questions pertaining to two major areas were investigated:

- (1) Would there be any significant difference in lung function (FVC, FEV₁, MIP, MIP₁, MEP, MEP₁ [dependent variables]) by subject group or passage of time (independent variables)?
- (2) Would there be any significant difference in music performance abilities (tone, note duration, and phrase duration [dependent variables]) by subject group or passage of time (independent variables)?

⁶ These are common measurements used in the medical field to determine of lung function.

CHAPTER 2

JUSTIFICATION/LITERATURE REVIEW

The Breath Builder™ was originally developed for use by wind musicians; however, Harold Hansen (the Breath Builder™ inventor) recognized its potential and believed it could also be used to assist other individuals. When an associate of Mr. Hansen introduced the Breath Builder™ to the medical field, it was seen as a medical breakthrough. The medical corporation (Chesebrough Ponds Inc.) to which it was presented used the idea to design their own breathing device prototype (Triflow). The corporation then marketed the device to the medical community, making millions of dollars in the first years after the device's introduction. Mr. Hansen filed a lawsuit against the corporation and won a court settlement (*Laurie Visual Etudes v. Chesebrough Ponds Inc.* [1979/1980]).

This brief history of the Breath Builder™ is relevant, as the medical field has performed and continues to perform research studies on the effect of breathing exercises and devices similar to the Breath Builder™ on lung function. Designated “incentive spirometers,” these breathing devices are described as “a device that encourages, through visual and/or audio feedback, the performance of reproducible, sustained maximal inspiration” (Overend, 2001, p. 972). Such devices are widely used in the treatment of patients with chronic obstructive pulmonary disease (COPD), to prevent postoperative pulmonary complications (PPC), and to help patients regain proper lung function after surgery. However, no studies have been conducted on the Breath Builder™.

Incentive Spirometry and Unhealthy Subjects

Though incentive spirometry and various breathing exercises, such as intermittent positive pressure breathing and deep breathing exercises, are a common type of physical therapy for post-operative patients, controversy exists regarding their effectiveness. In a systematic review, Overend et al. (2000) examined forty-six studies that compared incentive spirometry's effectiveness in preventing postoperative pulmonary complications in subjects after surgery. Of the forty-six studies reviewed, thirty-five were deemed unreliable due to flawed methodologies. Of the remaining studies, only one found treatment of incentive spirometry to be significant (Celli et al., 1984), while others found no significance (i.e., Dull & Dull, 1983; Gale & Sanders, 1980; Matte et al., 2000; Ricksten et al., 1986; Schwieger et al., 1986; Stock et al., 1984, 1985).

More recent studies, again with none focusing on the Breath Builder™, have continued to find conflicting results. Agostini et al.'s (2008) research found incentive spirometry useful, but maintained that it should not replace the work of a physiotherapist:

Incentive spirometry is a relatively good measure of lung function and may be used to assess respiratory recovery in the days after thoracic surgery. . . . but there is currently no evidence that incentive spirometry in itself could either replace or significantly augment the work of the physiotherapists. (p. 300)

Other researchers have found that incentive spirometry alone did not make a significant difference in lung function but did affect other factors. Basoglu et al. (2005) noted that incentive spirometry did not change the lung function in subjects with COPD, but did have a positive effect on improved arterial blood gases and “health-related quality of life” (p.353). Romani et al. (2007) found intermittent positive pressure breathing to be more efficient when compared to incentive spirometry; however, incentive spirometry was

more effective in improving respiratory muscle strength in patients undergoing myocardial revascularization surgery with significance occurring in maximal expiratory pressure (MEP), specifically MEP 24 hours ($p=0.02$) and 48 hours ($p=0.01$) after surgery. (p. 94). Westwood (2007) found “the addition of the incentive spirometer, as part of an intensive post-operative physiotherapy programme, decreased the occurrence of pulmonary complications and length of stay on the surgical high dependency unit” (p. 341).

Though the results of studies on incentive spirometers in unhealthy populations are conflicting, what cannot be overlooked is the fact that hospitals continue to use them and that previously mentioned studies have found positive results due to utilization of the devices. It is important to remind readers that these studies were limited to the rehabilitation of unhealthy subjects. What about healthy subjects?

Breathing and Healthy Subjects

This investigator targeted a healthy population; therefore, an overview of literature focusing on the effect of breathing exercises and devices on the lung function of healthy populations is warranted (Gething et al. 2004, Griffiths & McConnell 2007, Parreira et al. 2005, Verges et al. 2008, Wylegala et al. 2007). The study of incentive spirometers in healthy subjects is rare, and because Parreira et al. (2005) focused on comparisons between spirometers, the topic of the effect on lung function and performance was not directly addressed. They chose the most common incentive spirometers used in clinical settings and separated them into categories of volume-oriented (Coach, DHD Medical Products; Voldyne, Hudson RCI) and flow-oriented

(Triflo II, Hudson RCI ; Respirex, DHD Medical Products).⁷ The intent was “to evaluate tidal volume and thoracoabdominal motion using volume and flow-oriented incentive spirometers, evaluate oxygen saturation and heart rate during the use of these incentive spirometers, and to compare the differences in results between the various spirometers” (p. 1106). Results showed the comparison between volume-oriented devices (Coach and Voldyne), with Voldyne reaching larger values of tidal volume and minute ventilation. Comparisons between flow-oriented devices (Triflo II and Respirex) showed Triflo II reaching larger values of inspiratory duty cycle (proportion of time during which the spirometer was used) and lower mean inspiratory flow. Comparisons between volume-oriented devices and flow-oriented devices demonstrated larger abdominal motion and abdominal displacement during use of volume-oriented devices compared to flow-oriented devices (p. 1105).

Many studies dealing with healthy subjects have demonstrated the effects of respiratory training in physical tasks such as cycling, swimming, diving, and/or running (Gething et al., 2004; Verges et al., 2008; Wylegala et al., 2007). Gething et al. (2004) performed a ten-week trial on three groups of cyclists. One group performed “inspiratory resistive loading” (resistant breathing exercise [IRL]), another performed the same task but with minimal resistance, while the third group was the control group (not given any exercise). The IRL device used was flow resistive, with subjects having to breathe through a 2 mm opening, present to prevent glottal pressure. The IRL device used in this

⁷ Although the Breath Builder™ was not used in this study, it should be noted that the original Triflo device made by Chesebrough-Ponds was based on the Breath Builder™. The second generation of the Triflo, Triflo II, was used in the study (Parreira et al., 2005).

study seems similar to the Breath Builder™; however, the IRL device only focused on inspiration while the Breath Builder™ encourages flow between inspiration and exhalation. After ten weeks, the group that performed “inspiratory resistive loading” exhibited reduced heart rate and ventilatory and perceptive responses to constant workload exercise and improved cycling times to exhaustion (p. 736).

Verges et al. (2008), in a re-analysis of nine studies performed in their lab in Switzerland, found respiratory muscle endurance training (RMET) “increased both respiratory and cycling endurance, reduced perception of breathlessness and respiratory exertion . . . and slightly increased ventilation” (p. 16). However, it is the level of ventilation that appears to have positively affected cycling endurance, rather than the decreased respiratory sensations (p. 21).

Griffiths and McConnell (2007) performed a similar study on rowing performance. Subjects over a four-week span used either inspiratory muscle training (IMT) or expiratory muscle training (EMT), followed by a six-week period of a combined IMT/EMT regimen. The lung function measurements taken were peak inspiratory flow (PIF), peak expiratory flow (PEF), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), and forced expiratory flow at 50% of FVC (FEF50%). No significance was found in many of the lung function measurements, namely FVC, FEV1, and FEF50%. No significance was found in the first part of the study in the EMT group either; however, significance was identified for this group between the baseline and after the six-week test. In addition, significance was found in peak inspiratory pressure, which increased in the IMT group during the four weeks and

six weeks of training.

Wylegala et al. (2007) studied respiratory muscle training and its effects on divers' swimming endurance. The hypothesis was that respiratory muscle training would increase the strength and endurance of the respiratory muscles allowing for longer swimming times before exhaustion (p. 394). Results indicated that respiratory muscle training significantly improved exercise endurance in subjects both in swimming on the surface and underwater, in respiratory endurance, and in both maximal inspiratory and expiratory muscle strength (pp. 399, 402).

Although conflicting evidence exists on the efficacy of incentive spirometry and various breathing devices on healthy and unhealthy populations, there have been no studies in either population using the Breath Builder™.

Breathing and Musicians

Many non-research-based articles have been written on the topic of breathing, as it is a basic fundamental for all wind musicians and thus essential for success. In an interview about the importance of breath support, the late Mitchell Lurie stated, "Breath support is the whole story. It's the root, it's the foundation of every one of those elements . . . tonal resonance, quality, pitch, articulation" (Waln, 1978, p.277).⁸ Kelly (1983) states in regard to the oboe "The time during which an oboist can sustain a note is not limited so much by the air pressure and air flow requirements of the instrument as by his breath-holding time." Similar comments have been written in regard to tuba. "[A] tuba player

⁸ Mitchell Lurie was a world-renowned clarinetist and teacher. While studying at Curtis he was recruited to play in the Pittsburgh Symphony Orchestra by Fritz Reiner and later played in the Chicago Symphony. He taught at the University of Southern California and at the Music Academy of the West, and was a prominent studio performer in Hollywood, CA.

must develop air capacity and breathing muscles in order to support and control the air stream needed for the instrument” (Stanley, 1975, p. 55). Clearly, the importance of breath support is a view that is also shared by other wind instrumentalists.

