

**The Effects of Accent Method Breathing on the Development of  
Young Classical Singers**

Author

Morris, Ronald

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# The Effects of Accent Method Breathing on the Development of Young Classical Singers

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*A dissertation submitted in fulfilment of the requirement  
for the award of the degree of Doctor of Philosophy*

**Ron Morris**  
**Student No. 361477**  
**Submission Date: 17/12/12**

**Supervisors: Huib Schippers**  
**Scott Harrison**  
**Helen Klieve**

## **Abstract**

Breathing and support are considered cornerstones of a secure vocal technique for classical singing. No area of vocal pedagogy has been more controversial and, despite recent advances in the understanding of how the respiratory system functions both in speech and song, some breath management strategies for singing continue to be at odds with scientific fact. Furthermore, many students find the development of these skills a challenge. Accent Method Breathing is a technique that is well grounded in science as it is based on the structure and function of the respiratory system. Accent Method was developed for the remediation of speech and voice difficulties but in the past 20 years it has also been used to help develop breathing and support in singers. The method has been used in both private singing studios and in institutions such as the Queensland Conservatorium Griffith University. Extant research in to Accent Method has focussed on its use in clinical populations and on its effects on the voices of normal speakers. Accent Method has never been evaluated specifically on singers though anecdotal evidence and clinical experience attest to its efficacy with this population.

The current study aimed to evaluate the efficacy of Accent Method Breathing with students of classical singing in the early years of their training. A group of students underwent a 10 week group instruction in Accent Method with a matched group of students acting as controls. Measures were taken pre and post intervention consisting of Maximum Phonation Time (MPT), Mean Air Flow Rate through steady state vowels (MFR) and a Phonetogram. The students were also recorded singing a standard passage that was later judged by an expert panel.

There were no significant differences identified in MPT or MFR post intervention however the experimental group, who received Accent Method training, did demonstrate highly significant changes to their phonetograms with both average dynamic range and the maximum number of semi-tones sung showing an improvement. Although the MFR did not show any significant results a qualitative analysis of the airflow tracing morphology did indicate a positive effect that appeared to be due to the Accent Method training. The panel of judges also demonstrated a greater preference for the experimental group's singing samples post intervention than they did for the control group's post intervention recordings.

Accent Method Breathing appears to be effective in bringing about change in the voices of young classical singers. Improvements in average dynamic range, total pitch range and air flow tracing morphology were identified. The panel of judges also expressed a preference for the singing samples of the students who had undergone Accent Method training.

## Statement of authenticity

The work contained in this dissertation is that of Ronald Morris and has not previously been submitted for an award at any other higher education institution. To the best of my knowledge and belief, no material previously published or written by another person has been included except where due reference is made in the dissertation. Selected material drawn from this dissertation that is the original work of the author has been previously published in a selection of book chapters throughout the course of completing this work.

Ronald Morris

July 2012

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## **Introduction The Art and Science of Singing**

Singing is a complex sensory motor activity that requires finely co-ordinated interaction of the organs of aural perception, phonation, respiration and articulation monitored by the musical right brain. Singing also involves emotional connection and the desire to communicate through music. Bunch (1998) summarises this complexity by stating, “simply put, the singing voice is a combination of mind, body, imagination and spirit – all of which work together – no one without the other” (Bunch, 1998, p. 1).

It is this intimate relationship between body and soul that has made it almost impossible to quantify that which is good singing. We can define healthy singing, efficient singing, artistic singing, emotional singing and probably even communicative singing but the response to singing is in many ways so personal, that a definition of what is good singing is extremely elusive. Similarly, it is also almost impossible to list or name the attributes of a singer. The words “a beautiful voice” seem obvious, a talent for singing, good diction and excellent musicianship also spring to mind, but over the years many great singers have arisen who at least initially did not seem to fulfil these apparently basic criteria. Maria Callas, one of the greatest singers of the twentieth century, was often criticised for having an ugly sound! Arguments continue even thirty years after her death about Callas’ talent, especially the voice itself, with listeners falling into one of two groups.

It's understandable that Callas' singing still polarizes listeners. Her voice can sound strident, dangerously out of control, even ugly. There is a leap you have to make to get to where she is as an artist; and once you cross over, it's hard to look back. (Tommasini, 1997)

Dame Joan Sutherland, nicknamed 'La Stupenda' for her realisation of dramatic coloratura roles, was also not free of criticism. "In addition to coloratura virtuosity, Sutherland's voice was noted for a tonal warmth rooted in a supreme technique. Critics, however, also noted a tendency to swallow vowels and blur her enunciation" (Microsoft® Encarta® Online Encyclopaedia, 2005).

Singing seems to be a natural expression of human emotion and musical feeling. There is not one culture on earth that does not sing. Singing is universal. Virtually everyone can make the connected, pitch changed phonation that forms the basis of singing, regardless of the aesthetic or musical quality of the sound that is produced. Professional or at least proficient singers are expected to be able to produce such a phonation that should be pleasant in tone, musical and communicative. The singer is in a unique situation as a musician. His instrument is not only played with his body or through his body but it truly is his body. Singers experience significant technical difficulties when playing and manipulating their instrument simply because it is their body. The sound source of the singer's instrument, (the larynx) is not visible to the player, except with the use of specialised equipment. The instrument also has quite limited kinaesthetic awareness and even limited sensory information available from many of its components. In addition the singer's instrument is controlled by nervous systems with both voluntary and involuntary functions and uses structures that are required for swallowing and breathing, as well as for making tone or music.

The singer's instrument is an integral part of their body and as such the instrument is able to respond immediately to the thought processes of the singer. There is also a direct link between the emotions and the voice which means that vocal tone, timbre or quality can be influenced by emotion. These conditions, poor visibility, poor sensation and poor kinaesthetic awareness coupled with excellent emotional and thought responsiveness have led to singing pedagogies that have relied heavily on imagery and on the perceived sensations of the singer and teacher. Teaching for the last 400 years has relied mainly on these aspects with usually very good results.

Singers have developed a connection to the medical professions and to voice science. As the instrument is the singer's body, problems with the voice are presented to medical professionals and as such the voice, how it is produced and how it can be changed or modified has been the subject of a considerable amount of scientific study. The voice, the singer's instrument, is also of great interest to the otolaryngologist, the speech therapist (speech pathologist), voice scientist and voice physiologist. Other core components of the vocal instrument such as the respiratory system and the postural alignment system have also been studied by physiotherapists, respiratory physicians, respiratory physiologists and even biomechanical engineers.

In the twenty first century then, singing is a paradox. We have large bodies of scientific knowledge about singing and the voice but an equally large and powerful body of belief about singing that is based on imagery, sensation and historical precedent. Pedagogues and scientists do not always agree on the best method for teaching or describing singing. Consequently in the studio, students of singing can meet teachers who teach purely through science or purely through imagery and sensation. Most commonly of course, students are taught by teachers who use a combination of the scientific knowledge (the new) with the images and sensation descriptions of traditional pedagogy (the old). Thanks to the work of voice scientists, there is now a reasonably clear understanding of vocal anatomy, vocal physiology and voice function. Up-to-date vocal pedagogues have the luxury of using evidence based practices in their studios, often combining their knowledge bases with those of the scientists to use evidence-based imagery for teaching.

Much of the focus of voice science has been on the source of vibration in the vocal instrument, which is the larynx. Laryngeal movement, postures and performance have been studied in great detail, for both speech and singing. Jo Estill was one of the most influential researchers in the development of the knowledge base about laryngeal movement and laryngeal postures for singing, and her system of laryngeal figures are used and understood by a large number of pedagogues and therapists. Work has also been carried out on the resonating systems and scientific analysis has begun to filter through to work on breathing and breath support for singing. Certainly no area of vocal pedagogy has been more contentious than breathing and support. Different schools of

breathing have developed over the years with proponents of each method dogmatically believing that their method holds the secret to vocal success. Many pedagogues have used anatomical knowledge and pseudo-science to justify their view of breathing and support. But the true nature of the breath for singing is only just becoming clear. That breath is important for singing cannot be disputed, but we are faced with questions concerning how it should be taught and described.

The perceptions of the singers themselves are of limited use in untangling the web of mystery that surrounds breathing for singing. The singers' sensations and beliefs about how they breathe for singing are often quite inaccurate, being erroneous in determining how the respiratory structures are being used. Singers appear to be guided by the language and type of instruction they have received in their own training, and this instruction later colours their perceptions of what their own bodies are doing when they sing. Watson and Hixon reported on a study of respiratory kinematics in singers, where the subjects were asked to write down their beliefs about how their own bodies worked during singing. They found that “the present subjects’ beliefs usually bore little or no correspondence to the respiratory events associated with their actual performance” (Watson and Hixon, 1987, p. 369). They also reported that singers whose respiratory profiles were similar often described different sensations and beliefs “subjects who sing in relatively similar manners can come to conceptualize their performances in dramatically different ways” (Watson and Hixon, 1987, p. 370).

Much of vocal pedagogy has been built on the sensations and perceptions of the singers and their teachers so it is no surprise that long held pedagogical concepts about breathing and breath support have been challenged by recent scientific insights. Work carried out in other related fields, such as respiratory physiology, respiratory medicine and voice science may be able to help answer questions about breathing for singing, with direct research possible to assess the efficacy of one method of breathing over another.

The Accent Method of Breathing is a system of teaching breathing and breath support for speech that has been used for many years by speech therapists and phoniaticians in Europe to treat disordered voices and to improve voice function in people with normal

larynges. More recently it has been used by singing teachers, particularly in the United Kingdom, to help singers and students of singing gain control over their respiratory systems for singing, as it appears to help the singer develop appropriate muscular support for the voice by the use of systematic breathing and vocalising exercises. Accent Method has been taught at the Queensland Conservatorium Griffith University since 2001, with a great deal of anecdotal evidence as to its efficacy from both students and the staff of the vocal department. This study aims to evaluate the effects that Accent Method has on the development of young singers by comparing results from a group of students who have undergone Accent Method training with those from a group who have not. A number of acoustic and aerodynamic measures will be used to identify change in the students' skills with additional information about change derived from auditory perceptual judgements made by a panel of experienced voice judges.

This study aims to answer the following question: What are the effects of accent method breathing instruction on the voices of young classical singers? Specifically,

- How does Accent Method relate to existing vocal pedagogies?
- How does Accent Method relate to current medical/scientific insights into breathing and singing?
- Will Accent Method training lead to changes in the pitch and dynamic ranges of the students' voices?
- If so, will these changes be greater than those seen in students who do not undergo such training?
- Will Accent Method training lead to changes in the maximum phonation time and airflow measurements through steady state vowels?
- If so, will these changes be greater than those seen in students who do not undergo such training?
- Will a panel of trained judges hear differences in students' voices pre and post training?
- Will the differences be greater for those students who underwent accent method training?

These questions will be addressed by a two part methodology:

- A review of relevant literature will place the questions in historical context and will examine them in relation to current medical/scientific findings.
- An experimental study aimed at demonstrating if changes in singing do occur following Accent Method training.

The experimental study will have students randomly assigned to one of two groups. Both groups will be assessed early in the academic year using analysis of phonetograms, maximum phonation times and mean airflow measures through steady state vowels. Kinematic studies, a common method of researching respiratory behaviours in speaking and singing, will not be used in this study. The pedagogical instruction provided in the experimental phase would achieve very similar kinematic results for all of the subjects in the Experimental group. Subjects in the Control group may or may not show kinematic differences but as studies by Watson and Hixon (1985) suggest, there is more than one way for using the respiratory physiology for singing. Measurements will therefore focus on the results of respiration and phonation rather than on the type of respiration itself. Subjects will also be recorded singing *Caro Mio Ben*, an Italian *arie antiche* by Giordani, in an appropriate key for their voice type. The Experimental group will then receive ten 45-minute Accent Method training sessions over the course of a term in their academic year. The Control group will also be seen for ten 45 minute sessions over the course of a term but they will receive sight singing instruction which is vocal in nature, i.e. they sing, but should not have any direct impact on measures of vocal function. All of the sessions of Accent Method training and practice will be provided by the researcher as will all of the sight singing sessions. Both groups will receive their normal singing instruction from their assigned voice teachers. Towards the end of the term both groups will be reassessed using the same tasks as on their initial assessment. They will also be re-recorded singing the same *arie antiche*. The two recordings of the *arie antiche* will be randomised in pairs for later judgement by a panel of experts.

The randomisation will occur for performance, so that some of the pairs will have the pre-training (first semester) recording as recording A, while for others this recording will be labelled as recording B. The subjects will also be randomised so that the experimental and control groups will be interspersed. An example of randomisation is shown below.

<i>Subject</i>	<i>Recording A</i>	<i>Recording B</i>
E1	Pre	Post
E2	Post	Pre
C1	Post	Pre
E3	Pre	Post
C2	Post	Pre
C3	Pre	Post

*E = Experimental Group, C = Control Group, Pre = Recording taken at the beginning of the academic term, Post = Recording taken at the end of the academic term.*

Throughout this study speech sounds will, for clarity, be designated by their International Phonetic Alphabet (IPA) symbols. In keeping with standard practice on the use of phonetic symbols, the symbols will be contained in pair of forward slashes e.g. the vowel sound “ah” as heard in the word “car” will be realised as /a/.

Ethics committee clearance for the experimental study has been granted under number: QCM/09/05/HREC.



# Chapter One The Importance of Breathing to Classical Singing

## Seventeenth and Eighteenth Centuries

Many of the earliest writers on singing barely mentioned the requirements of a singer and appeared mainly concerned with style, artistry and some cautionary notes to singers. For example Pier Francesco Tosi, one of the earliest sources on singing (1723), advises singers to "...hold out the length of the notes without shrillness and trembling" and that "the singer should always stand with a reasonable appearance and with an expression more towards a smile than of too much gravity, avoiding grimaces and tricks of the head" (Coffin, 1989, p. 2). This statement tells us nothing about the skills a singer should have but the mention of holding out the notes without shrillness or trembling would seem to point to the importance of breath.

Giambaltista Mancini was a castrato soprano as well as a respected teacher in the Bologna School of Bel Canto. His book *Practical Reflections on the Figurative Art of Singing*, (1774, revised 1777) was the first book to focus on the registers of the singing voice and thus begin to directly address the technical aspects of singing. Mancini also gave some indications of what is required of a young singer, prior to commencing training. Coffin (1989) outlines his thoughts thus: "Success could come only to those with a good voice backed by natural musical intelligence. Then, there should be an elevated chest, harmonious proportions of the vocal organs, symmetry of the mouth and teeth, and nose neither too short nor too long, because imperfect organs and physical defects are incurable and inevitably result in imperfect singing" (p.7).

Interestingly Mancini does appear to allude to the complex interaction of mind, body and spirit that Bunch (1998) (see introduction) points out by the list of physiological features being counterbalanced by the natural musical intelligence. Mancini also makes it clear that the long course of training (5 to 7 years as a minimum) in the Bel Canto era should not be undertaken without these prerequisites. He further makes mention of the delicate interplay between breathing and voicing. "If the union of these two parts (the breathing and the pronunciation) reaches the point of perfection, then the voice will be

clear and agreeable. But if these organs act discordantly, the voice will be defective and the singing will be spoiled.” (Coffin, 1989, p. 9)

Modern scientific research tells us that the interaction of air pressure and flow with the muscular activity in the larynx does indeed lead to a clear and agreeable sound whereas imbalance gives a sound of reduced quality which may over time even damage the larynx. This imbalance of muscle activity and breath flow produces voice that is known as pressed phonation which may over time develop into a muscle tension dysphonia (Harris, 1998, p. 187). Mancini, without the benefit of modern technology, without even the laryngeal mirror, has made mention of an important physiological fact about voice production. It is again interesting to note that the use of breath and the comments about the interaction of breath and articulation point to the importance of breathing and breath management to this early pedagogue.

## Nineteenth Century

Whilst the exact teaching methods and exercises of the great castrato singer/teachers of the first age of Bel Canto were not precisely delineated or even written down by them, Manuel Garcia (the elder) who lived from 1775 to 1832 is thought to have provided us with at least the exercises, if not the actual teaching secrets of the older Italian masters. Published as *Exercices Pour La Voix* somewhere between 1819 and 1822 in Paris, it was translated into English and republished in London by Boosey in 1824. Garcia (the elder) was himself a fine singer and Rossini’s *Barber of Seville* was written for him. *Exercices Pour La Voix* contained 340 exercises but had only 4 pages of preliminary discourse on singing since Garcia (the elder) believed that instruction by a master was still required (Coffin, 1989, p. 11). Garcia (the elder) in combination with the writings of his son Manuel Garcia (the younger) (1805 – 1906) gives us perhaps the best insight into the exercises of the Bel Canto era but they suggest that singers should possess a vocal talent and a willingness to work as the only prerequisites to success. Interestingly, breathing exercises, practised separated from singing, were routinely used by the younger Garcia, suggesting that he believed that breath management was an important factor in the skills of a singer.

Matilde Marchesi (1826 – 1913) was a student of Garcia (the younger) and was thoroughly trained in his techniques.