Development of proper breathing habits is also essential, as all other aspects of playing arise from proper breathing. Pino (1980) emphasizes in his book, *The Clarinet and Clarinet Playing*, “The truth is that all other aspects of clarinet playing should be considered less important than airflow because they actually *depend upon* it” (p. 45). This sentiment is echoed by Allen (1973), who states, “proper breathing cannot be overemphasized . . . as every aspect of performance is affected by breath support” (p. 51). This includes aspects such as articulation, tone, and phrasing, as illustrated by various authors of articles appearing in *The Instrumentalist*.

In regard to the flute, Walker (1989) states, “embouchure formation, tone, tonguing, and phrasing of the flute all depend upon proper breath control” (p. 56). In regard to airflow and tone, Grocock (1957) posits, “The student will not be able to articulate correctly unless his breath is constant and sufficient . . . [and] tone is instigated by the breath mechanism, not by the tongue” (pp. 87, 88). Proper breathing is not only necessary for successful tone, tonguing and phrasing, but improper breathing can cause many musical inconsistencies. Allen (1973) observes that, “Proper phrasing, consistent articulation, and stylistic concerns are also inseparably connected with correct breath support . . . [in addition] many performance difficulties, commonly designated as technical impediments, are the result of inadequate breath support” (p. 51). McCarthen (1962) also expresses improper breathing technique as a basic problem. “One of the most important and most basic problems incurred in single reed playing is that of breathing and

proper use of air” (pg. 93). The topic of breathing and its essential role in music making is far-reaching, spanning all wind instruments.

In response to the various issues of breathing, many authors have discussed the physiology and anatomy involved in breathing, breathing pedagogy, and descriptions of breathing exercises (Allen, 1973; Fouse, 1980; Grocock, 1957; Kelly, 1983; Leuba, 1980; Stanley, 1975; Walker, 1989). These types of highly-descriptive articles assist teachers and students. “Few teachers fully understand how the body works in regard to breathing. Those that have partial understanding do not teach it correctly” (Kelly, 1983, p. 7). Others write because they feel musicians need to work constantly on proper breathing, regardless of level or ability. “Breathing is easy to overlook. The techniques of proper breathing should begin with the first lesson and continue through the intermediate and advanced levels” (Fouse, 1980, 36). Allen (1973) agrees that teachers throughout the spectrum of education should continue to emphasize the importance of breathing and posture to their students regardless of their instrumental-performance level (p. 53).

Non-research based articles are essential in increasing the awareness of the importance of breathing to the musical community; however, none are based on scientific studies nor do they discuss lung function and/or musical abilities from a research-based viewpoint. Research-based studies are essential as they may not only complement the aforementioned articles, but also broaden the discussion and knowledge of this universal musical issue. In addition, such studies should not only include various breathing exercises but also breathing devices such as the Breath Builder™.

Research-Based Literature Involving Musicians, Breathing, and Lung Function and/or Musical Abilities

There have been claims, addressed as early as 1874 by Stone, that playing a musical instrument causes the development of emphysema. “Many writers have stated that forced expiration employed in the playing of wind instruments tended to produce emphysema of the lungs, but the real amount of the pressure has never been measured” (Stone, p. 13). One purpose of Stone’s study was to measure the pressure needed to play a high and low note on various wind instruments (oboe, clarinet, bassoon, horn, cornet, trumpet, euphonium, and bambardon)⁹ and to discern whether the pressure would be forceful enough to cause emphysema. Stone (1874) found that most of the pressures were small, not even attaining, much less exceeding the pressure needed to sneeze or cough, and therefore unlikely to injure the lungs or to produce emphysema (p. 14). See Figure 1 for the resultant pressures Stone found for each instrument.¹⁰

Instruments	lower notes	highest notes
Oboe	9 inches of water*	17 inches of water
Clarinet	15 inches of water	8 inches of water
Bassoon	12 inches of water	24 inches of water
Horn	5 inches of water	27 inches of water
Cornet	10 inches of water	34 inches of water
Trumpet	12 inches of water	33 inches of water
Euphonium	3 inches of water	40 inches of water
Bombardon	3 inches of water	36 inches of water

Figure 1: Resultant Pressures of Various Wind Instruments (Stone, 1874, p. 14)

*inches of water is a unit of pressure

⁹ A bambardon is a brass instrument resembling a tuba but with a lower pitch; a bass or contrabass tuba.

¹⁰ Future research on resultant pressures of wind instruments is suggested.

Researchers still question whether playing a musical instrument causes emphysema. “The belief that professional wind players often develop emphysema is still prevalent” (Bouhuys, 1964). In addition, questions have been raised about other respiratory disorders, such as asthma. These types of studies comprise a significant body of research regarding musicians and breathing.

A study often cited in support of the notion that wind playing causes emphysema is Akgün and Ozgönül (1967). The study involved the lung volumes of musicians who played a wind instrument called the *zurna*, a Turkish wind instrument similar to the oboe. Results showed most lung functions related to good health (vital capacity, total lung capacity, maximal breathing capacity, and maximal expiratory and inspiratory flow rates) were lower in wind players than non-wind players, and other measurements that may reflect inefficiency in breathing (residual volume, functional residual capacity, and residual volume/total lung capacity ratio) were higher in players as compared to non-players (p. 950).

An important factor, however, in the Akgün and Ozgönül study is the inconsistency between players and non-players in regard to smoking. The seventeen subjects (musicians ages 26-38) were:

[M]oderate to heavy cigarette smokers (twenty or more cigarettes a day) and had a long history of smoking. The results obtained for the players were compared with seventeen non-players who had approximately the same physical characteristics, but eight of the non-players were light smokers (one to ten cigarettes a day) with relatively short smoking histories, and the remainder were nonsmokers (p. 946).

Akgün and Ozgönül (1967) acknowledge in their study that “it is appropriate to conclude that moderate and heavy smoking, with a rather long smoking history, play a

predominant role in the difference in lung function results of *zurna* players” (p. 950). It remains vital not to overlook this aspect of the study when using the results to support the theory that playing a wind instrument causes emphysema.

Gilbert (1998) also addressed emphysema, among other topics, in wind players. In regard to emphysema, his assertion is the results remain inconclusive. “Few studies have demonstrated changes consistent with emphysema in wind players. Most studies have failed to conclusively answer this question” (p. 26). In addition to emphysema, Gilbert also discusses various breathing difficulties in wind players (i.e., respiratory infections, respiratory tract infections, chronic respiratory diseases, and extrapulmonary losses of air also known as air leakage or loss of seal). These topics are important as wind players rely on their ability to produce a sound with precise manipulations of airflow, pressure, and duration (p. 27). In regard to asthma, Gilbert (1998) states,

[T]he constant strain on the respiratory system by wind performance might be expected to aggravate asthma . . . however, structured conditioning of the respiratory muscles, through physical therapy and breathing exercises, may actually reduce exacerbations of asthma. Remarkably, asthma-related skeletal deformities such as pectus carinatum and excavatum, have reportedly disappeared in youths excelling at wind playing, over years of practice. (p. 26)¹¹

Gilbert (1998) describes breathing and producing sound on a wind instrument as follows: “the generation and propagation of an air column— from alveoli, through the tracheobronchial tree and larynx, and across the embouchure— are likely the most important physical requisites for producing sound” (p. 24). It seems the exposure to barotrauma (physical damage to body tissues caused by a difference in pressure between

¹¹ Pectus carinatum describes a protrusion of the chest over the sternum, often described as giving the person a bird-like appearance. Pectus excavatum describes an abnormal formation of the rib cage that gives the chest a caved-in or sunken appearance.

an air space inside and the surrounding gas or liquid) may cause breathing issues in musicians: “the performer of a wind instrument repetitively exposes the full respiratory tree to barotraumas, which can result in detectable microcellular injury, allergen exposure and rarely frank herniation of the large conducting passageways” (pp. 26-27). Gilbert (1998) also posits:

. . . [a] combination of both producing and enjoying the performance of music is synergistic in minimizing pulmonary complaints, [but that] it remains to be elucidated whether musicians who excel at wind playing have exceptional pulmonary function, demonstrate a physiologic advantage due to self-selection, acquire a physiologic advantage due to years of training and experience, or simply have a heightened awareness for health and well-being. (p. 27)

Lucia’s (1993) *The Effects of Playing a Musical Wind Instrument in Asthmatic Teenagers* addresses asthma and the effects of playing a wind instrument. The study was designed to determine how playing a musical instrument would effect asthmatic symptoms (number of days of bronchoconstrictive symptoms, changes in attitude [panic-fear responses], irritability [changes of mood], and fatigue symptoms) in wind players versus non-wind instrument players. Though no significant difference was found between the two groups in number of days with asthma symptoms or bronchoconstriction, or days of fatigue, changes in attitude and irritability were significantly worse in the non-wind players (p. 8). Instrumentalists demonstrated a significantly better health picture, with fewer asthma flare-ups and fewer hospital visits than non-instrumentalists and perceived themselves better able to cope with the disease, had fewer occurrences of asthma, and were less prone to emotional swings than the non-wind players (p. 8-9). Lucia (1993)

concluded playing a wind instrument carries with it the possibility of “long-term therapeutic” effects (p. 9).