A superb musician, she, like Garcia (the younger), had an unexceptional voice...Marchesi knew a natural voice and exceptional talent when she heard it – she developed it according to strict principles to such an extent that she is historically considered unrivalled as a teacher of the female voice. (Coffin, 1989, p. 32)

Marchesi set out her principles of teaching quite clearly in her published works *Theoretical and Practical Vocal Method* and *Ten Singing Lessons*. Marchesi states that a singer would be able to sing well;

who has learned how to breathe well, and who has equalised the voice, neatly blended the registers and developed the activity of the larynx and the elasticity of the glottis and resonant tube in a rational manner, so that all possible shades of tone, power and expression can be produced by the vocal organs... (Coffin, 1989, p 36)

Marchesi, in this statement, appears to focus on the development of a strong vocal technique, concerning herself with the integration and fine co-ordination of the body systems required for singing. “First technique and afterwards aesthetics” (Coffin, 1989, p. 36).

Marchesi clearly states that good breath control is necessary to the singer; she places it first in her list of skills that a singer must have to sing well. By the time of Marchesi (the late nineteenth and early twentieth century) breathing is being clearly identified as an important skill for the singer.

Julius Stockhausen was another student of Garcia (the younger) who made a significant extension of the Garcian technique. He was particularly concerned with articulation and its effects on the vocal cords and vocal expression (Coffin, 1989, p. 38). Stockhausen's *Method of Singing* was published in 1884 and in it he maintained that "a beautiful tone is the first and most important basis of the art of singing." He also stated that;

A good voice and a lively imagination are not enough for becoming a good singer; they are the preliminary conditions for artistic singing, which can only be attained by unremitting and careful study. What will always distinguish him from the untaught singer, who is lacking in control over his breath, or in flexibility, or in distinctness of pronunciation, is that he perceives at once the meaning of the artistic task before him and enters into it with full command of the means necessary for its interpretations. (Coffin, 1989, p. 41)

Stockhausen again refers to the complex interactions of the body, mind and spirit in his discourse on what is artistic singing. He, like Marchesi, and one assumes the Garcias, believes that technical prowess, the co-ordinated and highly developed muscular movements needed in singing, provide the vehicle for the musicality and interpretation to show. Breath holds a place of prime importance for him as can be seen by his listing of breath control as one of the things that separates the trained from the untrained singer.

Lamperti is another of the hallowed names of singing pedagogy and along with the Garcias, this other father and son team, Francesco Lamperti (father) (1813 – 1892) and Giovanni Battista Lamperti (son) (1839 – 1910) is believed to be responsible for much of the pedagogy taught in the twentieth century and that is still being researched and taught today. Francesco Lamperti despaired that the quality of singing had deteriorated in his age which he attributed to singers appearing on stage without "being thoroughly grounded in the principles of the art of singing" (Coffin, 1989, p. 57). F. Lamperti believes "He who knows how to breathe and pronounce well, knows how to sing well" (Coffin, 1989, p. 58).

G. Lamperti, like his father, was not a famous singer but a famous teacher. He claimed that his method could be traced back to many of the Old Italian masters. He listed the chief requirements of a singer as being “voice, musical talent, health, power of apprehension, diligence and patience” (Coffin, 1989, p. 63). He also described a teacher’s role as placing, developing and equalising the voice and stated that the requirements of a teacher are “experience, a sensitive ear, the gift of intuition and individualization” (Coffin, 1989, p. 63). He, like his father, was concerned with breathing, posture and the vocal registers.

## Twentieth Century

The Lampertis commenced a school of singing teaching much like the Garcias. Posture, breathing and registration appeared to be the corner stones of their techniques. Later American teachers such as William Shakespeare and William Earl Brown fostered the work of the Lampertis and passed their ideas on to later generations of teachers and singers.

William Earl Brown is an important link from the Lampertis to more modern pedagogy. He transcribed many of the teaching maxims of Lamperti, directly, from his own lessons with the master, and from the time he spent with Lamperti as an assistant teacher. His book *Vocal Wisdom: Maxims of Giovanni Battista Lamperti* also includes some materials that Lamperti himself has written; of particular interest are Lamperti’s comments about the need for the study of breath, vocalisation and classic repertory as carried out in former times to ensure a return to great singing (Brown, 1957, p. 1).

One part of the lay world says that there are no longer real voices, and the other that there is no longer any talent. Neither is right. Voices still exist, and talent too, but the things which have changed are the study of the breath, of vocalisation and classic repertory, as cultivated by the singers of former times. They used to study for four or five years before they dared to be seen publicly in a small role. Nowadays, after maltreating the larynx

for a few months, the student considers himself an artist, and attempts the most difficult feats. (Lamperti, 1893, quoted in Brown, 1957, p. 1-2)

Lamperti certainly makes it clear that he believes that singers require a great deal of training before they are ready to perform. It is also important to note that he places breath above the other aspects of singing that he feels need attention, suggesting that for him, control and use of the breath was one of the most important aspects of singing.

The recurring theme of breath and breath management as a requirement of good singing and as a necessary skill of a singer appears throughout the historical pedagogical literature. It is somewhat assumed in the earliest writings of the castrati such as Tosi in the 1700s but is clearly stated as vital by the middle of the 1800s. More modern pedagogies are essentially, in effect, built upon the older ones and carry that recurring theme of breath as a requirement of the singer well into the twentieth and twenty first centuries.

In the early 1970s, John Burgin made a collection of thoughts from a review of the literature about singing for his doctoral dissertation. This was published in 1973 and provides access to statements made from the 1950s through to the early 1970s, in mainly American publications, including the journal for singing teachers and working musicians. Many of his references are not from scientific articles nor are they even rigorously peer reviewed material but they do give great insight into the thoughts of eminent American teachers of the day.

“Musicianship, languages, stage deportment, personality and all the supplementary items may receive high rating, but it is the voice itself which is the keystone of the arch”  
(Mower, 1954, quoted in Burgin, 1973, p. 19).

Mower highlights the primacy of the voice itself over all the other components of good singing. Certainly a natural talent, an instrument of quality must be possessed by the

singer, but how could that could be developed shaped and preserved was not reported by Burgin.

“Good singing is the result of correctly functioning, neuro-muscularly co-ordinated athletic activity” (Linguist, 1955, quoted in Burgin, 1973, p. 21)

Linguist is again focussing on the physical component of good singing, like many pedagogues from Marchesi onward; technique followed by aesthetics appears to be the rule. This maxim is also articulated by Appelman in 1967 when he states: “artful singing is the act of co-ordinating instantaneously the physical sensations of respiration, phonation, resonance and articulation” (Burgin, 1973, p. 21)

Christy in 1967, in contrast, gives a complete list of the attributes of a successful singer which does attempt to cover all the areas of body, mind, imagination and spirit listed by Bunch (1998).

1. An attitude of enthusiastic interest, pleasure and confidence.
2. Intelligent, regular practice habits.
3. Vital upright and expansive posture.
4. Efficient diaphragmatic-costal breath control.
5. Freedom, vitality, expressive colour, efficiency, sonority and evenness in tonal production.
6. Mastery of correct, clear and beautiful diction.
7. Mastery of Legato technique.
8. Mastery of agility and flexibility technique.
9. Sensitive, intelligent and movingly expressive interpretation.
10. Natural, gracious, poised and attractive stage presence (Burgin, 1973, p. 20)

Burgin also points out that a large number of writers (24 in fact) alluded to the primary function of breathing to the singing act. A selection from these writers is detailed below:

Breathing should be very carefully studied. The beauty of singing will depend on how the forces of the breathing mechanism are coordinated with phonation (Lester, 1957).

My feeling is that the entire basis of good singing is proper breathing (Rosalie Miller, 1951).

So important is correct breathing that should the singer's method be wrong, the singing method will not be right (McLean, 1964). (Burgin, 1973, p. 42-43)

Statements such as those listed by Burgin, clearly show that a great number of mid twentieth century pedagogues believed that breathing was very important to the development of a good voice, and a solid singing technique.

In the latter part of the twentieth century pedagogues were often not as explicit as to the requirements of a singer or of a singer's technique, but the importance that they continue to place on breathing can be inferred from the fact that virtually every pedagogical text that has been written contains a chapter on breathing, breath management or breath support. Vennard, Miller, McKinney and Chapman, all of whom will be evaluated in more detail in a subsequent chapter, place a great emphasis on the breath. Each pedagogue has a major chapter on breathing in their texts.

In her doctoral dissertation, Blades-Zeller aimed to find out “How do the nation’s [America’s] most outstanding teachers of voice performance teach?” (Blades-Zeller, 2002, p. vii). She developed a list of outstanding teachers by surveying the body of American voice teachers as a whole. She then proceeded to interview the teachers on this list in order to gain insight into their teaching practice. Her initial interview



questions contained a request for the teachers to describe their approach to teaching the following concepts of vocal technique: posture, breathing and breath support, tonal resonance, diction, registration, unification and tension-eliminating tension problems (Blades-Zeller, 2002, p. x). Interestingly, Blades-Zeller places the teaching of breathing quite high on her list of concepts, again suggesting for her that breathing is of prime importance to singing.

It [the breath] has historically been a hotly contested subject, with widely divergent approaches endorsed by reputable voice teachers. As was expected, the statements regarding breath, breath support, and the constitution of optimal function in breath management were varied and diverse. However, given the tradition of controversy and contradictory beliefs about breath and “breath support”, a surprising degree of consensus was also evident among the pedagogues. (Blades-Zeller, 2002, p. 9)

Blades-Zeller identified six concepts that she felt showed a consensus amongst the pedagogues in respect to breathing:

1. Good singing posture is a prerequisite to good breath.
2. Breath is air flow energy, which becomes utilized sound.
3. Through expansion of the rib cage and the contraction of the diaphragm, a partial vacuum is created in the lungs. Air will then rush in to fill the partial vacuum.
4. Breath management is a dynamic balance using air flow and a low base of “support”.
5. Breath management requires pacing the breath to the demands of the phrase.
6. Breathing involves a “release”, breath renewal should be incorporated into the “release” of the sound; the “release” is the replenishment of breath (i.e. “The release is the new breath”).

Early in the twenty first century it is obvious that, if these statements form a consensus, many pedagogues in the United States are continuing to use concepts that are not wholly scientific in their basis. Statements such as “breathing involves a release” and “breath is air flow energy that becomes utilized sound” appear to be images or vocal concepts that cannot be directly related to physiology.

The management of the breath; specifically how to take it, conserve it or use it has long occupied the singing world. As we have seen some of the earlier writings on the voice, those of Mancini in his *The Figurative Art of Singing* from 1774 (expanded in 1777) make comments about the breath. While not specific about the exercises or the mechanisms that are used, Mancini exhorts the singer to have ‘graduation of the breath’ when singing in florid passages and suggests that; “if the union of these two parts (the breathing and pronunciation) reaches the point of perfection, then the voice will be clear and agreeable” (Coffin, 1989, p. 9). Many of the earlier writings on the voice concern themselves mainly with style and performance practice rather than with technique, but even so it does seem that breath management was an integral part of the singer’s technique which was learned from his master.

Unfortunately, the actual exercises used by the great castrati masters such as Porpora, Tosi and Mancini have been lost to us, or are only reported in much later writings (especially the Garcias), and their purpose and accuracy have been open to interpretation. However, much of modern vocal pedagogy has been built on these interpretations of the old masters and it is possible to trace schools of teaching from the Garcias and Lampertis that claim to be based on the pedagogies of the Bel Canto. Some concepts that continue to influence modern teaching such as 'appoggio', to lean on the support, 'la lutte vocale', the vocal struggle (an image of support), registration, and voice placing can be traced back to the work of these early writers. The work of Blades-Zeller suggests that although most pedagogues that she surveyed felt that breath was important to singing, many continue to use images or concepts that are not wholly science based.

An examination of a selection of the pedagogical literature, both historical and more current suggests that good singing requires, apart from the naturally beautiful

instrument, well-co-ordinated neuro-muscular action, well managed breathing, good articulation and a lively musical and artistic intelligence. Certainly it is beyond dispute that breathing, breath support and breath management are key skills for any successful singer.

## Chapter Two Respiratory Anatomy and Physiology

Modern scientific methods, particularly in the last 50 years, have made it possible for us to understand to a great extent, how the voice and the breathing mechanism operate. Since the 1960s pedagogues such as Vennard in his book *Singing the Mechanism and the Technic* have attempted to use these more scientific methods to demystify singing, but it is clear from the more recent work of Blades-Zeller that this has not been completely successful, at least in the area of breathing! In more recent years most of the research has focussed on the larynx and the vocal folds. However some work has directed its attentions onto the breath management and support systems.

Separate from the study of singing, a great deal of work has been carried out by physiologists, speech pathologists, physiotherapists and respiratory physicians into the respiratory system and breath management. Much of this study from the scientific community has focussed on how the structures and muscles of the respiratory system work and interact in live subjects. The information obtained allows us to move beyond that which is derived from cadavers in the anatomy rooms or from the sensations of the singers themselves.

The study of anatomy is vital to understand the structure of the body, i.e. “the respiratory system”. However anatomy alone is unable to give completely accurate information about how those structures operate, particularly how those structures interact when performing specific tasks.

In order to make judgements about the current vocal pedagogies approaches to teaching breathing, breath management or support, it is necessary to have a firm understanding of how the respiratory system is structured and functions.

## The Structure and Function of the Respiratory System

The respiratory system is a complex arrangement of structures that has as its primary goal the exchange of air. Oxygen is taken on board by the body and waste carbon dioxide is expelled from the body through the auspices of the respiratory system. Hixon (1987, p. 1) reminds us that the respiratory system in man has two main functions; breathing for life and breathing for speech or singing.

The respiratory system consists of:

- A set of tubes that connect the lungs to the outside air (the trachea, bronchi and bronchioles)
- The lungs where gas exchange occurs
- The rib cage which serves to both protect the delicate lungs and assist in their management
- Muscular structures that provide the necessary energy to drive the system

The respiratory system is predominantly housed in the thorax but some of its muscular components are contained in the abdomen (Hixon, 1987, p.1).

The set of tubes that connect the respiratory system to the outside air are generally considered to begin below the level of the larynx. The larynx acts as a valve that prevents food and fluid from the pharynx entering our airway. Above the level of the larynx, in the mouth and pharynx, air and food share a common pathway. Interestingly the nose, which has a major function in warming and humidifying the air we breathe, is used only by air.

The trachea extends from the lower border of the larynx (about the level of the fifth cervical vertebra) to opposite the third thoracic vertebra where it divides into two bronchi, one for each lung (Leonard, 1983, p 178). The trachea is essentially a cylinder made up of cartilage and membrane. The cylinder is slightly flattened at the posterior aspect. The cartilages are 16 to 20 in number and are in the shape of irregularly shaped

rings with the anterior portion being cartilage and the posterior portion being made up of a fibrous membrane which is a flexible wall shared with the oesophagus (Hixon, 1987, p. 5). The entire structure is enclosed in a fibrous but elastic membrane (Leonard, 1983, p. 178). The adult trachea is approximately 11-12 centimetres in length and is from 2 to 2.5 centimetres in diameter in males (in females the tracheal diameter may be slightly smaller) (Leonard, 1983, p. 178).

The right bronchus is approximately 2.5 centimetres long and is made up of six to nine rings. It is also shorter and at a more horizontal direction than the left (Leonard, 1983, p. 178). The bronchus continues to divide (these divisions are known as bronchioles) until the alveoli are reached. The alveoli are the air cells where exchange of gases occurs; they are very small and are lined with delicate mucous membrane.

The left bronchus is longer than the right being approximately five centimetres in length. It has 9 to 12 rings and is of a slightly smaller diameter. The left bronchus has to cross the oesophagus and the descending aorta on its journey to the left lung. It too continues to divide into bronchioles until the alveoli are reached (Leonard, 1983, p. 178).

The lungs are often simply defined as a pair of spongy sacs. Hixon (1987) describes them as “cone shaped structures that are of a porous, spongy texture and that possess an abundance of resilient elastic fibres” (p. 6). He goes on to say that whilst it is a gross oversimplification of their structure and function, there is some value in seeing the lungs as large elastic sacs that are filled with air and which have the ability to change size and shape (Hixon, 1987, p. 6).

The right lung is slightly larger than the left lung, having three lobes instead of two (Leonard, 1983, p. 179). This is due to the fact that the heart and lungs share the thoracic cavity and the heart is of course situated on the left.

The lungs are covered with a membrane known as the visceral pleura. There is also pleura (known as the parietal pleura) lining the thoracic cavity and the top of the

diaphragm. “Together these membranes form a double walled sac that completely encases the lungs. Both walls of this sac are covered with a thin layer of lubricating fluid that permits them to move easily one on another” (Hixon, 1987, p. 7). Rubin (1998) states that “the pleural cavity is a fluid filled potential space that binds the lungs to the rib cage and diaphragm such that any movements therein cause corresponding increases or decreases in lung volumes” (p. 51).

The rib cage which bounds the area known as the thoracic cavity is described by Hixon as a barrel shaped cage of bone and cartilage (Hixon, 1987, p. 7). The rib cage is bounded at the back by the thoracic vertebrae which are vertebrae numbers 8 to 19 (there being 34 vertebrae in man, 7 cervical, 12 thoracic and 15 abdominal) (Leonard, 1983, p. 248). The thoracic vertebrae comprise only a very small portion of the cage as most of it is formed by the ribs.