Asthma, for many, is seen as a hindrance to performance. Asthma, combined with shallow breathing, lack of breath control, and performance anxiety, are addressed by Carolyn Holm (1997) in her dissertation, *Correctives to Breathing Hindrances in Flute Performance, with Emphasis on the Alexander Technique*. Holm focuses on the advantages of using the Alexander technique to alleviate breathing hindrances.

There is adequate material on the process of specialized breathing for flutists, but there is extremely limited literature on the hindrances to efficient breathing flutists experience at the various stages of development. . . . and still less concerning what can be done to eliminate or alleviate these hindrances. (pp. 5, 25)

Phillips (1985) and Sehmman (2000) take a different approach in examining breathing and musicians. Using his students as the subjects and his classroom as the laboratory, Phillips (1985) focuses on the effects of group breath-control training on elementary students’ singing ability. Forty subjects (grades 2 - 4) were randomly assigned to experimental and control groups. The experimental group received training in breath control while the control group received no training. The results of the study demonstrated that subjects in the experimental group seemed to change their breathing habits from “chest” breathing to “abdominal-diaphragmatic-costal” breathing which improved vocal range, vocal intensity, and pitch accuracy (p. 179).

Sehmman (2000) studied elementary-level brass players (grades 4 – 6) to determine if breath management instruction would significantly change the physical breathing mode, lung capacity, and the following performing measures: tone quality, range, and duration. The experimental group consisted of 32 students (N=32) who

received instruction on the use of air, while the control group consisted of 29 students (N=29) who continued regular study from their instruction books.

The sixteen-week study consisted of the following:

Week 1	measurements taken
Week 2-6	weekly group breath management instruction (treatment)
Week 7-10	subjects prepare for a solo and ensemble contest, no treatment given
Week 11-15	treatment resumes for 5 weeks
Week 16	post-testing

Figure 2: Sehmman Study Timetable

Significance was found in the experimental groups' abdominal displacement, range, and duration, affirming that breathing instruction in group lessons is effective in improving elementary brass players' breathing and performance. Tone quality and lung capacity were found to be insignificant. Both Phillips (1985) and Sehmman (2000) used breathing exercises in their study, but no breathing devices.

Research has discussed incentive spirometry and respiratory muscle training in unhealthy people, compared various models of incentive spirometers, discussed the use of respiratory muscle training with athletic populations but not musicians, discussed breathing issues in musicians, or studied healthy musicians but did not use a breathing device as the mode of respiratory exercise. A study on the Breath Builder's™ effect on musicians' lung functions and various performance abilities is necessary to help fill this void in the research literature.

CHAPTER 3

METHODOLOGY

The intent, goals, various procedures and musical characteristics for the study were discussed with Dr. Donald Hamann, Professor of Music Education at the University of Arizona. He agreed to be the official advisor for the study. The sports medicine department was contacted, and a meeting between this investigator, Dr. Stephen Paul, and Dr. David Millward was conducted. Dr. Paul, a clinical assistant professor at UA Campus Health, and Dr. Millward, a physician at UA Campus Health, agreed to be co-principal investigators. In addition, Dr. Millward asked Dr. Mark Brown, pulmonologist and professor at the Arizona Respiratory Center, to be an advisor and he accepted.

Dr. Brown suggested the lung function measures to be utilized in this study and after a preliminary review of research regarding various lung function measurements this investigator agreed, as did Dr. Paul and Dr. Millward. This investigator interviewed Dr. William Bickel, a University Distinguished Professor Emeritus of Physics, for suggestions regarding sound equipment and study procedures. As a teacher of the Physics of Music class at the University of Arizona, Bickel has many years of experience with sound analysis and the measurement instruments used for this process.

A required course by the Human Subjects Board was completed and this investigator was certified to perform research involving human subjects. In addition, a proposal was submitted and approved by the Human Subjects Board, a necessary component for all studies using human subjects (See Appendix F).

In gathering information regarding the Breath Builder™ this investigator interviewed Brian Frederickson, Nick Ranieri, Keith Underwood, and Keith Johnson (See Figure 3 for details).

Person	Affiliation	Expertise/Additional Information
Brian Frederickson	Director of Wind Song Press Limited, a company dedicated to the dissemination of information related to the preservation of the Arnold Jacobs legacy.	-Was the assistant to the highly respected tuba player, Arnold Jacobs who was a champion of the Breath Builder™. -Is the current director of Wind Song Press and a distributor of the Breath Builder™.
Nick Ranieri	Original partner and manufacturer of the Breath Builder™.	-A bass player, he was the financial contributor that helped Mr. Hansen, inventor of the Breath Builder™, start the manufacturing of the device. -Following Mr. Hansen's death, Mr. Ranieri continued the Breath Builder™ business.
Keith Underwood	Professor of Flute at NYU Steinhardt Department of Music	-Has over twenty years experience with the Breath Builder™ and continues to use it in his teaching.
Keith Johnson	Regents Professor of Trumpet at the University of North Texas.	-Has over twenty years experience with the Breath Builder™ and continues to use it in his teaching.

Figure 3: Interviews Regarding the Breath Builder™.

Preliminary recordings of various musical excerpts were performed in the recording studio and a meeting was held with Wiley Ross, University of Arizona recording engineer, to determine the set-up of the studio equipment, the specific musical excerpts to be incorporated, and the protocol procedure for the study's recording sessions.

Subjects for the Breath Builder™ study were recruited from the University of Arizona's clarinet studio. Each participant was asked to sign study permission forms approved by the Human Subjects Board. The subjects were divided into Control Group 1 and Experimental Group 1 using matched pairs based on playing ability.

A schedule for the lung function measurements was determined and Dr. Paul and Dr. Millward administered the lung function tests as this investigator recorded the data.

Wiley Ross and this investigator met to determine a schedule for the subjects' musical recordings. Wiley Ross, or one of his trained assistants, recorded the audio data needed for study completion. After testing schedules were established, this investigator communicated to each subject regarding his/her role in the study and the established schedules for the recording and lung function tests.

During the course of the study, when subjects of Experimental Groups 1 and 2 received a Breath Builder™, a procedure was provided for them to follow, as well as a log to record their use of the Breath Builder™ throughout the study. The total duration of this study was eight weeks, after which the lung function data and musical excerpt data was analyzed.

Study Methodology

The study sample included fourteen clarinetists from the clarinet studio at the University of Arizona, a combination of undergraduate and graduates, with an age range of 18 – 27. To maintain a balance in playing ability, the subjects were divided into two equal groups (Control Group 1 and Experimental Group 1) using matched pairs.

The study was performed in two four-week sections. During the first section of the study, the subjects were tested three times: at the beginning of the study (pretest), during week one of the study (test), and during week four of the study (post-test). After the pretest, each subject in Experimental Group 1 was given a Breath Builder™ and a scripted demonstration of the device. Each was also given written instructions (See Appendix G) and a log to record use of the device (Appendix H). Members of Control

Group 1 were not provided Breath Builders™ and were instructed to continue with their normal practice routine.

The completion of the post-test in week four marked the end of the first half of the study. During the second portion of the study, Control Group 1 was given Breath Builders™ and relabeled as Experimental Group 2 (the post-test results from Control Group 1 were used as the baseline measurement for Experimental Group 2). Experimental Group 2 followed the same procedures as Experimental Group 1, giving measurements during week one (test) of the second half of the study and during week four (post-test).

At the end of week four, Experimental Group 1 was asked to stop using the Breath Builder™ and was relabeled as Experimental Group 3. Following this cessation, the subjects were measured during week one and week four of the second half of the study to note any change in lung function or performance.

Measurement Methodology

Using a spirometer and a manometer, subjects provided their initial (pretest) pulmonary lung function measurements. Measurements included Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC), Maximal Inspiratory Pressure (MIP), and Maximal Expiratory Pressure (MEP).

The subjects' musical abilities with respect to tone, note duration, and phrase duration were measured through the performance of three musical examples (See Appendix I). Performances were held in the recording studio at the University of Arizona's music department. All subjects performed in a standing position with the

microphone positioned twenty-two inches from the edge of the clarinet bell. On the subject's right was a peak meter providing each musician a visual reference of the decibel (db) level for the playing for the first two excerpts. On the subject's left was a pair of headphones used during the third example.

The three musical examples consisted of the following: G1 (the low G in the Chalumeau register of the clarinet), G2 (the throat-tone G in the Chalumeau register), and a sustained phrase of substantial length. Each example was played and recorded three times.

For the first example, the subject was instructed to take a deep breath and then sustain the note G1 at $84 \text{ db} \pm 1 \text{ db}$ for as long as possible. This process was repeated for example two on the note G2.

For the third measurement, subjects were asked to play a musical excerpt consisting of a long continuous phrase (based on the theme from the second movement of Poulenc's *Sonata for Clarinet and Bassoon*) at a tempo of sixty beats per minute. The phrase was written at such a length that the clarinetist would not successfully be able to play the entire phrase (64 beats total) in one breath. Before playing this phrase, the subject was instructed to put on a set of headphones covering only one ear, allowing the subject to hear his or her natural sound. Through the headphones, the subject was provided a set metronome click to help ensure a consistent tempo. The subject was instructed to take a large breath and to play as much of the phrase as possible. This phrase was recorded three times. The musical example recorded for phrase duration, was also utilized for the analysis of tone.

Data Analysis

Once the study was completed, lung function and musical data were analyzed. Analysis of the lung function measures and musical elements of note and phrase duration were performed using a 2-way ANOVA (analysis of variance) with repeated measures.

Three judges evaluated the tone quality of the musical examples. The judges consisted of a professor of clarinet, a doctoral graduate clarinet student, and an orchestral conductor. A researcher-generated rubric on tone was provided and the judges were trained in its use with musical examples. Once training was completed, the judges evaluated the musical excerpts of the study using the researcher-generated rubric (see Appendix J). The results from the judges were analyzed using a 2-way ANOVA (analysis of variance) with repeated measures.

CHAPTER 4

RESULTS

The two research questions pertaining to two major areas investigated were:

- (1) Would there be any significant difference in lung function (FVC, FEV₁, MIP, MIP₁, MEP, MEP₁ [dependent variables]) by subject group or passage of time (independent variables)?
- (2) Would there be any significant difference in music performance abilities (tone, note duration, and phrase duration [dependent variables]) by subject group or passage of time (independent variables)?

The data were analyzed using Two-Way ANOVA with repeated measures. The independent variables in all analyses were group (control group 1, experimental group 1, experimental group 2, and experimental group 3) and the passage of time (pretest, mid-test and post-test). In analyses dealing with research question 1, the dependent variables were the lung function tests (FVC, FEV₁, MIP, MIP₁, MEP, MEP₁). In analyses dealing with research question 2, the dependent variables were the musical performance abilities of phrase duration, note duration, and tone.

In analyses addressing the first research question: “Would there be any significant difference in lung function (FVC, FEV₁, MIP, MIP₁, MEP, MEP₁ [dependent variables]) by group or passage of time (independent variables),” no main effect differences were found by lung function. However, a significant (Rao R [6,44] = 2.68; $p < .0264$) interaction effect was found by MIP (See Figure 4 below) such that the scores for groups using the breath builder started with the lowest pretest score (experimental group 1) and

the second highest pretest score (experimental group 2) and concluded as the second highest post-test score and highest post-test score, respectively. The control group began with the third lowest score and concluded with the third lowest score while the experimental group (experimental group 3), which stopped the use of the Breath Builder™, started with the highest pretest score and concluded with the lowest post-test score.

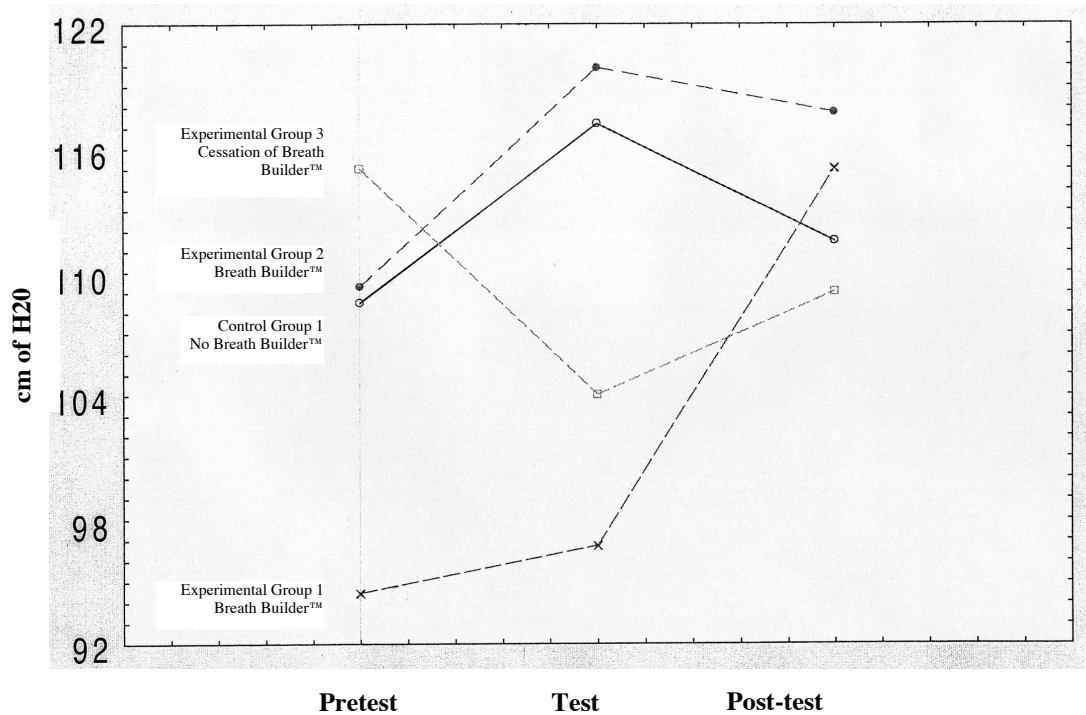


Figure 4: MIP Interaction Effect

A significant (Rao R [6,44] = 2.44; $p < .0401$) interaction effect was also found by MIP₁ (See Figure 5 below) such that the scores for groups using the breath builder started with the lowest pretest score (experimental group 1) and the second highest pretest score (experimental group 2) and concluded as the second highest and highest

post-test scores respectively. The control group began with the third lowest score and concluded with the third lowest score and the experimental group (experimental group 3), which stopped the use of the Breath Builder™, started with the highest pretest score and concluded with the lowest post-test score.

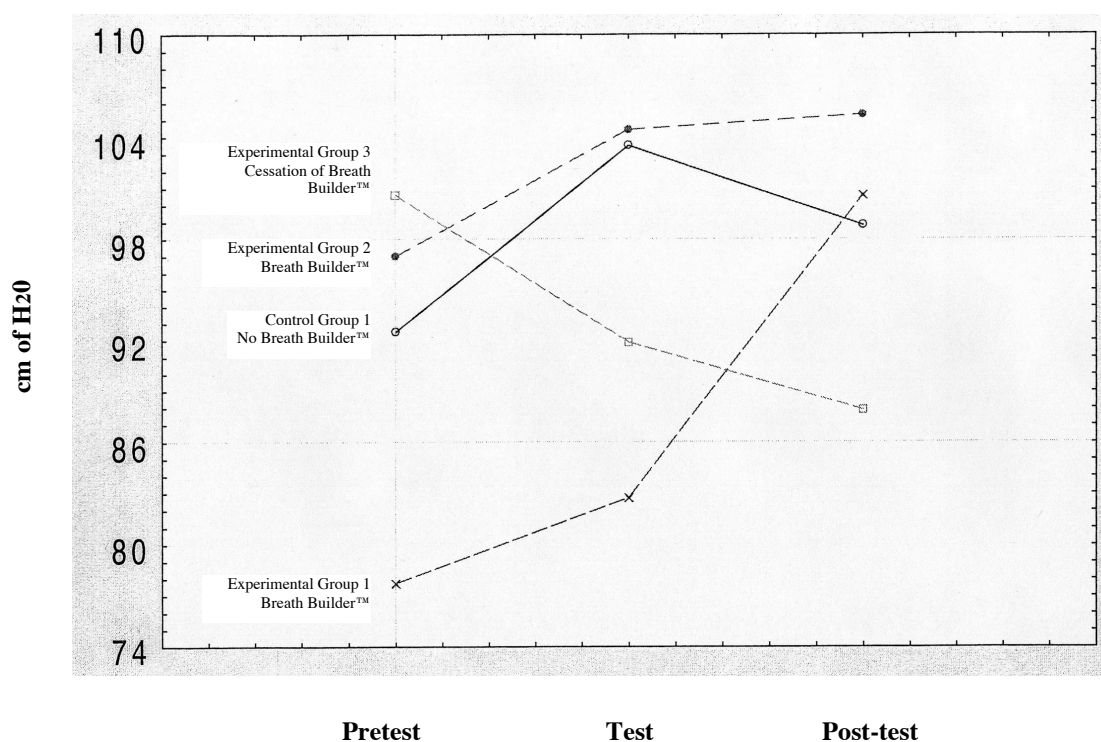


Figure 5: MIP₁ Interaction Effect

The second research question was: “Would there be any significant difference in music performance abilities (tone, note duration and phrase duration [dependent variables]) by group or passage of time (independent variables)?” No significant main effect or interaction effect differences were found by music performance abilities.

CHAPTER 5

DISCUSSION/CONCLUSION

Proper breathing is important to the success of the wind musician. In an interview, the late Anthony Gigliotti, former principal clarinet of the Philadelphia Orchestra and former teacher of clarinet at the Curtis Institute, stated “[B]reathing is fundamentally the most important aspect of playing *any* wind instrument, not just the clarinet” (Hegvik, 1970, p.181). Therefore, it is not surprising that countless breathing exercises exist, as well as devices specifically designed to improve musicians’ breathing. This study focused on the effects of the breathing device called the Breath Builder™.

In regard to lung function, this study’s results showed no significance in the measurements of FVC, FEV₁, MEP, and MEP₁. These results are similar to studies that examined the effect of incentive spirometry (Basoglu et al., 2005; Matte et al., 2000; and Ricksten et al., 1986).