There are 12 ribs, one arising from each of the thoracic vertebrae. The ribs are flat arch shaped bones that slope downwards and outwards to give the rib cage its characteristic rounded form (Hixon, 1987, p. 2). At the front, rib number one is essentially fused to the flat sternum or breast bone, while the ribs numbered two to seven have costal cartilages that join independently to the sternum. The costal cartilages from ribs number eight, nine and ten join that of rib number seven, so they are not attached to the sternum directly. Ribs 11 and 12 are known as the floating ribs and have no attachment at their anterior ends (Rubin, 1998, p. 52). Because of their attachments and the arrangement of the ligament and joint capsules the ribs are capable of movement at both their vertebral and sternal ends. Rubin (1998) states that “the costotransverse articulations are plane synovial joints with a broad superior ligament and a relatively weak posterior ligament. The ligament of the tubercle is short and weak. These ligaments prevent proximal sliding but allow for superior-inferior sliding.” (p. 52). This allows the ribs to move slightly up and down on the vertebrae and rotate to some degree but not to move outwards from them. At the anterior end of the ribs the costal cartilages numbered two to seven all have synovial joints to the sternum that allow movement.

The first rib is the shortest with length of ribs increasing until rib seven after which the length of the rib itself decreases. The length and orientation of the ribs determines the pattern of movement which they demonstrate (Rubin, 1998, p. 52). The ribs are usually described as having both a pump handle and a bucket handle movement (Bunch, 1997, p. 34-35). Ribs one to five are usually described as having the pump handle motion. In these ribs, the most lateral part of the rib tends to be lower in relation to the vertebral and sternal ends so that the sternal end moves obliquely on inspiration which increases the anterior-posterior dimensions of the chest. Ribs numbered five to ten, on inspiration tend to move the chest wall in a lateral as well as in an anterior-posterior direction and are thus described as having a bucket handle motion.

Many singing pedagogies ascribe great importance to the movement of the ribs in breath management (these will be discussed in greater detail below) but it is interesting to note that Bunch in her 1997 text *Dynamics of the Singing Voice* takes great pains to describe the exact nature of the ribs and their movement but asserts that “the well-trained singer does not move these [ribs numbers one to five] very much for two reasons; (1) the diaphragm plays a major role in their breathing pattern and (2) the rib cage is already partially elevated by the assumption of the correct posture.” (p. 35). Bunch (1997) also states that excessive movement of these ribs is detrimental to good singing because it usually requires the use of neck muscles. Additional and unwanted tension around the larynx can be created by the excessive use of the neck muscles in singing:

The size of the chest is increased laterally and somewhat anterior-posteriorly by the movement of ribs 5, 6 and 7. Because ribs 8 to 10 are directly attached to the costal cartilage of the 7<sup>th</sup> rib they also participate in this movement .... When the body is properly aligned, these natural movements of the lower chest and abdomen become obvious both to the singer and the trained observer. (Bunch, 1997, p. 35-36)



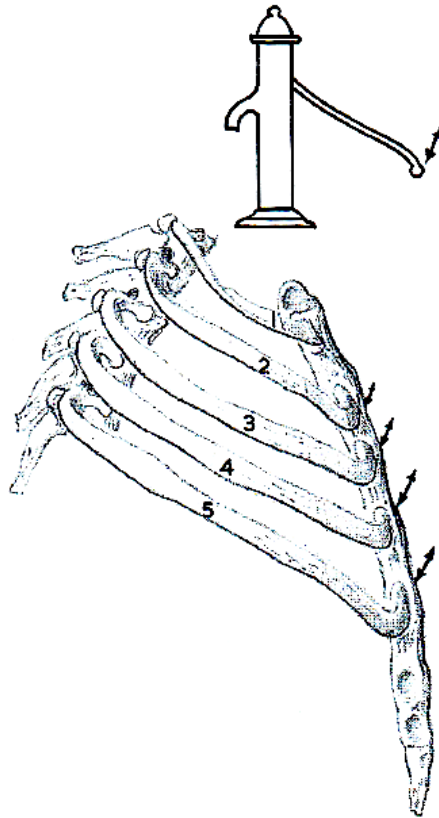
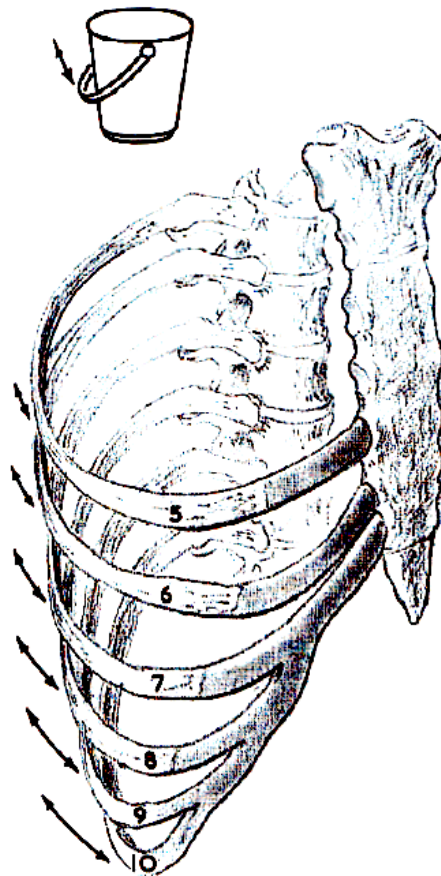


Fig. 14. Schematic representation of pump handle motion of ribs.

**Note:** The anterior ends of the ribs are lower than the posterior ends. The shape of the joints only allows for rotation, because of this and the slope noted above, the anterior ends move upwards and forwards, and downwards and backwards, hence the term pump handle movement. In addition these ribs are attached directly to the sternum. The change in the dimensions of the chest produced by movements of these shorter ribs is less than that produced by the more complex movements of the longer lower ones.

Figure 1

*Pump handle action of the ribs as depicted in Bunch, 1997, p36*



**Fig. 15. Schematic representation of bucket handle motion of ribs.**

The costo-vertebral joints of ribs of the fifth to tenth pairs allow anterior-posterior and lateral movement of these ribs. The eighth, ninth and tenth pairs are capable of considerable lateral movement because they have no direct attachment to the sternum, also the long bars of cartilage at the costal margin allow for considerable distortion during inspiratory movement, and the restoration of this deformation plays an important role in expiration during quiet respiration. It follows that calcification, and therefore hardening, of these cartilages which may occur with aging will limit freedom of respiratory movement.

Figure 2

*Diagram showing the Bucket Handle action of the ribs from Bunch, 1997, p. 35*

The muscles that drive the respiratory system can be found in both the thorax and the abdomen and act on the lungs, not directly, but through the binding of the lungs to the rib cage and diaphragm that occurs via the visceral and parietal pleurae. The respiratory

system is flexible and elastic throughout and the muscular forces that operate on it do so against this backdrop of stretch and recoil.

“The lungs and the thorax normally operate together as a unit, it is important to realize that their natural resting positions in the intact unit are different from their individual resting positions when the two are separated” (Hixon, 1987, p. 7). If the lungs were to be removed from the thorax they would immediately collapse and contain almost no air. The elastic tissues of the bronchioles and alveoli would spring back to their smallest state so that they would be of a significantly less volume. The resting position of the thorax with the lungs removed is more expanded and would be of a greater volume (Hixon, 1987, Sundberg, 1987). “With the lungs and thorax held together as a unit by pleural linkage, the respiratory apparatus assumes a resting position between these two separate positions such that the lungs are somewhat expanded and the thorax is somewhat compressed” (Hixon, 1987, p.7). This resting position represents a state of balance or neutral position so that the force of the lung’s desire to collapse is equal to the force of the thorax’s (including the diaphragm and abdomen) desire to expand (Hixon, 1987, p.8).

The pressures within the respiratory system are also of great importance to the understanding of how the respiratory musculature operates. Pressure can be identified within the lungs (Alveolar Pressure), between the two pleural walls, that is within the thorax but outside the lungs (Pleural Pressure) and within the abdomen (Abdominal Pressure) (Hixon, 1987, p.8). It is important to remember that with the respiratory apparatus in the resting position, alveolar pressure is equal to atmospheric pressure.

The mechanics of respiration which involves the function of respiratory system relates directly to the muscles that drive the system. It can be viewed in terms of the breath cycle, inspiration and expiration and in terms of the volumes and pressures within the respiratory pump.

## Inspiration

Inspiration or inhalation occurs when air flows into the lungs. “Air flows from regions of higher pressure to regions of lower pressure” (Hixon, 1987, p. 8). When the air ways are open and the respiratory system is in neutral or resting position there would be no flow, as the alveolar pressure is equal to the atmospheric pressure. To achieve air movement into the lungs the alveolar pressure must be sufficiently decreased below the atmospheric pressure to develop a pressure gradient in favour of inward air flow (Hixon, 1987, p.8).

Air molecules within the lungs provide pressure (force per unit area) by colliding with one another and with the structures of the lungs. When the volume of air within the lungs is expanded, the molecules are less crowded, so they are involved in fewer collisions and the pressure is lower. Conversely, when the volume is decreased, collisions are more frequent and the pressure is greater. Specifically, volume and pressure are inversely related, provided that temperature remains the constant and that the respiratory airways are closed to the outside. Under such circumstances, doubling the volume halves the pressure and halving the volume doubles the pressure. (Hixon, 1987, p. 9).

Decrease of the alveolar pressure is achieved by increasing the volume of the lungs. Since the lungs are linked to the thoracic cavity by the pleural linkage, increases in thoracic volume result in increases in lung volume, decreases in alveolar pressure and the subsequent inward flow of air.

The muscles that increase the volume of the thoracic cage can be separated into two groups: the primary muscles of inspiration, consisting of the diaphragm and the intercostal muscles and the accessory muscles of inspiration such as the sternocleidomastoid, scalenes, pectoralis minor, serratus anterior, serratus posterior, quadratus lumborum and levatores costarum (Rubin, 1998, p. 51). Some writers also include the pectoralis major, the subclavius and the latissimus dorsi as accessory muscles of inspiration but since their role appears to be only in very forced respiration and

indeed under some dispute they can be ignored for the purposes of this discussion. Campbell (1970) goes so far as to state that “of all the muscles which are generally thought to act as accessory muscles of inspiration, only the scaleni and the sternomastoids [sternocleidomastoids] show significant respiratory activity in man” (p. 181).

The diaphragm is a large double domed sheet of muscle which is attached to the back of the xiphoid process, the inner surfaces of the 7<sup>th</sup> to 12<sup>th</sup> costal cartilages and the vertebral column (Rubin, 1998, p. 54). At rest the right side is slightly higher than the left and the diaphragm has a depressed median space where the heart lies (Rubin, 1998, p. 54). The diaphragm is always active in inspiration regardless of the type of inspiration and Bunch (1997) states that “it is responsible for 60-80% of increased volume in deep inspiration” (p. 37)

When the diaphragm is activated its fibres shorten and straighten causing the domes to descend. The diaphragm therefore flattens and comes forwards pushing the contents of the abdomen slightly down and out. The muscles of the abdomen yield to this increased abdominal pressure causing an outward bulge in the in the upper abdomen (epigastrium). This in turn increases the vertical depth of the thoracic cavity which creates the necessary volume change to decrease the alveolar pressure and allow air to flow into the lungs (Rubin, 1998, p. 54).

Bunch (1997) notes that many singers believe this bulge outwards to be the diaphragm itself! Because of the attachment of the diaphragm to the lower ribs and the direction of its pull, descent of the diaphragm is also responsible for increasing the lateral dimensions of the thoracic cage by raising the lower ribs. Agostoni and Sant Ambrogio report on patients that have either undergone cervical cord transaction or spinal anaesthesia and they state that in these patients the lower half of the rib cage moves outward with inspiration (contraction of the diaphragm) while the upper half moves in (Agostoni & Sant Ambrogio, 1970, p.150). This suggests that the movement of the diaphragm is predominantly responsible for the outward movement of the lower rib cage since other muscles that could have that function are effectively paralysed.

Electrical activity of the diaphragm has been studied by the use of needle electrodes through the costal part of the body wall or by means of bipolar surface electrodes placed in the oesophagus.

“During quiet breathing the (electrical) activity increases progressively throughout inspiration and decreases in the early part of expiration to become nil at about half the expiration time” (Agostoni & Sant Ambrogio, 1970, p.152). The diaphragm is also active during expulsive efforts such as parturition, defaecation or vomiting where it works synergistically with the abdominal muscles to increase intra-abdominal pressure. Some activity is also found during strong expiratory efforts, particularly when lung volumes are low. During phonation the diaphragm’s activity diminishes and ceases during the first two to three seconds after inspiration (Agostoni & Sant Ambrogio, 1970, p.154). The diaphragm’s role during the expiration phase in classical singing is under dispute but Sundberg (1987) reports on a study where the diaphragm was active under a number of conditions during the expiration phase and Bouhuys, Proctor and Mead (1966) also found that three out of five non-professional singers used active diaphragm activity to balance the respiratory recoil forces at high lung volumes. It appears that the diaphragm may have a role to play in balancing the pneumatic forces in the respiratory system during singing.

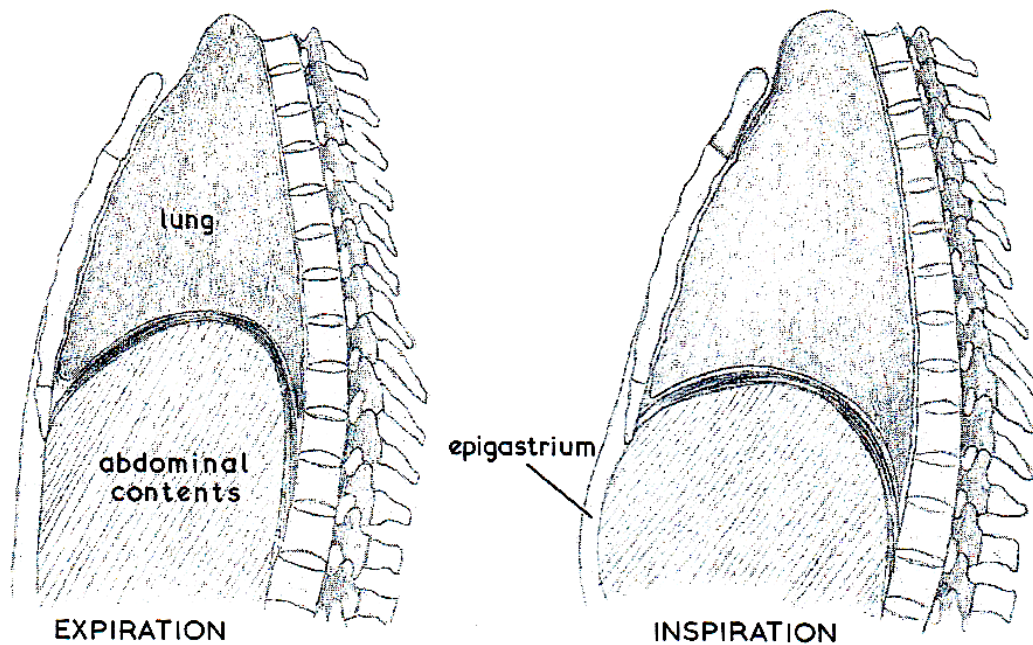


Fig. 18. Diagram of respiratory movements of the diaphragm.

Figure 3

*Diagram showing the effects of diaphragmatic descent from Bunch, 1997, p. 38*

The intercostal muscles are actually to be found in 3 layers, lying between the ribs. They are known as the external intercostals and the internal intercostals while the incomplete most internal layer is known as the innermost intercostals (Rubin, 1998, p. 57; Leonard, 1983, p.81).

The external intercostals extend from the inferior margin of one rib to the superior margin of the one below, with the muscle fibres running in an oblique direction oriented forward and down. The external intercostals run between each of the ribs and extend from the vertebral column at the back to the joint of the costal cartilages with the sternum or for the lower ribs into the union with the 7<sup>th</sup> costal cartilage (Hixon, 1987, p. 13). Activation of the external intercostals tends to raise the ribs but because of their orientation they work most effectively on the lower ribs (Rubin, 1998, p. 54). Bunch (1997, p. 39) disagrees with this statement as she feels that most of the rib raising occurs through diaphragm action with the external intercostal muscles serving only to stabilize the rib cage wall to allow the diaphragm to move the ribs as a unit. Bunch (1997, p. 39) also points out that much of the literature on the intercostal muscle function in books

on speech and voice is not up to date and she sets out a useful review of the literature on the function of the intercostal muscles.

As early as the 1950s, Campbell attempted to study the electrical activity of the respiratory muscles using surface electrodes. “He concluded that some parts of the intercostals were active in quiet inspiration and in voluntary forced inspiration and that no distinction was possible between the internal and external layers.” (Bunch, 1997, p.39) Taylor in 1963 used specially constructed needle electrodes that were inserted directly into the muscles and his study used 80 human subjects. “Taylor demonstrated two functionally distinct layers of intercostal muscle in all parts of the chest wall. The superficial one was activated only by inspiratory efforts, and the deeper one by expiratory efforts.” (Bunch, 1997, p. 39). Taylor’s work was confirmed and extended by Campbell (1968, 1970, 1974, 1978); Sears (1973); and Basmajian (1978).

The external intercostals are certainly active during inspiration. Whether this activation does lift the ribs themselves or merely stabilizes the rib cage wall so that other (probably diaphragmatic) forces can lift it is still open to debate. Rubin (1998), Hixon (1987) and Bunch (1997) all report that the role of the intercostal muscles as a group is to stabilize the chest wall. “Their function [the intercostal muscles] is to maintain the stability of the chest wall, to prevent it being sucked in during inspiration” (Rubin, 1998, p. 54).

The internal and innermost intercostals lie deep to the external intercostals and their fibres run in the opposite oblique direction. Their attachments are also different with the upper attachment further from the fulcrum of rib movement than the lower which reverses the direction of their pull so that they are thought to lower the ribs (Rubin, 1998, p. 57). They appear to be more involved in expiration than inspiration so their actions will be discussed in more detail in the description of expiration.

During quiet respiration and much of respiration for speech the action of the diaphragm and intercostal muscles account for most of the changes in thoracic cage dimensions. Other accessory muscles have the potential to change the size of the thoracic cage and their use is often seen in forced inspiration or in the breathing patterns of patients who



need to use an upper chest or clavicular breath pattern of breathing to compensate for paralysis or weakness in the chest muscles or diaphragm (Hixon 1987, Campbell & Newsom Davis, 1970).

The sternocleidomastoid muscle is a large and quite strong muscle located in the neck. The muscle originates on the skull behind the ear on the mastoid process and passes downwards in the neck in two divisions. One division inserts into the clavicle and the other into the sternum. If the head is fixed in position this muscle has the potential to raise the sternum and through their attachments to the sternum it also raises the ribs (Hixon, 1987, p. 14). Campbell (1970) notes that the sternocleidomastoid muscles are usually inactive in quiet respiration but always contract towards the end of a voluntary maximal inhalation (p.184). He also states that although the sternocleidomastoid muscles are used greatly by patients with compromised respiratory systems their mechanical importance is difficult to assess since they can only move the ribs upwards and he feels that this action is responsible “for the [typical] up and down movement with little lateral expansion observed in patients with chronic airways obstruction” (Campbell, 1970, p. 185).

The scalenes are a group of muscles that run from the vertebrae where they originate as muscle tabs downward and forwards where each of the three muscles the anterior, medius and posterior merge the tabs into their own discrete muscle bundles. The anterior and medius insert into the upper border of the first rib whilst the posterior inserts into the outer surface of the second. Activated as a group these muscles act to raise the first and second ribs (Hixon, 1987, p. 14). Campbell (1970) states that the scalenes do have a good mechanical advantage in raising the upper two ribs and whilst electrical activity is often noted in these muscles, even during quiet respiration, he is uncertain as to their contribution to the in-breath. “.... while the scaleni are readily employed as muscles of inspiration, their total contribution to the force of inspiration is probably not great compared with those of other muscles” (Campbell, 1970, p. 183)

The subclavius is a small narrow muscle that originates on the under surface of the clavicle and runs downward and forward to the midline where it attaches to the first rib

and the first costal cartilage. Contraction of this muscle would lift the first rib if the clavicle were stabilized (Hixon, 1987, p. 15).

The pectoralis major originates from the humerus (the major bone of the upper arm) and has a complex insertion of its large and fan shaped fibres into the sternum, the upper costal cartilages and the clavicle. If the upper arm is stabilized the pectoralis major draws the sternum and the upper ribs upwards (Hixon, 1987, p. 15). The pectoralis minor runs underneath the pectoralis major, originating on the scapular and inserting into the outer surfaces of ribs two through to five. When the shoulder is stabilized the pectoralis minor can raise these ribs (Hixon, 1987, p. 15).

The levatores costarum are 12 small muscles that are located on the back of the rib cage. They arise from the thoracic vertebrae and extend downwards and slightly outwards to the posterior surface of the rib immediately below. When these muscles contract they should elevate the ribs (Hixon, 1987, p. 16). Rubin (1998) notes that these muscles attach very close to the fulcrum of rib movement and a small force could therefore have significant effects on rib movement, Dickson (1982) feels that the muscle is working at too great a mechanical disadvantage to be effective (Rubin, 1998, p.58).

The latissimus dorsi is a large flat muscle that originates on the humerus and fans out to run downwards across the back of the lower thorax. This is another muscle with a complex insertion which includes the posterior surfaces of the lower three or four ribs. Once again if the arm is braced the fibres inserted into the lower ribs should elevate them.

Many of the actions of these accessory muscles of respiration require that the muscle is stabilized at the end away from the thorax. For this reason there is often a significant recruitment of muscular energy needed for them to exert an inspiratory effect which makes them possible but inefficient increasers of the thoracic cage volume. The accessory muscles can and do contribute greatly to forced inspiration and their action is able to compensate for an inability to move the diaphragm and intercostal muscles. Bunch states that "Overactivity of the sternocleidomastoids and muscles raising the

shoulder girdle creates a type of shoulder breathing which hinders good vocal production and is aesthetically displeasing.” (Bunch, 1997, p.47). So whilst these muscles can be used for inspiration, reliance on them, rather than on the diaphragm and intercostal muscles would be detrimental to the singer.

## **Expiration**

Expiration or exhalation occurs when air flows from the lungs. Just like in inspiration there has to be a difference between the alveolar pressure and atmospheric pressure if air flow is to occur. In inspiration, the alveolar pressure was dropped by increasing the lung volumes. Once inspiration has ceased, that is the lungs can increase in volume no more, the alveolar pressure and the atmospheric pressure will again be equal. To commence the outward flow of air the alveolar pressure needs to be greater than the atmospheric pressure. “In the human respiratory pump this is accomplished at times by non-muscular forces and at other times by both muscular and non-muscular forces, which reduce the size of the lungs-thorax unit, thereby compressing the alveolar air and raising its pressure above atmosphere” (Hixon 1987 p17). In quiet respiration the expiration forces are essentially passive and consist of the elastic recoil mechanism of the lungs and rib cage (Hixon 1987, Rubin 1998 and Sundberg 1987). Thus the movement of the approximately 500mls of air seen in quiet respiration is controlled predominantly by the active contraction of the diaphragm for inspiration and the elastic recoil of the system for expiration.

There are two types of expiration, passive and active which can be employed to meet the various demands of moving air from the lungs. Passive expiration is achieved predominantly by elastic recoil of the respiratory system whilst active expiration requires interaction of the elastic recoil with additional muscular action.

Hixon (1987) states that “Expiration above the resting expiratory level usually is passive. As such it is accomplished not by muscular effort, but by non-muscular forces that return the lungs and the thorax to their usual volumes at the resting expiratory level.” (p. 19) Following on from quiet inspiration when the inspiratory muscles are relaxed the

lungs will recoil towards a smaller volume. The recoiling lungs also pull inward on the thorax and pull upwards on the diaphragm, thus reducing the size of the thoracic cavity back towards neutral (resting expiratory level). In deep inspiration, defined by Hixon (1987, p. 19) as relatively high lung volumes of greater than 55% of vital capacity the thorax is also stretched beyond its natural size and will also contribute directly to the recoil of the system with the rib cage and diaphragm tending to recoil towards their resting positions. It is simplistic to think that the inspiratory muscles switch off immediately that inspiration has occurred. Hixon (1987) states that; “They [the inspiratory muscles] actually continue their activity into the early part of expiration, with the force they exert gradually decreasing and acting as a releasing brake against the lung recoil forces.” (p. 19) Although this type of expiration is labelled as passive expiration it is not truly passive until the inspiratory muscle forces switch off from their braking function at about the 2<sup>nd</sup> second in the expiration cycle.

Active expiration can occur at any time in the expiration cycle, it is not merely limited to the expiration that occurs once elastic recoil is complete. Rubin (1998, p. 57) states that active expiration is required once the lungs are at 35% vital capacity since this is the level that is thought to be the resting expiratory level. Active expiration above this level (35% vital capacity) will serve to increase alveolar pressure and airflow but any expiration below this level will be by necessity be active. Rubin (1998) also states that “for controlled expiration during phonation and for increasing the intensity or duration of sound, activities that are critical in singing, more expiratory muscular activity is necessary than that obtained via recoil.” (p. 58).

Muscles of active expiration either: lower the ribs or sternum to decrease the dimensions of the thorax, or increase the abdominal pressure to push the diaphragm upward to decrease the vertical dimensions of the thorax. It is important to remember that the abdominal cavity can be seen as a muscular bag bounded by the diaphragm at the top and the muscles of the pelvic floor below. The abdominal muscles form the sides and front of the bag. The volume within the abdominal cavity remains basically constant (since it consists of the viscera) so that when the diaphragm descends the abdominal wall, when relaxed, (the most flexible component of the bag) is distended. Conversely

when the muscles of the abdominal wall contract and the diaphragm is relaxed the contents of the abdomen are driven up into the thorax which raises the intra-thoracic pressure which can expel air from the lungs (Rubin, 1998, p. 59).

“Whereas there are multiple muscle groups that can, under varying circumstances, be brought into play for direct or accessory assistance in inspiration, there are somewhat fewer muscle groups available for expiration.” (Rubin, 1998, p. 58). Muscles that are most likely to be involved in active expiration are thought to be: internal intercostals, external abdominal oblique, rectus abdominis, transversus thoracis, transversus abdominis, internal abdominal oblique, subcostals, sacrospinals, iliocostalis lumborum and the serratus posterior inferior (Rubin, 1998, p. 59).

The internal intercostals are thin muscles that are situated in the rib spaces lying beneath the external intercostals. Their fibres run upwards and forwards from one rib to the one above. The fibres run almost at right angles to the fibres of the external intercostals (Hixon, 1987, p. 20). The internal intercostals pull the ribs downwards and stiffen the rib interspaces (Hixon, 1987, p. 20). Rubin (1998, p. 57) indicates that “the intercostal muscles are more active during phonation/singing wherein they help maintain the subglottic pressure.”

The external abdominal oblique arises from the lower eight ribs and runs forwards, downwards and medially to insert into the rectus sheath, linea alba and the iliac crest (hip bone) and the inguinal ligament in the groin (Rubin, 1998, p. 59). “When it contracts, the external oblique draws the lower ribs downwards and displaces the contents of the abdomen inward, thus raising the abdominal pressure.” (Hixon, 1987, p.22)

The internal abdominal oblique is another large flat muscle that lies internal and slightly more medial to the external oblique. It originates rather broadly over the whole iliac crest and inguinal ligament and its fibres run upwards and medially to insert into the costal cartilages of the lower four ribs and the mid line abdominal aponeurosis (linea alba). On contraction this muscle draws the lower ribs down and pulls the abdominal wall inward (Hixon, 1987, p. 23).

The transversus abdominis too originates from the iliac crest and inguinal ligament but it also arises from the inner surfaces of the lower six costal cartilages. These fibres actually interweave somewhat with the fibres of the diaphragm and the lumbar vertebrae. The fibres run transversely to insert into the linea alba rather like a cummerbund (Rubin, 1998, p. 60). On contraction the transversus abdominis displaces the abdominal wall inward, again raising the abdominal pressure (Hixon, 1987, p. 23).

The rectus abdominis originates at the crest and symphysis of the pubis and the fibres run upwards to insert into the xiphoid process and the fifth, sixth and seventh costal cartilages. Contraction draws the sternum down and the abdominal contents inwards (Rubin, 1998, p. 60, Hixon, 1987, p. 22).

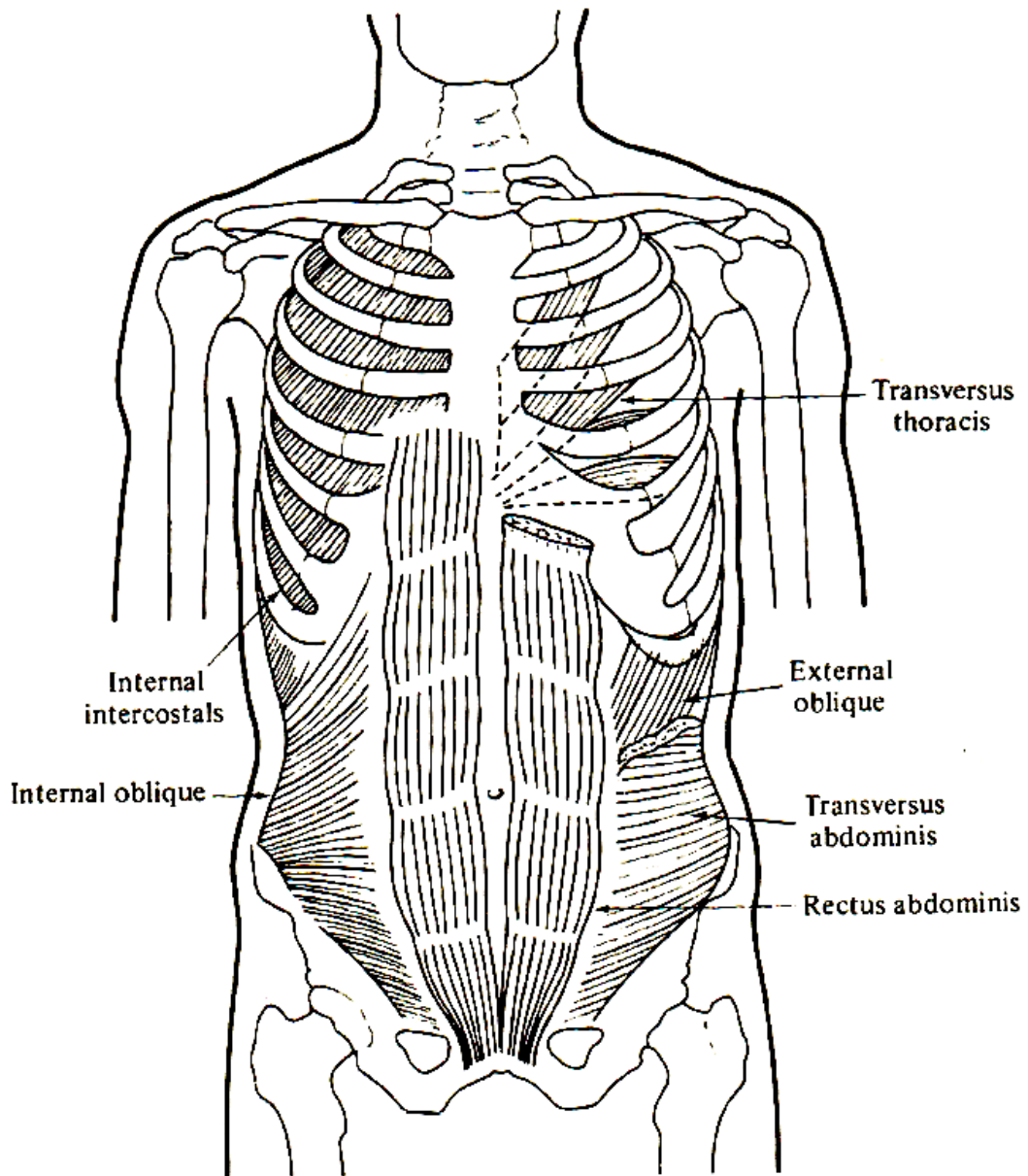
The transversus thoracis originates from the xiphoid process and the lower portion of the sternum and runs laterally to insert onto the costal cartilages of the second to sixth ribs (Rubin, 1998, p. 60). Contraction of this muscle tends to lower the ribs to which it attaches and has an effect of narrowing the thoracic cage (Hixon, 1987, p. 21).

The subcostals are thin strips of muscles that originate from the deep surfaces of the ribs near the vertebral column and insert into the second and third ribs, near the rib angles. Their fibres parallel those of the internal intercostals and they are thought to have similar functions (Rubin, 1998, p. 60).

The sacrospinals are a group of powerful muscles that run between the rib cage and the vertebral column. Their lumbar portion forms a lever with the lower ribs and may help to depress the lower ribs (Rubin, 1998, p. 61).

The serratus posterior inferior is located on the back. It originates from the lower thoracic and the upper lumbar vertebrae and the fibres slant upwards to insert into the lower borders of the last four ribs. Contraction of these muscles pulls the lower ribs down (Hixon, 1987, p. 22).

The quadratus lumborum is located on the back wall of the abdominal cavity. It originates from the iliac crest and the fibres run upwards to insert into the lumbar spine and the back of the lowest rib. Its contraction is thought to depress the lowest rib (Hixon, 1987, p. 22).



**FIGURE 1-11.** Muscles of expiration.

Figure 4

*Diagram showing the primary muscles of expiration from Hixon, 1987, p. 20.*

As in inspiration the exact muscular interactions required for expiration are not fully understood. Anatomists evaluate muscle movements in isolation but in the living specimen there are numerous muscular interactions that occur simultaneously. Just as the inspiratory muscles do not switch off immediately that expiration commences many of the expiratory muscles work either together or in sequence to promote the desired effect of increasing abdominal and alveolar pressure.

Bunch (1997, p.47) also highlights the fact that these abdominal muscles also have a postural function through their actions on the rib cage and she suggests that the rectus abdominus while a powerful flexor of the lumbar spine does not play a significant role in respiration. Bunch goes on to state that the main functions of the abdominal muscles in respiration are to raise intra-abdominal pressure which in turn aids the upward movement of the relaxed diaphragm by pressing the abdominal viscera onto it.

Subglottic pressure is another factor that must be considered in relation to expiration for singing purposes. “[Subglottic pressure] is a pressure created by the flow of expired air against partially closed (adducted) vocal folds.” (Bunch, 1997, p. 51) Subglottic pressure is of some importance to airflow but is vital to achieving a constant intensity of sound. Subglottic pressure is mediated not only by the respiratory system but also by adjustments to the laryngeal musculature.