Data from this study did, however, reveal a significant interaction effect for the lung function measurements of MIP and MIP₁, such that the scores for groups using the Breath Builder™ started with the lowest pretest score (experimental group 1) and the second highest pretest score (experimental group 2) and concluded as the second highest and highest post-test scores, respectively. The control group originated with the third lowest score and concluded with the third lowest score, while the experimental group (experimental group 3), which ceased use of the Breath Builder™, started with the highest pretest score and concluded with the lowest post-test score.

This interaction effect demonstrates that the subjects using the Breath Builder™ improved in inspiratory muscle strength and then after cessation of the Breath Builder™ decreased in inspiratory muscle strength, losing some, but not all of the gains made while using the Breath Builder™.

The increase in inspiratory muscle strength found in this study was also found in Gething et al. (2004), Griffiths & McConnell (2007), and Wylegala et al. (2007). The findings of an increase in inspiratory muscle strength, but not in FVC or FEV₁, also occurred in Griffiths & McConnell (2007), whose study was of the same duration as the Breath Builder™ study. In addition, Wylegala et al. not only found an increase in MIP, but also an increase on tidal volume and maximal expiratory pressure, which differs from the current study's findings. This may be because Wylegala et al.'s study protocol was to have the subject inhale and exhale against the same level of resistance, whereas the current study had the subject inhale and exhale against varying resistance levels. In addition, Wylegala et al. required their subjects to perform the breathing protocol for a much longer duration than the current study. Similar results as Wylegala et al. might be made possible by lengthening the duration of the breathing exercise and/or maintaining the same resistance throughout the breathing exercise.

In contrast to the Breath Builder™ study, an increase in certain other lung function measurements, such as vital capacity (VC), but no increase in FEV₁ or in inspiratory muscle strength are noted in Verges et al. (2008), who found a significant increase in VC, PEF (peak expiratory flow), and MVV (maximal voluntary ventilation), but recorded no change for FEV₁, P_Imax, and P_Emax (maximal respiratory strength

measures). Romani et al. (2007) also found an increase in respiratory muscle strength with the use of incentive spirometry, significance was found regarding maximal expiratory pressure (MEP) rather than maximal inspiratory pressure as in this study. The subject population for the Romani et al. study however consisted of patients undergoing myocardial revascularization surgery and significance only occurred 24 hours and 48 hours after surgery. Romani et al. tested their subjects within a shorter time frame than the current study; nevertheless, this information is worth noting for possible future studies in regard to short-term and long-term effects of the Breath Builder™ on respiratory muscle strength.

In general, the lack of increase in FVC in this study is consistent with many of the studies previously discussed (Basoglu et al., 2005; Griffiths & McConnell (2007); Matte et al., 2000; Ricksten et al., 1986). However, using different lung parameters in a future study, such as vital capacity (Verges et al., 2008) or tidal volume (Wylegala et al., 2007) may affect results.

Replications of the current study could include an increase in the duration of exercise with the Breath Builder™ and its possible effects on respiratory endurance and/or lengthening the duration of the study. For example, Griffiths & McConnell (2007) found significance in the expiratory muscle training group, but only between the baseline and six-week tests. A study of longer duration might find insightful results. Other items to consider could include: scheduling, the clarinet reed, the clarinet model and make, tonal analysis, and climate. Different performers feel they play their best at different times of the day. For example, some performers feel they perform better in the afternoon, while others are more comfortable in the evening. Future studies could examine whether

a varied time schedule would affect results, as all subjects would test during the time of day when they felt they experienced their highest playing abilities.

Future studies may also examine the clarinet reed and the climate. The clarinet reed, made of a specific type of cane called *arundo donax*, is affected by weather and especially by humidity (West, 1979, pg. 309). The optimal condition would be a recording studio with investigator-controlled temperature and humidity.

Controlling the type of clarinet used in the study might also provide useful information. There are many different brands and models of clarinets, each with its own characteristics (i.e., bore size, weight, and keywork).

Another study could examine the effect of the Breath Builder™ on tone, specifically pertaining to the overtone series. Such a study could record and analyze, via spectral analysis, the subject's sound with a spectrograph, a device that provides a visual representation of the sound in overtones.

Future studies may also examine the effect of the Breath Builder™ on subjects in varying altitudes. With several large subject populations in disparate cities at varying altitudes, it may prove insightful to see if altitude will affect results. Using high school students or community players may be considered, but it is important that the clarinet population be one that practices consistently, therefore college or professional populations are ideal.

Broader studies in addition to the clarinet population could prove beneficial, such as a study on elderly musicians and the effects of the Breath Builder™ on their playing ability and lung function or a study involving different instruments, such as the rest of the woodwind family (i.e., flute, saxophone, oboe and/or bassoon), brass instruments (i.e., horn, trumpet, trombone and/or tuba), and voice, since all require refined breathing skills.

The Breath Builder™ was originally created for musicians to improve breathing technique. The results of this study demonstrate that the device may have the potential to help populations outside of music where breathing affects performance or quality of life. Such populations may include athletes, extreme sports enthusiasts, and asthmatics.

Breath control is a vital skill essential to all wind musicians. With this understanding, Harold Hansen invented the Breath Builder™ to aid his students, and this study has shown the Breath Builder™ to be beneficial to clarinetists. Until now, no studies had been conducted on breathing devices and musicians. The results of this study demonstrate that further research on the Breath Builder™ and other such devices is warranted and should be conducted. This seminal research may serve both performers and pedagogues in that as a result of this study, this technique may be more readily adopted and used by musicians to help improve performance.

APPENDIX A

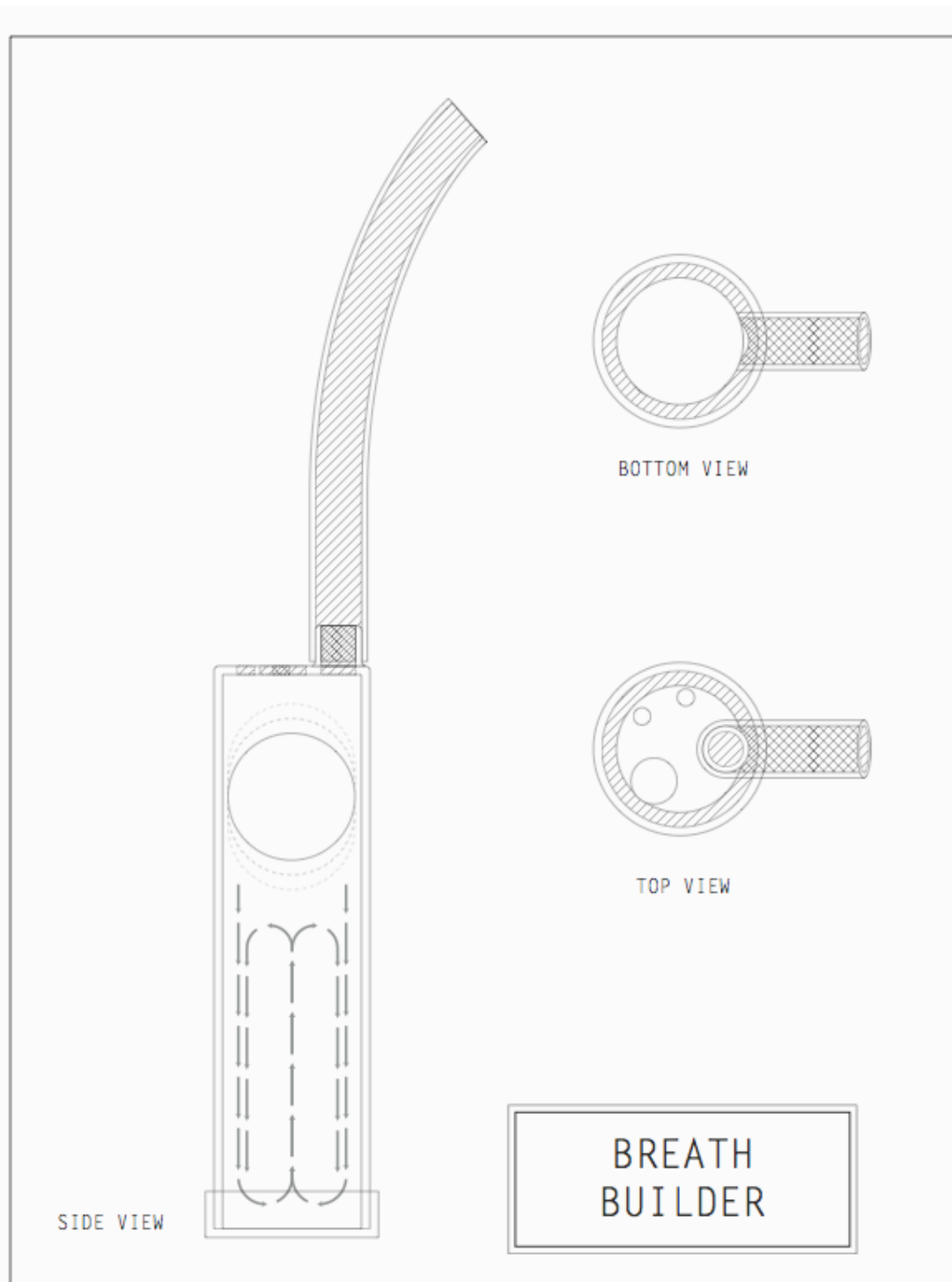
THE BREATH BUILDER™



RDG Woodwinds (2004). *Breath Builder*. Retrieved November 24, 2008, from http://www.rdgwoodwinds.com/product_info.php?products_id=412