In singing, subglottic pressure varies from 2 to 50 cm of H<sub>2</sub>O....To generate a constant subglottic pressure for singing, a graded, coordinated action of the inspiratory and expiratory muscles is required, and physiologists, for example Sears (1977), consider the intercostal muscles ideally suited for this task. These muscles have mechanoreceptors which allow fine regulation and gradation in their actions, therefore they are capable of causing delicate adjustments in pressure. (Bunch, 1997, p. 53)



## Breathing for Singing

Watson and Hixon (1987) describe singing as a “complex biomechanical process” (p, 337). They also note that there is a rich folklore surrounding singing but that there have been few investigations into the biomechanics of singing. Twenty years later it is still fair to make these comments especially in regard to breathing and breath support. Since the advent of the flexible fibre-optic scope and the use of stroboscopic light, a large amount of research has focussed its attentions on the larynx and the processes of phonation. Jo Estill, for example, has been a major force in the mapping of laryngeal behaviours and manoeuvres in both speaking and singing, but the studies examining breathing for singing remain limited, both in absolute number and in the scope of their research. Many studies have used only very small numbers of singers and this can make it difficult to draw generalised conclusions about breathing for singing.

Research about breathing for singing can be divided broadly into two types; those studies that have used kinematic methods of investigation and those that have used electromyography. The recording of pressure, from the oesophagus and abdomen has also been used, but these measures usually accompany one or the other types of investigation.

Kinematic studies rely on measuring the changes in the anterior-posterior dimensions of the chest wall. The chest wall can be divided into two parts namely the rib cage and the diaphragm-abdomen, as, in kinematic terms a part is defined as a mechanism that displaces volume as it moves (Hixon, 1987, p. 95). The combined volumes displaced by the rib cage and the diaphragm-abdominal wall are equivalent to the total lung volume change. It is possible to obtain information from kinematic data that not only reflects volume changes, but also airflow and muscle group activation. Electromyographic studies (EMG) aim to identify the presence of electrical activity in the muscle. This electrical activity is a sign that active muscular contraction has taken place. EMG studies are particularly useful for identifying which muscles are active at any one time but EMG responses do not always give accurate information on the force of the muscular contraction. Information has been gleaned from both investigation methods, no one

method of investigation is absolutely better than the other, and one method will be chosen over another depending on the exact focus of the experiment.

Watson and Hixon (1987) found that untrained male subjects used respiratory patterns for singing that were very similar to the patterns used for the production of normal or loud spoken voice. However, they were also specifically interested in evaluating the respiratory performance of classically trained singers (p.360). Watson and Hixon studied the breathing patterns of classically trained singers in both speaking and singing tasks. They chose classically trained singers, since classically trained singers tend to receive more formal training than other types of singers. Watson and Hixon also noted that it is also “around their art that the most passionate and expanded controversies have developed concerning the use of the respiratory apparatus” (1987, p. 338).

As is usual with this type of research, subject numbers were small, with only six singers. Watson and Hixon chose six male singers, all of whom were baritones. This was to provide some homogeneity in the group and to allow direct comparisons between singers and non-singers singing the American national anthem. The data from non-singers were available from previous research. All of the singer subjects had greater than or equal to five years of classical singing training, post high school, and had completed or were currently enrolled in graduate training, in vocal performance or choral conducting. The subjects had also had extensive performance experience, performing widely in opera, concerts, recitals or graduate recitals (Watson and Hixon, 1987, p. 338).

Respiratory data were taken from the chest wall using kinematic measures that provided movement, volume and accurate determinations of the volitional and inherent forces used in the respiratory tasks undertaken (Watson and Hixon, 1987, p. 338). When using these kinematic measures the chest wall is seen as a two part system consisting of the rib cage and abdomen.

Assessment tasks included both speech and singing. Speech tasks consisted of: two minutes of conversation with the investigators, passage reading, passage reading at what the subject perceived to be twice the normal volume and a recitation of the words of the

first verse of the American national anthem. Singing tasks consisted of: the American national anthem, two Italian songs in contrasting styles, *Amarilli Mia Bella* by Caccini (which is slow and sustained) and *Che Fiero Costume* by Legrenzi (which contains rapid moving passages) as well as an aria of their own choice.

Overall Watson and Hixon found that there were few significant differences between the trained singers and the untrained singers on speaking tasks.

The kinematic data generated by the present subjects for various speaking activities are highly similar to those obtained from the vocally untrained normal men studied previously. Only the occasional use of slightly higher lung volumes and rib cage volumes separates the present subjects from untrained subjects... (Watson and Hixon, 1987, p. 360)

By combining the data from this group with that previously obtained Watson and Hixon was able to make relatively certain statements about the muscular mechanisms used in speaking.

For the expiratory portion of the breathing cycle, the rib cage and abdomen exerted expiratory forces that drove the chest wall at a speech-specific configuration dictated largely by a predominant activity of the abdomen. This combination of forces was the same but heightened for loud speaking....From off the general background configuration set by the abdomen, the diaphragm was activated and worked against the relatively taut abdomen to elevate the relaxed (or nearly so) rib cage. The powerful inspiratory activity of the diaphragm thus restored the respiratory apparatus to a higher lung volume, rib cage volume and abdominal volume by lifting the rib cage and overpowering the active abdomen, forcing it outward despite its continued expiratory effort. (Watson and Hixon, 1987, p. 360)

Despite very similar kinematic data on speaking tasks there were very significant differences between the trained and untrained singers on singing tasks. Direct comparisons can be made between the two groups on the anthem singing task since both groups performed this item. As mentioned previously untrained singers use respiratory adjustments that are very similar to normal or loud speaking. The trained singers, although their speaking data were not significantly different from the untrained singers showed marked differences in their singing performance.

The trained singers showed continuous adjustments in lung volume, rib cage volume and abdominal volumes. Changes in lung volumes were also extensive, beginning at quite high lung volumes and continuing through a large proportion of the vital capacity. Trained singers used greater muscular effort than the untrained singers, probably to overcome the very large relaxation pressures generated by such large lung volumes. It is also important to note that the trained singers used much greater muscular effort in the singing task compared even to their own speaking attempts (Watson and Hixon, 1987, p. 361).

Watson and Hixon also reported that the changes in lung volumes during singing were accomplished through a large range of relative volume contributions by the rib cage and the abdomen. Two main types of adjustments were noted. Those that involved relatively gradual shifts in the relative contributions of the rib cage and abdomen or those involving more rapid shifts in contribution, which was usually associated with abrupt changes dictated by the passage being performed. "Overall patterns differed a great deal across subjects, revealing a variety of individual styles of chest wall displacement for singing" (Watson and Hixon, 1987, p. 361). Watson and Hixon go on to postulate that whilst there might be a number of ways of using the chest wall for singing, the pattern used by each subject would be influenced by how the subject has learned to use his own physiology for singing and by the type of instruction in terms of breathing and breath support he has received (Watson and Hixon, 1987, p. 361). Interestingly untrained singers all used very similar patterns of respiratory activity whilst singing (that is very similar to normal or loud speaking) so it would seem that

there is a significant instructional or training effect on the respiratory behaviours of trained singers.

“The chest wall was distorted continuously from its relaxed configurations during singing by the present subjects, meaning that muscular forces were continuously in operation” (Watson and Hixon, 1987, p. 362). The rib cage was always more expanded and the abdomen less expanded than they were when relaxed at corresponding lung volumes, confirming the use of muscular effort.

The general nature of the distortion of the chest wall for singing was similar to that of speaking, although singing in contrast to speaking, usually involved far greater deformation of the chest wall and very different volume histories for the rib cage and abdomen. (Watson and Hixon, 1987, p. 362)

During expiration the general background task was to exert more positive efforts in the chest wall (that is, either more expiratory or less inspiratory) as the lung volumes decreased. This would ensure a steady stream of air at the correct pressure for phonation. It is important to remember that at high lung volumes the elastic recoil of the respiratory system is such that the system will be generating quite high relaxation pressures, that is the air will want to leave the lungs without any specific muscular input. At these high lung volumes the muscles of inspiration rather than of expiration could still be active, so that the muscular action would be exerting a negative rather than a positive pressure effect!

“Under high lung volume or soft singing conditions, or both, the mechanism most likely operating generally would entail increasingly less negative [inspiratory] efforts by the rib cage and increasingly more positive [expiratory] efforts by the abdomen” (Watson and Hixon, 1987, p. 362). Watson and Hixon believe that it is the muscles of the rib cage rather than the diaphragm alone that predominate in this situation. The high rib cage volumes observed in his current subjects seem to confirm this assertion since it is known that in upright subjects, negative chest wall efforts against

high relaxation pressures are invariably generated with the inspiratory muscles of the rib cage (Watson and Hixon, 1987, p. 363).

Presumably, use of the rib cage, and not the diaphragm, to generate negative muscular pressures under the conditions described [high lung volumes with high relaxation pressures] has to do with several advantages the rib cage offers to the singer. First, the rib cage is in contact with a far greater portion of the surface of the lungs (about three fourths) than is the diaphragm (about one fourth). This means that movements of the rib cage need to be far less extensive than those of the diaphragm to effect the same changes in alveolar pressure. Second, the inspiratory muscles of the rib cage are smaller in size, faster acting, greater in number, and more richly endowed proprioceptively than those of the diaphragm. This affords the rib cage a finer graded control over inspiratory efforts than is possible through the use of the diaphragm. Third, the rib cage is able, in the upright body position, to supplant the need for contraction of the diaphragm during inspiratory efforts by virtue of its influence on the hydraulic forces exerted through the abdominal contents. This permits net inspiratory control of the respiratory apparatus through the high lung volume range via recourse to the use of only one inspiratory part of the chest wall. (Watson and Hixon, 1987, p. 363)

It is important to remember that Watson and Hixon's statements above relate to the activity of the chest wall once the lungs are filled to a high volume. The singer used the diaphragm to fill his lungs with air but then uses predominantly, but not exclusively, rib cage inspiratory muscles to balance the pressures and volumes to provide the needed steady stream of air.

Just as the inspiratory muscles of the rib cage are active in the high lung volume range, so are the expiratory muscles of the abdomen. It seems like a contradiction that these expiratory muscles are actively trying to push air from the body while the inspiratory muscles of the rib cage are actively trying to retain it but the generalised reduction in

abdominal volumes coupled with the frequently noted rib cage volume increases in Watson and Hixon's subjects confirm that this is indeed happening. Watson and Hixon state that the singer receives an important efficiency gain by activation of the abdomen in these high lung volume circumstances.

That gain is that the active abdomen provides an opposing member in the parallel arrangement of the chest wall (rib cage and abdomen) against which the rib cage can develop pressure. This means that the increasingly less negative efforts [inspiratory efforts] of the rib cage can be resolved economically into alveolar pressure rather than into chest wall shape change (principally an outward moving abdomen) that would partially offset the decreasing force adjustment of the rib cage. The inferred generation of an increasingly more forceful abdominal effort as the breath group proceeds through the high lung volume range is consistent with the desirability of providing an increasingly firm and less distant opposing member for the rib cage to work against as it delivers increasingly less negative [inspiratory] efforts. (Watson and Hixon, 1987, p. 364)

These data from high lung volumes seem to suggest that the abdominal muscles are active, performing their expiratory function regardless of the relaxation pressures in the lungs, lung volume or inspiratory muscle activity in the rib cage. This is an important finding in terms of describing breathing for singing and in contrasting it with breathing for speaking. Even when there is no obvious need for expiratory muscle activity, such as when the relaxation pressures are so high that inspiratory rib cage muscle activity is significant, the muscles of the abdominal girdle are recruited for the work of singing.

When the lung volumes are at mid or low levels there are expiratory efforts in both the rib cage and the abdomen.

Implication of both the rib cage and the abdomen in the suggested mechanism is supported by (1) the general rib cage volume and abdominal

volume decreases demonstrated by the present subjects through the mid and low lung volume ranges and (2) the frequent changes in relative volume contributions of the rib cage and abdomen observed for the subjects through these ranges. (Watson and Hixon, 1987, p. 364)

Watson and Hixon go on to point out that the abdominal muscles have a very similar efficiency to that obtained at high lung volumes with the additional benefits of mechanical tuning of both the diaphragm and rib cages.

The expiratory efforts of the abdomen serve to displace the diaphragm headward which increases the length of the diaphragm's fibres and the radius of its curvature. This mechanically tunes the diaphragm to enable it to function quickly and powerfully as a force generator for inspiration (Watson and Hixon, 1987, p. 364). In addition to the mechanical action on the diaphragm, the abdomen exerts an upward lifting force to the rib cage that elevates it, increases its volume and places its expiratory muscles at greater and more optimal lengths for the generation of quick and forceful pressure changes (Watson and Hixon, 1987, p. 365). Watson and Hixon also point out the abdominal component of the chest wall distortion was substantially more in the singing than in the speaking data with this group of singers again confirming the importance of the abdominal wall in breathing for singing.

The rib cage also has assets for expiration at mid and low lung volumes that are analogous to two of its gains at high lung volumes. The rib cage is in contact with a large surface area of the lungs and its muscles are capable of fine graded control of muscular pressure (Watson and Hixon, 1987, p. 365).

Inspirations of the subject group for singing usually were very quick, involved large volume excursions of the lungs, rib cage and abdomen, and were accomplished by using a wide range of relative volume contributions by the two chest wall parts. (Watson and Hixon, 1987, p. 365)



Just as there were for expiration, the subjects in the study showed a variety of styles for inhalation. Watson and Hixon postulate that this could be due to self-preference for what seems effective for them and the influences of previous teaching about breathing. Overall though, the most prevalent style of inspiration involved both rib cage and abdominal volume increases. In those subjects where there were no simultaneous, symmetrical changes in rib cage and abdominal wall volumes, the most predominant pattern was an abdominal volume increase followed by a rib cage volume increase. Watson and Hixon found that inspirations for singing often involved changes in the chest wall that were greater than the volumes seen during relaxation. Most inspirations showed a distortion of the chest wall from its relaxed configuration towards that of a more expanded rib cage and a less expanded abdomen volume (Watson and Hixon, 1987, p. 365).

“During inspiration, the general background task for the present singing subjects presumably was to exert rapidly increasing negative [inspiratory] chest wall efforts” (Watson and Hixon, 1987, p. 365). Watson and Hixon believe that the diaphragm is primarily responsible for the in-breath with the abdomen reducing its expiratory activity at the same time. “Inspiratory effort by the rib cage does not seem a likely possibility, given the relative volume contributions observed for the present subjects...” (Watson and Hixon, 1987, p. 365). They go on to state that the diaphragm is implicated as the prime mover in inspiration due to the large outward movements of the abdomen during inspiration. This belief is supported by the work of Bouhuys and colleagues (1966) and Proctor (1968) both of whom demonstrated large transdiaphragmatic pressure in singers during inhalation which would be consistent with vigorous diaphragm contraction.

Watson and Hixon state that the use of the diaphragm rather than the rib cage to generate the required negative pressure for inhalation may have some systemic advantages. The diaphragm is the most powerful of all the inspiratory muscles and can through its action displace both the rib cage and the abdomen in the inspiratory direction. The use of the diaphragm for the in-breath then leaves the rib cage free of inspiratory work so that it can immediately commence control of the intra-thoracic

pressures during expiration. It is important to remember that at high lung volumes the rib cage works in an inspiratory (negative) direction to help balance the alveolar pressures for singing. Finally the diaphragm can be continuously tuned mechanically by the abdomen (as mentioned above), regardless of lung volume, to work as quickly and as efficiently as possible for the next in-breath (Watson and Hixon, 1987, p. 366).

The abdomen is also implicated in the inspiratory mechanism since the abdominal volumes were usually smaller than relaxation volumes during inspiration. Watson and Hixon postulate that the continued positive (expiratory) exertion of the abdomen provided a mechanical fulcrum for the diaphragm to work from in its efforts to raise the rib cage and fill the lungs (Watson and Hixon, 1987, p. 366). Watson and Hixon go on to state that “the different patterns of inspiratory style demonstrated among the present subjects probably are related to the particular abdominal control strategy chosen by different subjects, not to significant differences in diaphragmatic function” (Watson and Hixon, 1987, p. 367).

Watson and Hixon also made some interesting observations about the transitions between inspiration and expiration. The main inspiration to expiration transitions involved a rapid displacement of volume from the abdomen to the rib cage. They postulate that this transition served to set up the chest wall for operation through the next breath group by a forceful incremental activation of the abdomen (Watson and Hixon, 1987, p. 367). Watson and Hixon also noted that this transition was common but in certain subjects a large inward abdominal wall movement was seen coincident with the initial moment of the utterance which may represent a training or instructional effect.

Transitions between expiration and inspiration also constitute an important part of the respiratory cycle for singing. “These involved rapid decreases in lung volume, sometimes the result of rib cage volume decreases and abdominal volume increases, and less often the result of abdominal decreases accompanied by a lesser or no decrease in rib cage volume” (Watson and Hixon, 1987, p. 367).

Watson and Hixon report that most of the expiration to inspiration transitions involved decreases in the rib cage volume and increases in the abdominal volume. They suggest that this apparent paradoxical manoeuvre occurs because the rib cage is continuing its expiratory force while the abdomen begins to lessen its expiratory force in preparation for the upcoming in-breath such action would result in the abdomen being forced outward. They believe that this paradoxical movement continues until the diaphragm is activated to commence the next inspiration.