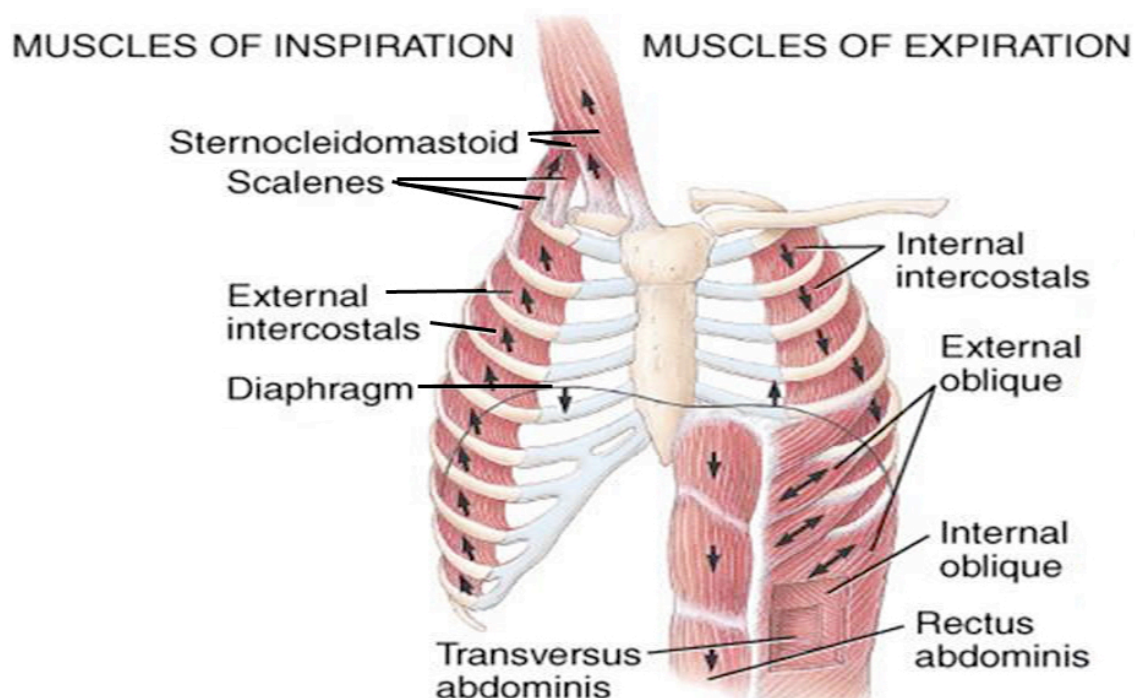
APPENDIX B

2-D TECHNICAL ILLUSTRATION OF THE BREATH BUILDER™



APPENDIX C

MUSCLES USED DURING INSPIRATION AND EXPIRATION



Pulmonary Ventilation (2009). *Pulmonary Tree*. Retrieved March 10, 2009, from <http://faculty.ccri.edu/kamontgomery/anatomy%20respiration.htm>

APPENDIX D

VITAL CAPACITY CHART- MALE

	20	25	30	35	40	45	50	55	60	65	70	75	80
4'6"	2.7	2.6	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.5
4'7"	2.8	2.7	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.7	1.6
4'8"	2.9	2.8	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	1.9	1.8	1.7
4'9"	3.0	2.9	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.1	2.0	1.9	1.7
4'10"	3.1	3.0	3.0	2.9	2.8	2.7	2.6	2.5	2.3	2.2	2.1	1.9	1.8
4'11"	3.2	3.1	3.1	3.0	2.9	2.8	2.7	2.5	2.4	2.3	2.1	2.0	1.8
5'	3.3	3.3	3.2	3.1	3.0	2.9	2.8	2.6	2.5	2.4	2.2	2.1	1.9
5'1"	3.4	3.4	3.3	3.2	3.1	3.0	2.8	2.7	2.6	2.4	2.3	2.1	2.0
5'2"	3.6	3.5	3.4	3.3	3.2	3.1	2.9	2.8	2.7	2.5	2.4	2.2	2.0
5'3"	3.7	3.6	3.5	3.4	3.3	3.2	3.0	2.9	2.8	2.6	2.4	2.3	2.1
5'4"	3.8	3.7	3.6	3.5	3.4	3.3	3.1	3.0	2.8	2.7	2.5	2.4	2.2
5'5"	3.9	3.8	3.7	3.6	3.5	3.4	3.2	3.1	2.9	2.8	2.6	2.4	2.2
5'6"	4.0	3.9	3.8	3.7	3.6	3.5	3.3	3.2	3.0	2.9	2.7	2.5	2.3
5'7"	4.2	4.1	4.0	3.8	3.7	3.6	3.4	3.3	3.1	2.9	2.8	2.6	2.4
5'8"	4.3	4.2	4.1	3.9	3.8	3.7	3.5	3.4	3.2	3.0	2.9	2.7	2.5
5'9"	4.4	4.3	4.2	4.1	3.9	3.8	3.6	3.5	3.3	3.1	2.9	2.7	2.5
5'10"	4.5	4.4	4.3	4.2	4.0	3.9	3.7	3.6	3.4	3.2	3.0	2.8	2.6
5'11"	4.7	4.6	4.4	4.3	4.2	4.0	3.9	3.7	3.5	3.3	3.1	2.9	2.7
6'	4.8	4.7	4.6	4.4	4.3	4.1	4.0	3.8	3.6	3.4	3.2	3.0	2.8
6'1"	4.9	4.8	4.7	4.6	4.4	4.2	4.1	3.9	3.7	3.5	3.3	3.1	2.8
6'2"	5.1	5.0	4.8	4.7	4.5	4.4	4.2	4.0	3.8	3.6	3.4	3.1	2.9
6'3"	5.2	5.1	4.9	4.8	4.6	4.5	4.3	4.1	3.9	3.7	3.5	3.2	3.0
6'4"	5.3	5.2	5.1	4.9	4.8	4.6	4.4	4.2	4.0	3.8	3.6	3.3	3.1
6'5"	5.5	5.4	5.2	5.1	4.9	4.7	4.5	4.3	4.1	3.9	3.7	3.4	3.1
6'6"	5.6	5.5	5.4	5.2	5.0	4.8	4.6	4.4	4.2	4.0	3.8	3.5	3.2
6'7"	5.8	5.6	5.5	5.3	5.2	5.0	4.8	4.6	4.3	4.1	3.8	3.6	3.3
6'8"	5.9	5.8	5.6	5.5	5.3	5.1	4.9	4.7	4.4	4.2	3.9	3.7	3.4
6'9"	6.1	5.9	5.8	5.6	5.4	5.2	5.0	4.8	4.6	4.3	4.0	3.8	3.5
6'10"	6.2	6.1	5.9	5.7	5.6	5.4	5.1	4.9	4.7	4.4	4.1	3.9	3.6
6'11"	6.4	6.2	6.1	5.9	5.7	5.5	5.3	5.0	4.8	4.5	4.2	4.0	3.7

Estimated vital capacities for males in liters. Follow height (in left column) and age (at top, in five year increments).

Vital Capacity Chart- Male (1991). *Vital Capacity*. Retrieved July 11, 2008, from <http://www.windsongpress.com/breathing%20devices/breathing%20devices.htm>