Chest wall function of the general nature inferred seems analogous to that observed for the initiation of connected speaking and singing in studies of untrained subjects and represents a preferred posturing of the chest wall, probably for reasons of mechanical advantage. (Watson and Hixon, 1987, p. 267)

Given this data it appears that trained singers do use their chest walls in a different way, when compared to untrained singers. As there was little difference between the performance of trained singers and normal subjects on speaking tasks it appears that the trained singers do choose to use their respiratory physiology differently for the purposes of singing. On singing tasks untrained singers use respiratory manoeuvres that are very similar to those used for normal or loud speaking but those of the trained singer differ significantly.

Watson and Hixon summarise the findings of their experiment as follows:

...the present data for singing suggest a role for the abdomen that is mainly one of posturing the chest wall in a manner that aids both the rib cage and the diaphragm in their primary functions. This role involves the configuration of the chest wall and extends across both phases of the respiratory cycle for singing. Pressurization of the pulmonary system for singing, by contrast, appears to be the major role of the rib cage during the expiratory side of the respiratory cycle as that structure functions to generate aeromechanical events of importance to the demands of the

singing program. Finally, the diaphragm has as its assignment the inspiratory side of the respiratory cycle, its role being to inflate the pulmonary system quickly so the singing program can proceed. (Watson and Hixon, 1987, p. 368)

Watson and Hixon only studied male singers in their initial 1985 experiments (those reported on in their chapter of Hixon's 1987 book) but a further study of female singers was carried out by Watson, Hixon, Stathopoulos and Sullivan in 1990. They used 4 highly trained female classical singers, all sopranos, and had them perform similar tasks to those previously undertaken by the baritones. The results obtained were consistent with those generated by the male subjects and Watson and his co-workers believe that there are no significant differences between male and female singers. The female singers showed very similar kinematic results for reading to those of untrained women and the results obtained on singing tasks were very similar to those of the trained male singers. This study, although it only involved 4 singers, is complementary to the previous study of Watson and Hixon. Significant and useful data has thus been obtained from a group of ten singers over the two experiments.

Proctor in his 1980 book *Breathing, Speech and Song* reports on some early experiments that were performed with himself acting as the subject. Proctor was not only a Professor of Otolaryngology and a respiratory researcher but also a highly trained professional singer. He draws conclusions about breathing for singing that are remarkably similar to those drawn by Watson and Hixon. Despite his tiny sample size (a number of only one on many occasions) it is interesting that he does come to such similar conclusions. He believes that the diaphragm is mainly involved in inspirations, the intercostal muscles control the pressure and airflow for much of the expiration and that the abdominal wall moves inward to assist the control of the outward flow of air.

Once full, or nearly full, lung volume is achieved and the vocal folds are approximated for phonation the diaphragmatic activity ceases and this

muscle becomes a relatively flaccid membrane interposed between the intercostals and the abdominals which take over at that point. Subtle changes in airflow and subglottic pressure are largely controlled by a balance between expiratory and inspiratory intercostal muscle activity, particularly at lung volumes above F.R.C [Functional Reserve Capacity]. Relatively loud tones (requiring high subglottic pressures) at all lung volumes, and continuance of even soft singing at lung volumes between F.R.C. and R.V. [Reserve Volume] require abdominal muscle activity. (Proctor, 1980, p.73)

Watson and Hixon (1987), even though their sample size was small (only 6 singers), felt that some of the differences in breathing style that they noted in their study may have been due to differences in the training and instruction that these singers had received about breathing. This supposition was supported by the fact that, how the singers described their breathing for singing and how they actually breathed for singing often did not match. "...the present subjects' beliefs usually bore little or no correspondence to the respiratory events associated with their actual performances" (Watson and Hixon, 1987, p. 369). A reason for this may have been that they described breathing for singing in the terms it was described or taught to them whilst their bodies, perhaps in spite of that instruction, with practice and stimulation, arrived at an efficient method of breathing for singing. Even though there was variability Watson and Hixon were able to make some generalised statements using data from the whole group and from some previous research on non-singers. They suggested that the singer's perceptions or perhaps even the instruction provided to him, though a source of some variability, cannot change what is fundamentally correct or physiologically possible for breathing. Watson et al's later work on female singers also supports this notion as there was again some variability amongst the subjects in terms of how the breath was managed but even so some consistent findings were obtained.

Thorpe, Cala, Chapman and Davis (2001) studied the difference between fully supported and less supported singing in a group of five professional singers. In an effort to reduce the intersubject variability, they recruited singers who had been

trained by a single teacher and so, presumably followed a more consistent method of breathing and support. Although this paper was focussed primarily on the differences between supported and less supported singing the kinematic data obtained on these singers is of interest.

Chapman (one of the co-authors) was the singing teacher who trained all of the subjects in this study. She teaches a method of breathing and support that “...emphasizes the use of abdominal support synchronized with the onset of phonation” (Thorpe et al, 2001, p.87). Chapman believes that the main muscles used for this abdominal support are the transverse abdominis, rectus abdominis and the internal and external obliques. Chapman uses primal sounds such as cries, sobs, laughs and yells as part of the process of learning her method of breathing and support since these sounds seem to naturally evoke actions in the muscles mentioned.

Chapman teaches that all singing should be supported [with these muscles] but it is noticeable that during “projected” singing there is a particular increase in muscle contraction in the lateral abdominal region. This lateral abdominal support appears to provide stability to the actions of the rib cage and diaphragm during phonation. (Thorpe et al, 2001, p.87).

Chapman also insists that this support is not active during inspiration and she asks the singer to release abdominal tension at the start of inspiration so that the diaphragm can descend quickly. She calls this onomatopoeically “SPLAT”. Dina Harris, one of her colleagues has since turned SPLAT into the following mnemonic: Singers Please Loosen Abdominal Tension (Chapman, 2006, p.41).

Thorpe et al indicate that although there are some minor differences in the recordings caused by the subjects all singing different repertoire, there are notable similarities between subjects’ respiratory patterns. Inspiration is commenced with a rapid manoeuvre where there is expansion in the abdomen that occurs concurrently with a decrease in rib cage volume. This manoeuvre results in a negligible volume change. This manoeuvre is very short in the order of only 100 milliseconds (Thorpe et al, 2001,

p. 90). After this, inspiration continues with expansion in both the rib cage and the abdomen. This is followed by a further realignment which consists of a simultaneous elevation of the rib cage and a drawing in of the abdomen. Vocalisation usually commences part way through this alignment. Expiration continues with a simultaneous decrease in both rib cage and abdominal dimensions (Thorpe et al, 2001 p. 90-92).

Thorpe et al note that the rib cage versus abdominal plots seen correspond well with the pedagogical instruction given to the singers. They also note that the paradoxical rib cage-abdomen movement described at the commencement of inspiration is consistent with the data generated by Watson and Hixon (1985) and described again in Hixon's 1987 book. It is also interesting to note that although Watson and Hixon showed a wide variety of respiratory patterns, comparable respiratory patterns to the ones described by Thorpe et al were observed in the more experienced singers.

Thorpe et al also note that in conditions of increased support, there is an increase in the lateral dimensions of the rib cage, coupled with a decrease in abdominal volume. "The dimension changes are suggestive of an increased abdominal pressure with the greater "support" evoked for the projected condition" (2001, p. 102). They also postulate that "simultaneous activation of the rib cage and abdominal muscles may result in more rapid and possibly better controlled changes in subglottal pressure" (Thorpe et al, 2001, p. 102).

In conclusion Thorpe et al believe that "the use of support exhibits itself ... as a movement away from the relaxation state, with abdominal muscle activation and the raising of the rib cage, coupled with a rapid release of expiratory muscle activity at the start of inspiration" (2001, p. 103).

The consistency of the data in the Thorpe et al study (2001) suggests that the training offered to singers and the concepts taught to singers about breathing can significantly affect the respiratory choices singers make in performance. The pedagogy used in this study follows the use of respiratory physiology well. Inspiration is essentially under the control of the diaphragm, during expiration there is active participation of the

abdominal muscles to increase abdominal pressure and tune the diaphragm for the next inspiration while the pressures required for phonation appear to be under the control of the rib cage. It is interesting to note that the most experienced singers in the Watson and Hixon study in 1985 used a very similar pattern of breathing especially for the fast singing and the aria singing (the most demanding types of singing) tasks.

In another study from the same laboratory by Foulds-Elliott, Thorpe, Cala and Davis in 2000, the differences between singing with and without emotional connection were evaluated. They had their subjects sing the same material, firstly in a technical way and secondly with full emotional connection. They found little difference in the mechanics of breathing for either condition but they did note that in the emotional connection condition there was generally greater outward movement in both the lateral and anterior-posterior planes of both the rib cage and abdomen which lead to an increased air flow in the emotional connection condition. Their main conclusion was that there was greater chest wall excursion in the emotional connection condition. This finding may help explain why the pattern of breathing seen by Thorpe et al (2001) occurred on the more difficult singing tasks in Watson and Hixon's earlier study, particularly the aria task, where more emotional connection could be expected.

A common thread running through the research into breathing for singing is that although there are some common or generalised conclusions that can be drawn from the scientific data, there is a degree of variability in the singers' methods. Control of the subglottic pressure is the prime focus of the breathing apparatus during phonation for singing and despite the fact that some singers appear to have an idiosyncratic method of achieving it, they all do so to a rather high degree of proficiency. Thomasson and Sundberg (1999) evaluated the consistency with which singers used their respiratory systems during singing. They postulated that although "...a variety of chest wall configurations can produce the same target subglottal pressures. If breathing behaviour is important to phonation, professional operatic singers should be consistent in with their respiratory behaviour, when repeatedly performing the same phrase" (Thomasson and Sundberg, 1999, p. 530).



The subjects for this study were five professional opera singers, two sopranos and three baritones. The singers were asked to perform three songs or arias of their own choice in a quasi-realistic concert environment; each musical item was performed three times. Ten phrases were randomly selected from the songs and the three takes of each of these phrases were selected for analysis. Thomasson and Sundberg evaluated lung volumes, rib cage movement and abdominal wall movement on each of the three takes of the same phrase. They found a high degree of consistency in lung volumes and rib cage movement in all five of the singers and also in two of their subjects a high degree of consistency in the movement of the abdominal wall. They concluded that “ [the high consistency] is in accordance with the hypothesis that breathing behaviour is important in singing” (Thomasson and Sundberg, 1999, p. 539). They also note that the uniform contribution of the rib cage to the control of the subglottic pressure confirms that rib cage behaviour is also highly relevant to singing. (Thomasson and Sundberg, 1999, p. 539). The activity of the abdominal wall was also reported on, however, they concluded that since only two of their subjects used the abdominal wall in a consistent fashion, that its movement was not relevant to singing. They do indicate however, that even no movement of the abdominal wall requires some muscular adjustment, lest the abdomen be displaced by the changes in the rib cage (Thomasson and Sundberg, 1999, p. 539). Thomasson and Sundberg suggest that the abdominal wall acts as either a stable platform for lung volume changes that are affected by rib cage movements or as a co-contributor to the lung volume changes (1999, p. 540), thus agreeing with Watson and Hixon (1985) about the use of both the rib cage and abdominal wall in singing.

Thomasson and Sundberg later (in 2001) evaluated the consistency of professional singers' inhalatory patterns as a follow on from their 1999 study where only expiration was assessed. They found that once again overall consistency was high, suggesting that the singers use similar patterns of respiration on repetitions of the same task. They state that “our results have indicated a great consistency with regard to both lung volume and rib cage movements in both quick and slow inhalations, in the five singers studied....A high degree of consistency was observed also for abdominal wall movement in three of the singers” (Thomasson and Sundberg, 2001, p. 383).

Although Thomasson and Sundberg were primarily investigating the consistency of the subjects' inhalation behaviours it is interesting to note that there also appears to be some agreement as to how the breath is taken and used. All of the subjects showed rib cage movement consistency while abdominal wall movement consistency was only seen in three of the five subjects (Thomasson and Sundberg, 2001, p. 382). Thomasson and Sundberg postulate that the variability of inhalatory behaviours amongst their subjects could have been due to body type differences or due to differences in singing technique. Two of the five singers showed erratic abdominal wall movement on inhalation which suggests that for them "the abdominal wall behaviour was insignificant to phonation" (Thomasson and Sundberg, 2001, p. 382).

It is possible that a particular abdominal wall behaviour results in the specific positioning of the larynx that is favourable to phonation. However, there may be other means to achieve the same goal. The three singers who showed consistent abdominal wall behaviour may be used to taking advantage of this effect, while the other singers used other means. (Thomasson and Sundberg, 2001, p. 382)

Hixon continued his researches into the respiratory function for singing until his recent death. His 2006 publication *Respiratory Function in Singing – A Primer for Singers and Singing Teachers* summarises his work and confirms the statements he has made based on earlier researches. A number of important concepts are stressed in his book particularly in respect to the role of the rib cage and abdominal wall in singing.

The rib cage wall and abdominal wall are active during most continuous singing phrases. ...Both the rib cage wall and abdominal wall squeeze during continuous singing phrases but the squeeze of the abdominal wall is more forceful than that of the rib cage wall. (Hixon, 2006, p 97)

Thus, the preferred muscular strategy for continuous singing increases the efficiency of chest wall function. By forcefully and continuously activating the

abdominal wall, the background shape of the chest wall is mechanically tuned to favour the inspiratory function of the diaphragm and expiratory function of the rib cage wall. (Hixon 2006, p 99)

Hixon has made it clear that the abdominal wall is vitally important in singing, it also seems, based on the work of Thorpe et al, that the abdominal wall is vital to the notion of “support” in classical singing.

These kinematic studies suggest that singers do have a recognisable approach to breathing. The use of lung volumes and the rib cage in controlling subglottal pressure appear as consistent findings, with use of the abdominal wall varying somewhat from singer to singer. It appears that the use of the abdominal wall may be related to the training that singers receive, since in the studies by Thorpe et al and Foulds-Elliott et al where the subjects all received instruction from the same teacher, use of the abdominal wall was very consistent and predictable. In the other studies, there was variability in the use of the abdominal wall however, in about half of the subjects’, abdominal wall movements were similar to those reported in the Thorpe et al and Foulds-Elliott et al studies. It appears that use of the abdominal wall does provide some advantage to singers in tuning the rest of the respiratory system for action and in the generation of support.

EMG studies have also been used to evaluate the respiratory system for singers. Leanderson and Sundberg reported on some EMG findings from the diaphragm in their summary article on breathing for singing published in the *Journal of Voice* in 1988. They found that the group of four singers that they used, showed two different patterns of diaphragm activity. In one the diaphragm was found to be continuously contracting throughout the phrase and the contraction even increased when the subglottal pressure was augmented, whilst in the other the diaphragm was entirely inactive throughout the phrase and was activated for inspiration only (Leanderson and Sundberg, 1988, p. 4). They also noted the differences that occur between singers, with one singer using abdominal musculature to assist in the singing of coloratura whilst another used the diaphragm. The use of both the abdominal muscles and the diaphragm were seen in one

subject on the octave singing task. This same subject showed very different diaphragm and abdominal muscle activity for both the nonsense and the emotive speaking tasks. This confirms the kinematic studies that suggest that there are significant differences in the use of the respiratory system for speaking and singing tasks in trained singers.

Watson, Hoit, Lansing and Hixon (1989) used surface EMG to evaluate the activity of the abdominal muscles during singing. They used four male singers, all professionals, who had had at least ten years of singing training. EMG was recorded from four sites on the abdomen; upper and lower lateral and upper and lower middle. Electrodes were also placed on the rib cage but these were not used for recording, merely to lead the subjects to believe that recordings were being taken from other respiratory system sites. Kinematic data was also recorded simultaneously (Watson et al, 1989, p. 25). Apart from a number of respiratory manoeuvres subjects were recorded speaking and reading (at normal volume and at twice the normal volume) as well as singing two Italian songs; *Amarilli mia Bella* by Caccini and *Che Fiero Costume* by Legrenzi. These two songs are of contrasting musical styles and were also used by Watson and Hixon in their 1985 kinematic study.

Watson et al found that there was almost no observable activity during the relaxation manoeuvre at any of the four recording sites and in the midline sites during tidal breathing. Some activity was noted during tidal breathing at the lateral sites with more activity recorded at the lower than the upper site (1989, p. 26). These results were in agreement with the kinematic data, with the abdomen displaced inwards during tidal breathing. During speaking tasks there was clearly observable activity at the lateral sites combined with slight or no observable activity in the middle sites. For three of the four subjects there was more activity in the lower lateral than upper lateral sites (Watson et al, 1989, p. 27). "This pattern is suggestive of activation of the external oblique abdominis, internal oblique abdominis, transverse abdominis, or some combination of these muscles, with little or no activation of the rectus abdominis" (Watson et al, 1989, p. 28). Watson et al (1989) also indicated that this pattern of results was not significantly different from the results obtained from a group of subjects without professional training or experience. The EMG data are in agreement with the kinematic data in

suggesting that there are no significant differences between trained singers and untrained speakers on speaking tasks.

During singing there was a substantial increase in the EMG activity of the abdomen over speaking. Once again there was more activity (at least in three of the subjects) recorded at the lower lateral site than the upper lateral site and there was substantially more activity in the lateral sites than in the midline sites (Watson et al, 1989, p. 28). Subjects demonstrated high amplitude EMG activity in both middle and lateral regions during the production of a loud sustained high pitched note such as that which occurred at the end of the fast song (Watson et al, 1989, p. 28). Once again kinematic data were in agreement with the EMG traces and were very similar to those obtained by Watson and Hixon in their 1895 study. During expiration the results can be summarised as follows:

The lowest overall levels of activation were associated with relaxing and the highest with singing. For breathing, speaking and singing, abdominal activity was greater in the lateral region than the middle region. Differential activation within the lateral region was observed with activity in the lower portion exceeding that of the upper portion. (Watson et al, 1989, p. 29)

It is important to note that EMG activity in the abdominal wall was quite regional, this makes studies that have relied on single electrode site recordings dubious as to their findings. Absence of EMG activity from a single site on the abdomen can not be equated with absence of activity of the abdominal wall as a whole (Watson et al, 1989, p. 30).