APPENDIX E

VITAL CAPACITY CHART- FEMALE

	20	25	30	35	40	45	50	55	60	65	70	75	80
4' 6"	2.3	2.2	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.4	1.3	1.2
4' 7"	2.4	2.3	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.5	1.3	1.2
4' 8"	2.5	2.4	2.3	2.3	2.2	2.1	2.0	1.9	1.8	1.6	1.5	1.4	1.2
4' 9"	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	1.6	1.4	1.3
4' 10"	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.6	1.5	1.3
4' 11"	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	1.9	1.8	1.7	1.5	1.4
5'	2.8	2.8	2.7	2.6	2.5	2.4	2.3	2.1	2.0	1.9	1.7	1.6	1.4
5' 1"	2.9	2.9	2.8	2.7	2.6	2.5	2.3	2.2	2.1	1.9	1.8	1.6	1.5
5' 2"	3.0	3.0	2.9	2.8	2.7	2.5	2.4	2.3	2.2	2.0	1.9	1.7	1.5
5' 3"	3.1	3.1	3.0	2.9	2.7	2.6	2.5	2.4	2.2	2.1	1.9	1.7	1.6
5' 4"	3.2	3.2	3.1	2.9	2.8	2.7	2.6	2.4	2.3	2.1	2.0	1.8	1.6
5' 5"	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.5	2.4	2.2	2.0	1.9	1.7
5' 6"	3.4	3.4	3.2	3.1	3.0	2.9	2.7	2.6	2.4	2.3	2.1	1.9	1.7
5' 7"	3.6	3.5	3.3	3.2	3.1	3.0	2.8	2.7	2.5	2.3	2.2	2.0	1.8
5' 8"	3.7	3.6	3.4	3.3	3.2	3.1	2.9	2.8	2.6	2.4	2.2	2.0	1.8
5' 9"	3.8	3.7	3.5	3.4	3.3	3.1	3.0	2.8	2.7	2.5	2.3	2.1	1.9
5' 10"	3.9	3.8	3.7	3.5	3.4	3.2	3.1	2.9	2.7	2.6	2.4	2.2	1.9
5' 11"	4.0	3.9	3.8	3.6	3.5	3.3	3.2	3.0	2.8	2.6	2.4	2.2	2.0
6' 4.1	4.0	3.9	3.7	3.6	3.4	3.3	3.1	2.9	2.7	2.5	2.3	2.1	
6' 1"	4.2	4.1	4.0	3.8	3.7	3.5	3.4	3.2	3.0	2.8	2.6	2.3	2.1
6' 2"	4.3	4.2	4.1	3.9	3.8	3.6	3.4	3.3	3.1	2.9	2.6	2.4	2.2
6' 3"	4.5	4.3	4.2	4.0	3.9	3.7	3.5	3.3	3.1	2.9	2.7	2.5	2.2
6' 4"	4.6	4.4	4.3	4.2	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.5	2.3
6' 5"	4.7	4.6	4.4	4.3	4.1	3.9	3.7	3.5	3.3	3.1	2.9	2.6	2.3
6' 6"	4.8	4.7	4.5	4.4	4.2	4.0	3.8	3.6	3.4	3.2	2.9	2.7	2.4
6' 7"	4.9	4.8	4.7	4.5	4.3	4.1	3.9	3.7	3.5	3.3	3.0	2.7	2.5
6' 8"	5.1	4.9	4.8	4.6	4.4	4.2	4.0	3.8	3.6	3.3	3.1	2.8	2.5
6' 9"	5.2	5.0	4.9	4.7	4.5	4.3	4.1	3.9	3.7	3.4	3.2	2.9	2.6
6' 10"	5.3	5.2	5.0	4.8	4.6	4.4	4.2	4.0	3.8	3.5	3.2	3.0	2.7
6' 11"	5.5	5.3	5.1	5.0	4.8	4.6	4.3	4.1	3.9	3.6	3.3	3.0	2.7

Estimated vital capacities for males in liters. Follow height (in left column) and age (at top, in five year increments).

Vital Capacity Chart- Male (1991). *Vital Capacity*. Retrieved July 11, 2008, from <http://www.windsongpress.com/breathing%20devices/breathing%20devices.htm>

APPENDIX F

HUMAN SUBJECTS PROTECTION PROGRAM LETTER OF PERMISSION



Human Subjects
Protection Program

1235 N. Mountain Ave.
P.O. Box 245137
Tucson, AZ 85724-5137
Tel: (520) 626-6721
<http://irb.arizona.edu>

23 January 2008

Wendy Mazon, Graduate Student
Advisor: Donald Hamann
Department of Music
PO Box 210004

RE: PROJECT NO. 08-0046-02 THE EFFECT OF THE 'BREATH BUILDER' ON A CLARINET PLAYER'S LUNG FUNCTIONS AND VARIOUS PERFORMANCE ABILITIES

Dear Ms. Mazon:

We received your research proposal as cited above. The procedures to be followed in this study pose no more than minimal risk to participating subjects and have been reviewed by the Institutional Review Board (IRB) through an Expedited Review procedure as cited in the regulations issued by the U.S. Department of Health and Human Services [45 CFR Part 46.110(b)(1)] based on their inclusion under *research categories 1, 2 and 4*.

Although full Committee review is not required, notification of the study is submitted to the Committee for their endorsement and/or comment, if any, after administrative approval is granted. This project is approved with an **expiration date of 23 January 2009**.

The Institutional Review Board (IRB) of the University of Arizona has a current *Federalwide Assurance* of compliance, **FWA00004218**, which is on file with the Department of Health and Human Services and covers this activity.

Approval is granted with the understanding that no further changes or additions will be made to the procedures followed without the knowledge and approval of the Human Subjects Committee (IRB) and your College or Departmental Review Committee. Any research related physical or psychological harm to any subject must also be reported to each committee.

A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

A handwritten signature in cursive script, appearing to read 'Elaine G. Jones'.

Elaine G. Jones, PhD, RN, FNAP
Chair, Social and Behavioral Sciences Human Subjects Committee

EGJ/mm

cc: Departmental/College Review Committee

APPENDIX G

BREATH BUILDER™ INSTRUCTION SHEET

Breath Builder™ Checklist

- Check your head and neck for alignment, length and softness.
- Is your posture open and balanced? Are your feet flat on the floor?
- Jaw pressure- are you biting?

Add your own -

-
-

When to Use the Breath Builder™

- Five days a week.
- At least 3 times a day (preferably during your practicing)
- Exercise time approx. 1-3 minutes

This should be done during your regular practice time. If for some reason you do not practice, make sure you still do the breath builder exercises. This is very important to maintain consistency within the group.

Throughout the exercise, become aware of any tension that you may feel and release it. Nothing should feel forced. Also, it is important that you read the reminders at the top of this page and remain conscious of them as you use the breath builder. **Take a break from the breath builder if you feel dizzy or lightheaded at any time.**

How to Use the Breath Builder™

1. Put the “Breath Builder™ log” on your music stand.
2. Use the large tube on your Breath Builder™.
3. Sit up straight and maintain an open playing posture.
4. Leaving all holes open, suck in and blow out through the tube with just enough air to keep the ball suspended at the top of the tube. Try to keep the ball suspended for as long as you can in both sucking in and blowing out throughout the exercise. This movement of air should be smooth and continuous, as should the transition between inhalation and exhalation.
5. Suck in and blow out with holes open at least twice.
6. As you continue to flow and move your air, close the large hole as you blow out, and open it as you suck in.
7. Try this at least once.
8. If you are able to comfortably keep the ball continuously suspended, try closing the large hole and one small hole as you blow out, and then open the holes as you suck in. Remember to use only the continuous amount of air needed to suspend the ball at all times.
9. Try this at least once.
10. Fill out log.

Sub. # _____

APPENDIX H

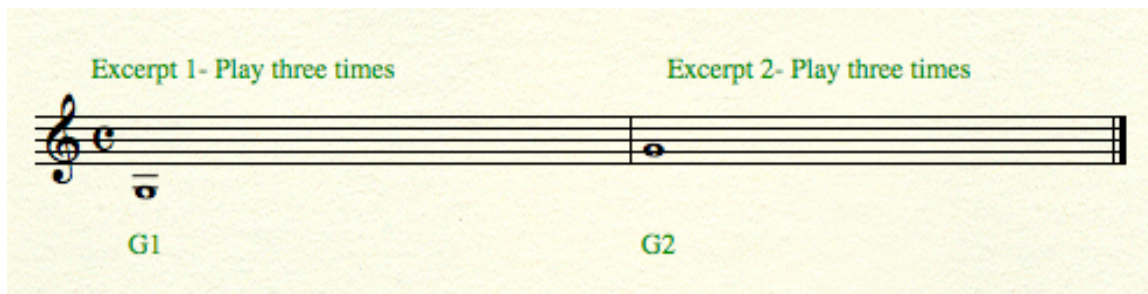
SAMPLE OF BREATH BUILDER™ LOG

[illegible]

APPENDIX I
MUSICAL EXAMPLES

Excerpt 1- Play three times

Excerpt 2- Play three times

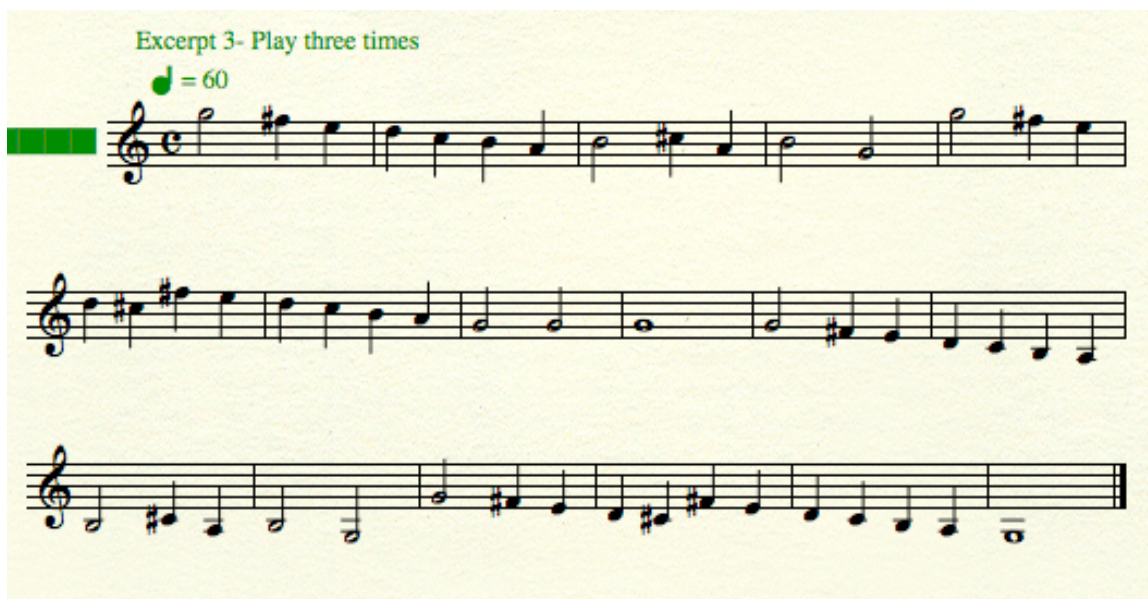


G1

G2

Excerpt 3- Play three times

♩ = 60



Control	7	6	5	4	3	2	1
Tone is well-controlled, timbre is uniform and consistent throughout the excerpt	Tone is well-controlled, timbre is uniform and consistent for the majority of the excerpt	Tone is well-controlled, and timbre is uniform and consistent for parts of the excerpt	Tone is uncontrolled, and not uniform in timbre for most or all of the excerpt				
Quality							
8	7	6	5	4	3	2	1
Tone is full, focused/centered, resonant, and clear, throughout the excerpt	Tone is full, focused/centered, resonant, and clear for the majority of the excerpt	Tone is full, focused/centered, resonant, and clear for parts of the excerpt	Tone is unfocused, dull, unclear, spread with no core to the sound, and edgy for most or all of the excerpt				
Air Support							
8	7	6	5	4	3	2	1
Tone and pitch are consistently well-supported by air throughout the excerpt	Tone and pitch are consistently well-supported by air for the majority of the excerpt	Tone and pitch are consistently well-supported by air in parts of the excerpt	Tone lacks support, pitch is largely inconsistent for most or all of the excerpt				
Articulation/attack							
8	7	6	5	4	3	2	1
Excellent breath support of articulation throughout the excerpt	Good breath support of articulation for the majority of the excerpt	Good breath support of articulation, but inconsistent for parts of the excerpt	Breath support is lacking greatly during articulation for most or all of the excerpt				

APPENDIX K

JUSTIFICATION MEMORANDUM

11/02/08

Dr. Rex Woods and Graduate Committee

School of Music

P.O. Box 210004

1017 N Olive Rd

Music Bldg, Rm 109

Tucson, AZ 85721-0004

Re: Justification Memorandum- I would like to propose a doctoral level project consisting of an article for submission to a scholarly journal and a public research presentation in lieu of a lecture recital.

The lecture recital document and lecture recital are both necessary elements to the completion of a D.M.A. degree. Most traditional lecture recitals are literature-based presentations that focus on a specific piece of literature rather than a concept-based issue regarding performance. The proposed topic of the Breath Builder™ study is atypical in that it is a concept-based approach to a fundamental performance issue- breathing. Both literature-based and concept-based topics are valid issues in the performance field. However, in some instances, there may be a more advantageous format than a lecture recital for presenting such concept-based data. The proposed Breath Builder™ study takes a mixed-methods approach with a strong quantitative component that can be most effectively presented as a written and oral project. This investigator would like to propose, in lieu of a lecture recital, substituting an academically rigorous doctoral level project which would include the preparation of an article for submission to a scholarly journal (such as *Psychology of Music* or *The Journal of Research in Music Education*) and a public research presentation. Please note that, like a lecture recital, this project will be in addition to the written dissertation.

The performance concept of the Breath Builder™ study is based upon breathing and breath control. As David Pino (1980) states in his chapter on “The Two Basics in Clarinet Playing,” “The truth is that all other aspects of clarinet playing should be considered less important than airflow because they actually *depend upon* it” (p. 45). Breathing is the source that gives life to every possible clarinet technique. Clarinet techniques such as finger technique, tone, tonguing, phrasing, and extended techniques are all affected by the performer’s use of air. For example, Pino (1980) states that finger technique “is reduced to just so much finger-wiggling, unless the airflow has been fully established first” (p. 45), and that it is not the embouchure alone that creates sound quality, but mostly airflow. “The embouchure itself does *not* cause good sound quality; only the airflow, with appropriate help from the embouchure, can do that” (p. 53). Breathing technique, a basic fundamental, is necessary to the understanding of performance and relevant to players of all levels and abilities, from beginning students to

professionals. Few examples exist that demonstrate the significance of proper breathing technique, the pillar on which all performer's capacities are built.

Performers discuss and utilize findings from research to enhance their performance every day; what makes such research unique is that it is approached and guided by the insight and experience of performers. Whether a discussion about the best type of cane to use when making reeds, various techniques to increase the response of a reed, or performance anxiety, all these topics require the performer's insight. Such research is performed both informally and formally. For example, Mr. Daniel Silver, clarinet professor at the University of Colorado, Boulder, provided an informational presentation on research he conducted regarding music and sport and how they relate in terms of stages of skill development and practice concepts. In addition to teaching at the University of Colorado, Boulder, Mr. Silver is a performer of international repute. His research, important to the music community, is unique because it is approached with insight and from the perspective of the performer.

A study on Stress Velopharyngeal Insufficiency by Dr. Chris Gibson recently won first place in the International Clarinet Association's ClarinetFest 2007 Research Competition. This topic was prompted by Dr. Gibson's own struggle with palatal air leaking during his clarinet practice and performance. The occurrence of this problem is very rare, but quite detrimental, as it seems to be a problem for performers of instruments that incur a high amount of intra-oral pressure when playing, i.e., clarinet and oboe. Dr. Gibson's research brought exposure to the problem as many musicians and doctors were not aware of its existence or treatment. Hopefully, with further research, this performance problem will gain continued attention and be solved. One might ask, would a music theorist or musicologist think of such a subject matter? Possibly not, because it was Dr. Gibson's performance perspective that drove him to work on this topic. This is why it is important for performers to continue to be involved with concept-based performance issues; otherwise, such ideas might never be addressed.

Many dissertation topics have a narrow focus, which may limit their audience. This proposed study is atypical in that although its focus is narrow, because of its mixed-methods approach and strong quantitative component, the proposed project provides the means for this topic to reach a much larger audience in the musical community (wind players, singers, music education), and in disciplines outside music, i.e. athletics and pulmonology. This is demonstrated by the various areas involved in this study, including music recording, sports medicine, and physics.

The proposed Breath Builder™ study incorporates this investigator's major and minor area of study (performance and music education). The investigator's goal is to become a university professor, and this study will continue to aid this investigator as a performer and teacher. In addition, publishing an article and giving a public discussion will strengthen this investigator's curriculum vitae.

Many other concept-based dissertations have incorporated a type of project in lieu of a lecture recital. Such a format bodes well for this type of research, especially since it carries a strong quantitative component. Thank you for your consideration in this matter.

Sincerely,

SIGNED: Wendy Mazon

APPENDIX L

RAW DATA AVERAGES FOR LUNG FUNCTION

Control Group 1- No Breath Builder™, normal routine

Experimental Group 1- Breath Builder™

Experimental Group 2- Breath Builder™

Experimental Group 3- Cessation of Breath Builder™

Forced Vital Capacity (FVC)

Group	Pretest	Test	Post-test
Control Group 1	5.06	4.94	4.88
Experimental Group 1	4.39	4.25	4.19
Experimental Group 2	4.74	4.76	4.83
Experimental Group 3	4.2	4.19	4.2

Forced Expiratory Volume in 1 second (FEV1)

Group	Pretest	Test	Post-test
Control Group 1	4.19	4.12	4.05
Experimental Group 1	3.72	3.67	3.71
Experimental Group 2	4	4.01	4.03
Experimental Group 3	3.71	3.6	3.67

Maximal Expiratory Pressure (MEP)

Group	Pretest	Test	Post-test
Control Group 1	173.33	184.67	182.17
Experimental Group 1	128.43	134.14	134.43
Experimental Group 2	174.71	176.29	171.43
Experimental Group 3	134.43	139.71	136.29

Maximal Expiratory Pressure in 1 second (MEP1)

Group	Pretest	Test	Post-test
Control Group 1	151	168.67	164
Experimental Group 1	115.43	110.43	116.86
Experimental Group 2	158.43	163.14	159.29
Experimental Group 3	116.86	125	121.14

APPENDIX M

RAW DATA AVERAGES FOR MUSICAL PERFORMANCE ABILITIES

Control Group 1- No Breath Builder™, normal routine

Experimental Group 1- Breath Builder™

Experimental Group 2- Breath Builder™

Experimental Group 3- Cessation of Breath Builder™

Tone Evaluation

Group	Pretest	Test	Post-test
Control Group 1	19.39	21.83	20.22
Experimental Group 1	15.95	16.86	18.62
Experimental Group 2	19.72	18.91	18.24
Experimental Group 3	18.62	17	16.76

Phrase Duration

Group	Pretest	Test	Post-test
Control Group 1	25.47	24.22	25.11
Experimental Group 1	25.2	23.84	24.28
Experimental Group 2	26.85	26.38	23.47
Experimental Group 3	24.28	25.85	25.47

Note Duration Low G \pm 2 db

Group	Pretest	Test	Post-test
Control Group 1	19.41	21.42	22.89
Experimental Group 1	13.57	13.03	18.98
Experimental Group 2	21.22	22.96	19.12
Experimental Group 3	18.98	17.3	15.59

Note Duration High G \pm 2 db

Group	Pretest	Test	Post-test
Control Group 1	16.97	20.7	16.49
Experimental Group 1	12.08	18.28	10.69
Experimental Group 2	16.17	20.19	21.75
Experimental Group 3	10.84	13.12	15.29

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