During inspiration there were decrements in the EMG activity of the abdominal wall associated with the in-breath. “Such decrements began either coincident with or slightly prior to the onset of inspiration and were present in both lateral sites or in the lower lateral site only” (Watson et al, 1989, p. 30). When the kinematic data were also analysed it became obvious that “for both speaking and singing, decrements often were associated with outward displacement of the abdomen” (Watson et al, 1989, p. 30). The decrements showed activity that was often as low as those showed in the relaxation

manoeuvres. It is thought that the decrements in abdominal activity associated with the in-breath, decrease the resistance offered by the abdomen to the descending diaphragm, allowing diaphragmatic contraction to be resolved into outward abdominal wall displacement. This lack of resistance to the descending diaphragm would allow a more efficient and effective in breath (Watson et al, 1989, p. 30). These decrements were brief in duration and there was a rapid return of abdominal activity, with it usually commencing before the inspiration was completed.

In conclusion, abdominal activation is clearly present during singing but is regional, with the lateral sites much more active than the medial ones. Deactivation of the abdominal wall is also seen on inspiration, which appears to assist the mechanical action of the diaphragm but even so the abdominal wall reactivates quickly to resume its role of posturing the entire chest wall for singing (Watson et al, 1989, p. 31).

Sundberg, Leanderson, von Euler and Knutsson (1991) also carried out EMG studies of the respiratory muscles used in singing. In addition they also used pressure recordings and synchronous sound recordings to evaluate the singers' respiratory behaviours. Sundberg et al (1991) remind us that singers have finely tuned control over the subglottal pressures produced while singing since subglottal pressure controls vocal loudness as well as exerting an influence on the fundamental frequency of the voice (p. 283). "...singers have to tailor subglottal pressure individually for each note, taking into account both its loudness and pitch. As subglottal pressure affects the fundamental frequency, the intended target pressures must be matched quite accurately for the singer to stay on pitch" (Sundberg et al, 1991, p 283-284).

Sundberg et al (1991) used two baritone singers as their subjects and took EMG recordings from the internal and external intercostals, the diaphragm and from the abdominal oblique muscle. The singers were asked to perform a number of vocal tasks but performed no aria or song singing. Body posture was also a variable in this study. Overall Sundberg et al found that the respiratory muscles behaved in predictable ways on most tasks.

During inhalation, the exhalatory abdominal oblique EMG showed signs of inhibition in synchrony with the diaphragmatic activity. During phonation on the other hand, the EMG for the abdominal wall and the diaphragm showed a synchronous activity pattern indicating that this subject contracted both these muscles during singing. This is particularly evident in the upright position, where the contractions for the upper tone are more forceful than in the supine position. (Sundberg et al, 1991, p. 290)

These results are quite similar to those obtained by Watson et al (1989) and confirm that the abdominal wall is actively engaged in configuring the chest wall during singing. Relaxation or at least inhibition of its activity also occurs during inspiration. The diaphragm is also active during inspiration and there is activity in the intercostal muscles throughout much of the breath cycle.

Most studies that have evaluated respiration for singing have focussed on the main muscles of respiration such as the intercostals, the lateral abdominals, the rectus abdominis and the diaphragm, but few studies have evaluated the role of the more secondary muscles of respiration such as those of the shoulders and neck. These muscles have traditionally been seen as having little or uncertain respiratory function in singing. Singing pedagogues have always paid attention to these muscles in terms of their roles in posture but the scientific community has given these muscles, particularly the trapezius and sternocleidomastoid muscles little attention (Pettersen and Westgaard, 2004, p. 56). Pettersen and Westgaard have studied the role of the trapezius muscle in classical singing and have found that “trapezius activity in classical singing is habitual; the activity level is often relatively high, but the same singing tasks can also be carried out with little or no trapezius activity” (2004, p. 56). They also found that when the trapezius is active in singing it has clear expiratory function and acts to compress the upper rib cage, conversely when the trapezius is inactive the upper rib cage is held in a more expanded position (Pettersen and Westgaard, 2004, p. 56). They wished to study the effects of a reduction in trapezius activity on other muscles of respiration and also to determine whether professional opera singers had greater activation of their expiratory muscles than a group of singing students.

Pettersen and Westgaard used four young professional opera singers and additional data from two groups of student singers, group A who were in their first or second year of conservatoire study (16 students) and group B who were designated as advanced classical singing students (12 students) (2004, p. 57). EMG recordings were taken from the trapezius, the sternocleidomastoids, the intercostals, the abdominal oblique and the rectus abdominis. Three singing tasks were performed, an aria of the singer's own choice, tones sustained until exhaustion, and extreme tones sustained until exhaustion.

There was a significant reduction in the activity of the trapezius and sternocleidomastoid muscles after biofeedback for all four of the professional opera singers that were studied. This reduction in activity was not accompanied by any changes in the EMG activity of the other muscles, the intercostals, the abdominal oblique or the rectus abdominis. This does suggest that use of these accessory muscles during phonation is not vital to the task of controlling subglottal pressure for singing. Pettersen and Westgaard also found that as a group the professional opera singers activated all of the muscles studied to a much higher level in the expiratory phase than either group of the student singers (2004, p. 62). Pettersen and Westgaard also reported that there was a large variation in the muscles activated both between individual singers and on individual tasks.

This study supports the others reported confirming that the muscles of the abdomen and rib cage are primarily responsible for the management of subglottal pressure for singing. Although many of the singers did use the accessory muscles, the trapezius or the sternocleidomastoid muscles or a combination of both, they were easily able to inhibit or reduce their action, without making any change to the activity of the other muscles under study. This suggests that the accessory muscles are not vital to breathing for singing. It would be interesting to know if the use of these accessory muscles affected the quality of the vocal tone produced however.

Through the use of kinematic and electromyographic analysis of breathing during singing a number of generally agreed facts can be identified. Firstly, there are significant



individual differences in how professional opera/classical singers use their respiratory apparatus. Regardless of these differences, all professional singers have fine control over subglottal pressure which allows them to produce tones of differing pitches, loudnesses and qualities at will. Closely aligned to this finding is that of Watson and Hixon in 1985, where they discovered that what singers thought about their breathing mechanics often bore little resemblance to physiological fact. It also appears that there is a significant training effect in the use of respiratory physiology for singing, as demonstrated by the fact that in Thorpe et al's 2001 study where all of the singers had been trained by the one pedagogue, there were significantly fewer differences in respiratory mechanics.

Secondly, singers show excellent consistency in their use of respiratory physiology as evidenced by the Thomasson and Sundberg studies in 1999 and 2001 which suggested that singers take the same breath and use the same set of respiratory mechanics to exhale the air when the same phrases in songs are repeated. This suggests excellent muscle memory and a strong motor learned component to breathing for singing.

Thirdly, trained singers use much greater muscular effort than non-singers or even advanced student singers when singing classically. This has been identified in EMG studies by Pettersen and Westgaard and in kinematic studies by Watson and Hixon.

Fourthly, a preferred, or at least a more common pattern of respiratory use can be identified. It consists of:

- A primarily diaphragmatic control of the inspiration, although the activity of the diaphragm does vary during exhalation.
- The rib cage being primarily responsible for controlling pressurisation of the pulmonary system for singing.
- The abdominal wall being mainly responsible for posturing the whole chest wall to aid the diaphragm and rib cage in their functions.
- Some evidence that the muscles of the abdominal wall play a significant part in generating muscular support for the voice.

Given these findings about breathing for singing which can be gleaned from the scientific literature, it is possible to draw some conclusions about an appropriate method of breathing for singing. In singing, when expiration is active and the intra abdominal pressure assists in the control of the outward flow of air for phonation, some interaction of the inspiratory and expiratory muscles is required. It appears that this interaction of the inspiratory and expiratory muscles forms the basis of breath support. As the muscles of respiration are mostly striated muscles and thus under voluntary control, systematic training should allow the singer to exert fine controls over the breath stream. In this way, an effective breath support system for singing consists of:

- Voluntary control of respiratory muscles so that the singer can increase or decrease support and breath flow at will.
- Efficient, flexible use of the respiratory physiology.
- Freedom from tension in the upper chest and neck.
- Maintenance of good postural alignment.
- A system of breath management that follows the natural functions of the inspiratory and expiratory muscles.
- Training of the respiratory muscles in terms of strength, co-ordination and endurance.

## Chapter Three Breathing and Breath Management in the Vocal Pedagogical Literature

There is perhaps no part of vocal pedagogy that has been so hotly contested over the years as breathing. Many different schools of breathing have developed, each claiming to be the one true and correct method. These schools of breathing can be broadly divided into three. Those that expound a ‘belly in’ method of supporting the voice, those that are completely opposite in approach and propose a ‘belly out’ method of support and finally those pedagogues who choose a neither one nor the other method. There are differences in exact technique amongst the different adherents to each school but the direction of movement of the abdomen (the prime mover in expiration) remains the same in each member of the school.

Almost all pedagogues believe that breathing, breath support or breath management are part of a solid vocal technique. The degree to which breathing is felt to be important varies greatly from one pedagogue to another. There are those such as Miller who state that “Breath management is the essential foundation for all skilled vocalism” (2000, p. 32) while others such as Estill believe that laryngeal positioning is of prime importance.

The growth of scientific knowledge about the respiratory system has tended to marginalise the ‘belly out’ school in more recent times particularly as kinematic studies such as those reported by Hixon in his 1987 book make it clear that inward movement of the abdomen was recorded from all singers during the expiration phase regardless of how they conceptualised their breathing for singing (p. 362). Whilst very little has been written suggesting the use of the ‘belly out’ strategy for singing in the last 20 to 30 years it is still taught by some teachers in the singing studio, especially by those who have not made an effort to keep up with more recent scientific developments in respiration. Interestingly the ‘belly out’ method of breath support is still a very popular method of breathing for wind instruments, other than voice, and references to its employment are often found in pedagogies for wind and brass instruments (Reynolds, retrieved July 17 2005).

McKinney points out that all methods of breathing, be they correct or incorrect, usually have some element of truth in them. Students who are taught belly breathing are instructed “take a deep breath and then push out against your belt while you sing. This has the effect of locking the diaphragm in the lowest position to which it has descended and not allowing it to make its return as air is expended” (McKinney, 1994, p. 60). It is true that the diaphragm must be allowed to descend as fully as possible, the element of truth in the belly breathing school, but the diaphragm must also be allowed to return to its un-contracted state during the breath cycle. The abdominal muscles must also remain free to move inward to help maintain the balance of air pressure required for singing. The 'belly out' school theory has been essentially exploded by the research into respiratory kinematics and can be disregarded. The 'belly in' and 'neither one nor the other' schools of breathing can be reviewed by examining some of the other writings on vocal pedagogy.

Many of today's pedagogues have beliefs about breathing for singing and breath management for singing that are based on the writings or teachings of pedagogues from the so called “Golden Age” of Bel Canto singing. Richard Miller, for example, claims to be a direct descendant of this school of teaching with his “appoggio” style of breath management. It is important to remember that pedagogues in historical times had essentially no access to scientific tools to investigate how their breathing systems worked, relying solely on their own sensations as singers and on the information available to them from the anatomy laboratory. We know that the singer's own perception of how their breath management or breath support system works often bears little resemblance to what actually happens physiologically (Watson and Hixon, 1987, p. 370). Anatomy laboratories are excellent places to observe structures and to trace the origins and insertions of muscles but due to the complex interactions that occur between muscles (in particular) in live subjects, it is often difficult to give accurate descriptions of the functions of the muscles themselves or to give clear and precise descriptions of how systems such as the entire respiratory system work. We now have a much better understanding of muscular actions and the interactions amongst structures within a system thanks to tools such as electromyography, x-ray, manometry and kinematics.

A brief overview of some of the earlier writings is valuable, since these authors may have influenced the work of more modern pedagogues, and may have also, to some extent, driven the way in which scientific research has been assimilated into current pedagogy.

Some of the earliest writings that we have on singing, those of Tosi and Mancini, have nothing specific to say about breathing. It is these castrati, the keepers of vocal knowledge from the first Bel Canto era, who were reputed to have the secrets of vocal pedagogy, including breathing, but only limited amounts of technical exercises were written down and described, and much of what they taught has been lost. The Garcias (the elder and the younger) were perhaps the first to write in some detail on the technical aspects of singing. Garcia (the elder) exhorted students to breathe slowly and without noise but his son (Garcia the younger) whose pedagogy was built upon that of his father used specific breathing exercises to give power and elasticity to the lungs. This is a common mis-perception about the lungs, which is that they have a role to play in breath management. We now know that the lungs are basically air filled sacs, and that breath is managed by muscles in the thorax and diaphragm.

Garcia (the younger) did, however, recognise the interaction of breathing with posture. “Shoulders thrown back without stiffness and the chest expanded, the diaphragm lowered without any jerk, and the chest regularly and slowly raised” (Coffin, 1959, p.32). Garcia called the complete inhalation “respiro” with the half breath or “mezzo-respiro” also taught. Garcia does correctly give the prime place in inhalation to the diaphragm and he also correctly identifies posture as important to breathing for singing. Garcia also makes much of the in breath with his exercises such as: inhalation very slowly through pursed lips until the chest is full, and the lungs filled then the breath is held for as long as possible, being examples of inspiration training. He also suggested slow expiration of air from a deep breath. It appears that these exercises were carried out separate from singing.

It appears that the Garcias were among the first to use the term diaphragmatic breathing, since it is referred to by a number of later writers. Today we also recognise the term diaphragmatic breathing, but there appear to be differences, in the meaning of that term,

from that of older sources. Many of the older sources seem to provide the diaphragm with an expiratory function that simply does not exist. In more modern times diaphragmatic breathing refers to the descent of the diaphragm during the in breath which is usually coupled with abdominal control of the out breath. This is consistent with the physiological fact that the diaphragm is a muscle of inspiration only. Some of the more modern pedagogies still exhort students to “sing from the diaphragm” but this appears to be an image that has existed almost from the beginning of vocal pedagogy, despite having no real basis in physiological fact (Watson and Hixon, 1987, p. 370).

Matilda Marchesi, another of the famous pedagogues, she was Dame Nellie Melba's teacher, insisted on normal breathing in which the lungs are expanded at the base to give the greatest quantity of air. She also believed that posture was important to breath. Marchesi also made comments about the use of corsetry which restricted abdominal movement, firmly believing that tight corsets that caused “lateral” breathing were detrimental. Marchesi, without the benefit of modern scientific equipment, appears to have correctly identified a number of necessary physiological facts. The concept of the lungs expanding at the base can be seen to relate to the descent of the diaphragm, while her abhorrence of corsetry that restricted abdominal distension indicates that she understood the relationship between the descent of the diaphragm and the movement of the viscera down and outwards.

Other pedagogues, teaching at a similar time to Marchesi, did not agree with her, particularly in relation to the concept of a “normal breath”. Stockhausen for example felt that diaphragmatic breathing was sufficient for the *mezzo respiro* but that extension of the ribs for the *respiro pieno* (deep or full breath) was indispensable. Stockhausen seems to believe that the ribs and the diaphragm work completely independently of each other, a belief that we now know to be in the main erroneous.

The Lampertis, father, Francesco and son, Giovanni Battista have probably had the greatest influence on breathing for singing since they are the first to have written about “*appoggio*” and the “*lutte vocale*” (vocal struggle). The *appoggio* is first mentioned in Francesco Lamperti's 1890 book: “The *appoggio*, or support of the voice, was to be

gained by the action of the muscles of the chest and diaphragm upon the lungs after opening the lower part of the throat on the vowel ‘a’ [x-ray photography indicates this is a vocal imagery]” (Coffin, 1989, p. 59). In some ways Lamperti is correct, the lungs are acted on by muscles that are not directly attached to them, but he is also ascribing to the diaphragm an expiratory function that modern science has proven that it simply does not have. From this description of appoggio, that is direct from Lamperti, it is clear that the concept of appoggio in this form is not based in physiological fact. Miller continues to defend appoggio as physiologically factual while still insisting that his breath management system is a direct link to the older masters such as Lamperti.

In common with other earlier pedagogues Francesco Lamperti tends to focus on the in breath with an instruction to singers to direct their attentions to the full inhalation of up to 18 seconds (similar to the Garcias). Despite making erroneous statements about the diaphragm’s expiratory function Lamperti also makes a number of correct statements such as those in his description of the Lutte Vocale: “With the full breath the diaphragm is lowered pressing on the organs below. When singing occurred, the inspiratory muscles struggled against the expiratory muscles to retain breath within the body. This he called the Lutte Vocale or vocal struggle” (Coffin, 1989, p. 61). We now know from kinematic studies such as those of Watson and Hixon (1985) that this vocal struggle does in fact exist. When the lungs are full of air, the elastic recoil of the system is attempting to expel the excess air from the lungs, inspiratory muscles in the rib cage continue to function to maintain an appropriate thoracic pressure. At the same time the abdominal wall is also active (expiratory function) to tune and posture both the diaphragm and the rest of the chest wall.

Francesco’s son Giovanni Battista also made some correct statements about breathing. He believed that the manner of breathing should be diaphragmatic as this was the only method that allowed singers to control the air with tranquillity. He also noted that strain was placed on the voice by the use of high or clavicular breathing and that posture and breath interacted. Giovanni Battista also believed that the control of the breath was the foundation of all vocal study. He also appeared to be slightly more accurate in his

description of the out breath when he stated: “Expiration should be effected chiefly by the abdominal muscles in a gradual manner to spin out the tone” (Coffin, 1989, p. 64).

Giovanni Battista Lamperti’s student and assistant teacher William Earl Brown wrote the book *Vocal Wisdom* in the 1930s (revised and expanded in the 1950s) based on the maxims of Lamperti that he heard first hand, as a student and then as assistant teacher. It is interesting to note the use of imagery, much of which is not based in physiological fact that was used for teaching. It is also possible to see how myths and traditions can be passed down as fact rather than as teaching images. The paragraphs in Brown’s book on incorporated breath are an excellent example of this.

The whole torso contracts and expands co-ordinately. The shoulders and hips are linked together to prevent expansion while filling the lungs for the purpose of singing. The pelvic region and breast bone mutually bear the strain of the energy of the inspired air. The force of this compressed breath crowds upward toward the “wish bone” causing the singer to feel broad shouldered and high chested. (The breast bone is attached to each shoulder.) .....Then the voice begins to vibrate, the diaphragm permits enough breath energy to escape to produce and feed the pulsations that we call tone – and without push or pull of muscle. (Brown, 1957, p.108)

Lamperti, through Brown, or rather Brown’s interpretation of what Lamperti told him, is correct physiologically in the following points: the torso does work as a unit in a co-ordinated fashion to manage breath, both the pelvic area and the breast bone (sternum) have muscular attachments that can be easily palpated during supported phonation (laughing, crying, sobbing and correct singing) and that the singer should feel broad shouldered and high chested (though because of posture not the breath itself). This passage unfortunately also contains a number of quite erroneous statements. If there is no expansion of the epigastric area as the diaphragm descends the breathing will be high and somewhat limited in amount, so if the shoulders and hips are linked to prevent expansion it would be very difficult for the lungs to fill with air. The diaphragm is again ascribed an expiratory function, it does not control the outward flow of air, it may act as



a brake to the expiratory force of the abdominal muscles but it certainly does not control overall expiratory energy. Finally the statements that muscles are not involved, neither push nor pull must certainly be an image. Inspiratory muscles must continue to work initially to overcome the elastic recoil of the system just after the inhalation or much of the breath would be lost too quickly and then once the intra-thoracic pressure has dropped sufficiently expiratory muscles must come into play to take over the control of the outward flow of air.

Throughout much of the early part of the twentieth century these types of pedagogical statements were used and passed to students as fact rather than as images. During the 1950s there was a great deal of interest from anatomists, physiologists and voice researchers into how the breath was used to sustain life and for the purposes of speaking. Pedagogues began to be influenced by this research and the work of William Vennard is a prime example of this early interaction between singing pedagogues and scientists.

Vennard's 1967 book *Singing – the Mechanism and the Technic* was a cornerstone of the pedagogical literature for most of the latter part of the twentieth century. Vennard described his book as frankly mechanistic and he attempted to demystify singing and couch it in purely scientific terms “[this book] is an attempt to compile under one cover objective findings from various reliable sources and relate them to the art of singing” (Vennard, 1967, p. iii).

Vennard believed that breathing was central to an efficient vocal technique.

There are those teachers who consider breathing the most important factor in tone production....Conversely poor singing is directly the result of poor breathing, that consequently there is a just one thing to teach in the studio – correct inhalation and exhalation. (Vennard, 1967, p. 18)

Vennard also stated that “it [breathing] is primary in importance, but it is easy to understand and can be practised without the aid of a teacher” (Vennard, 1967, p. 18). Vennard’s basis for stating this was that all the muscles involved in respiration can be voluntarily controlled. Certainly this appears to be true at least to some extent. Even the diaphragm can be activated to initiate a breath by conscious thought, even if the fine graduation of its movement may not be under our voluntary control.

From his position in the middle of the twentieth century, Vennard was able to draw conclusions from some of the other singing pedagogies either by direct interaction with some of their chief practitioners or with singers who had been taught themselves by these founders. He notes that there are quite a few singers who are successful, in spite of what appear to be poor breathing habits, especially mentioning Lilli Lehman. Lilli Lehman was one of the great sopranos of the early twentieth century, who for most of her career championed “pan-costal” breathing. Pan-costal breathing required that the abdomen be drawn tightly in, on the in breath so that chest could fill with air (not physiologically sound at all!). It was only later in her career that Lehman learned to release the abdominal wall to allow the diaphragm a quick and easy descent. Vennard rightly points out that everyone does breathe and as long as the air goes in and flows out again with reasonable steadiness singing can occur. However, he also states that if the breath can be increased so can the quality of the singing. (Vennard, 1967, p. 18).

Vennard also makes a strong connection between good posture and good breathing and he likens the posture of the singer to the task that beginning instrumentalists have, in learning to correctly hold their instrument before beginning to play it.

The head, chest and pelvis should be supported by the spine in such a way that they will align themselves one under the other – head erect, chest high, pelvis tipped so that the tail is tucked in. The position of the head and shoulders allow the jaw to be free, not pulled back into the throat. This liberates the organs in the neck. The high chest implies that the shoulders go back, but they should relax and feel comfortable....A certain amount of tonicity of the abdominal muscles will be needed to keep the

pelvis upright, but there must not be so much that deep breathing is impossible. This aspect of posture should be ignored if it prevents abdominal breathing. (Vennard, 1967, p. 19)

Vennard correctly identifies the need for the abdominal muscles to relax to allow the diaphragm a quick and easy descent. In many ways, well before the term was coined Vennard is asking the singer to maintain their core stability but allow freedom in the abdominal wall to assist breathing for singing. Vennard also stated that “There must also be an expansion of the ribs to provide leverage for the muscles of breathing” (Vennard, 1967, p. 20). It appears that he believes that the ribs can move independently of structures such as the diaphragm though Rubin (1998) and Bunch (1997) make it clear that the lower ribs, in particular, move because of the diaphragm’s attachment to them, rather than separate from it.

Respiration is a complex physiological process of which phonation is only a secondary function. For purposes of study it may be analyzed into three types of breathing: chest, rib and diaphragmatic or abdominal. The first should be de-emphasized; the most efficient breathing for singing is a combination of the latter two. (Vennard, 1967, p. 20)

Vennard has again made a correct statement when he identifies the combination of rib-diaphragmatic and abdominal breathing as the most efficient for singing. These two types of breathing equate to the actions of the primary inspiratory and expiratory muscles as described by Hixon (1987) while his descriptions of “chest” breathing relate most closely to the actions of the secondary muscles of inspiration. Vennard is perhaps one of the first singing pedagogues to use accurate anatomical and physiological information to support his breathing pedagogy. He, because of his understanding of correct anatomy and physiology, is firmly within the ‘belly in’ school of breathing.

Vennard’s description of the respiratory system is essentially correct though he does ascribe to the older anatomists descriptions of the functions of the internal and external intercostal muscles, with one group responsible for inhalation and the other for

exhalation. Rubin (1998) and Bunch (1997) state that the intercostals act to stabilise the rib cage wall and to assist in maintaining correct intra-thoracic pressure rather than being responsible for the increase and decrease of lung volumes. In his desire to be anatomically accurate Vennard does mention the fact that the fibres of the intercostal muscles do change their direction of pull as their attachments get closer to the sternum, which would of course change their function, if it were truly to control lung volumes. Vennard's statements about the diaphragm are also completely accurate and he even comments on the close interaction between the ribs and the diaphragm, although he does not appear to understand that it is the diaphragm's movement rather than the movement of the ribs that predominate in the inspiratory cycle. "Naturally this flattening of the dome (of the diaphragm) will be co-ordinated with the expanding of the ribs, to which it is attached at its circumference" (Vennard, 1967, p. 24). Vennard also made use of radiographic studies to back up his statements. X-ray studies prove that the diaphragm always descends on inhalation and it descends radically on deep breathing (Vennard, 1967, p. 24).

Vennard makes comments about the muscles of the abdomen and pelvic floor which he believes are vital for good breathing for singing:

Needless to say, the action of these muscles [pelvic floor] is instinctive, as is the case with most of the respiratory musculature. Training these muscles consists of conditioning these reflexes into patterns which are more efficient for singing and this only modifies the overall behaviour somewhat. (Vennard, 1967, p. 25)

In making these statements about the 'instinctive' or 'reflexive' nature of these muscular movements, Vennard is alluding to a vital component of any vocal technique, that it must be physiologically appropriate. It is not sound practice to ask a singer to move muscles or use muscular systems in ways for which the body is not designed. The most efficient use must be made of physiology and this will usually occur when the body is allowed to make its own choices about how it will function.

Chest breathing, which is also known as clavicular or shoulder breathing is described by Vennard as the breathing of the exhausted athlete or the person who is out of breath and gasping for air. The heaving chest that is associated with this type of breathing is a sign that the body is struggling to get enough oxygen for life. Vennard advises against this type of breathing for four reasons:

First, it is inefficient. It is inspiratory and provides no control over exhalation....Second, it looks bad. When a singer collapses his chest, his shoulders droop and his posture becomes poor....Third, chest breathing can easily lead to muscular tension in the throat. The muscles that raise the breast bone have attachments at the top of the neck....Fourth, abdominal breathing which is best cannot take place correctly when the ribs are heaving. (Vennard, 1967, p. 27)

The second type of respiration is characterised by the sideways expansion of the ribs which Vennard terms costal or rib breathing. With the heels of the hands placed against the lower ribs at the sides and the fingers lightly touching in front. "When he [the singer] inhales, his objective will be to push them [the hands] as far apart as possible" (Vennard, 1967, p. 28). Vennard also points out that some great teachers such as Marchesi did not believe in costal breathing any more than in clavicular breathing. "They felt that the rib muscles should only be used to expand the ribs and keep them in this position, making possible the most efficient operation of lower muscles, the true motors of breathing" (Vennard 1967, p. 28). Vennard goes on to point out "that the normal expansion of the ribs is primarily sideways, partly forward and very little upward so that it coordinates with belly rather than shoulder breathing" (Vennard, 1967, p. 28).

Vennard appears to understand the link between the lower ribs and the diaphragm since he indicates that the rib movements coordinate with the abdominals rather than the shoulders but he is in error as he feels that the ribs could have quite independent movement from the diaphragm. More recent writers (Bunch 1997 and Rubin 1998,) believe that the diaphragm is the prime mover of the lower ribs with the intercostal muscles mainly concerned with maintaining rib cage integrity and preventing the rib cage

from being sucked in by the negative pressure in the thorax created by the descending diaphragm. The attachment of the diaphragm to the lower ribs also ensures that they swing outwards (Vennard's sideways movement) on inspiration.

The third type of breathing described by Vennard is diaphragmatic-abdominal or 'belly-breathing'. It is in essence diaphragmatic in inhalation and abdominal in exhalation.

The diaphragm is one of the most powerful muscles in the body, and certainly a most important one. It is not only a partition between the rib cage and the belly, but it is related to both types of breathing and thus implies that they should be coordinated. (Vennard, 1967, p. 28).

Vennard goes on to give an excellent explanation of how the diaphragm moves and how its movement impinges on the abdominal contents. He also comments on how the bulge at the level of the epigastrium relates indirectly to diaphragm movement. "When it [the diaphragm] flattens, this area will push forward. Plunket Greene [a famous baritone of the early twentieth century] called it the "breathing muscle" (Vennard, 1967, p. 28). It is of course not the diaphragm at all, something that many pedagogues have quoted erroneously for years, but an opportunity to feel the movement of some of the stomach contents and other muscle junctions that are caused by the descent of the diaphragm.

Vennard reiterates that a combination of rib and belly breathing is the best possible technique.

The contraction of the diaphragm causes it to lower and partly flatten, increasing the capacity of the thorax. It is the muscle of inhalation. The contraction of the abdominal muscles decreases the capacity of the entire trunk, including the thorax except in certain functions. They are the muscles of exhalation. They are resisted and steadied in their contraction by the diaphragm, but it only causes confusion to think of this muscle being the active factor. The diaphragm does not support the tone....The

diaphragm steadies the tone but does not support it. (Vennard, 1967, p. 30)

Vennard is making a clear statement about physiological fact with which he aims to debunk the long held view that the diaphragm somehow manages to contract for inhalation and then relax in such a way that it actively supports the air on exhalation and to control the voice. Vennard's belief that the diaphragm steadies the tone, that is the breath flow and support, has not been conclusively proven but in a study by Sundberg and his co-workers it was found that singers usually recruited the diaphragm to rapidly decrease subglottic pressure at high lung volumes (Sundberg, 1987, p.36). Sundberg's experimental group was very small, only four subjects and no mention was made as to their level of skill. One of his subjects showed diaphragmatic activity throughout the duration of the sung phrase. Sundberg also reported that this singer tended to generate a higher subglottic pressure with his abdominal wall which was then reduced to the correct one by the activity of the diaphragm. Sundberg postulates that this high degree of concomitant contraction will help to reduce the displacement of the abdominal contents and thus minimise the influence of their inertia on a rapidly changing subglottic pressure. He cites a paper by Rothenberg in 1968 that claims that in tasks requiring rapid and precise movements of structures it seems to be a generally applied strategy to activate both the muscles accelerating the structure and those that will arrest the movement of the structure (Sundberg, 1987, p. 37).

This analogy of the accelerator and the brake, with the abdominal wall being the accelerator and the diaphragm the brake would explain the results that Sundberg obtained. Interestingly this accelerator/brake concept is core to the pedagogical model of breathing taught by Janice Chapman and expounded in her book *Singing and Teaching Singing* (2006).

Sundberg also cites other earlier papers such as Bouhuys et al in 1966 who found that three out of five, non-professional singers used the diaphragm to reduce the respiratory recoil forces for singing long, soft, sustained tones at high lung volumes (Sundberg, 1987, p.37).

Vennard also attempts to explain the phenomenon of the “bouncing epigastrium” which many pedagogues have used as a proof of good diaphragmatic development. He rightly points out that the bulging of the epigastrium occurs due to muscular interactions between the diaphragm and the abdominal muscles not from the diaphragm alone. Vennard correctly identifies this “bouncing” as a result of reflexive muscular interactions since it occurs quite clearly in coughing (as well as in other primal or primitive noises such as laughter, sobbing or crying). He also makes it clear that the abdominal muscles are responsible for the rapid expulsion of air caused during coughing though he does make note of the fact that the diaphragm will also tense to help control the force of the outgoing air stream (Vennard, 1967, p. 31).

Vennard appears to deserve his place as one of the 'greats' of vocal pedagogy of the twentieth century. He critically examined the language and practices of vocal pedagogues and attempted to relate them to the scientific principles of his day. Apart from a few minor additions to our knowledge, such as information about the intercostal muscles gained through electromyographical and kinematic studies, Vennard's descriptions of respiratory anatomy and physiology are correct. He has usually interpreted the language and practices of the pedagogue correctly and has made clear and concise scientific connections. Vennard's claim that a combination of rib and belly breathing (we now call this abdomino-diaphragmatic breathing) is the best for singing fits well with current physiological knowledge. Many of Vennard's breathing exercises also fit well with current theory though less emphasis is now placed on strength in the inhalation phase (Vennard uses heavy books on the belly or encourages a solid thrust outwards of the epigastrium on inhalation) and more on flexibility and control of the out breath through the abdominal musculature.

Vennard's text was considered a standard in vocal pedagogy for a number of years. His work is usually referred to in most singing texts since his time, although it is becoming less popular, due no doubt to the publication of many other tomes. He can be seen as a significant influence on most of the American writers on vocal pedagogy since the 1960s.



Richard Miller is also considered one of the giants of singing pedagogy in the late twentieth and early twenty first centuries. He has written numerous books on singing and teaching singing, perhaps the most well-known of which is his 1986 book entitled *The Structure of Singing – System and Art in Vocal Technique*. Miller is a firm believer that breath management is vital to good singing. His books all provide insight into his beliefs about breathing and breath management in statements ranging from the simple, to the more detailed and complex such as:

“Breath management is the essential foundation for all skilled vocalism” (Miller, 2000, p.32). “In cultivated singing, thoracic, diaphragmatic, and abdominal aspects of respiration must be coordinated (dynamic muscle equilibrium) without exaggerated activity in any one of the three areas” (Miller, 1986, p. 23).

Technical skill in singing is largely dependent on the singer’s ability to achieve consistently that fine co-ordination of air flow and phonation – the vocal contest – which is determined by co-operation among the muscles of the larynx and the chest wall, and diaphragmatic contraction, a dynamic balancing between sub-glottic pressure and vocal fold resistance (Miller, 1986, p.23).

Miller is seen by many as a link between the older style of sensation and imagery based vocal pedagogy and more up to date scientific knowledge. Miller believes that teachers must have accurate anatomical and physiological knowledge to teach well, and he claims to base his concepts about breathing on detailed anatomical and physiological fact, quoting frequently and heavily from classic anatomy sources such as *Gray’s Anatomy* and from research in the 1960s by workers in acoustic phonetics such as Ladefoged.

Miller, in all of his works, takes a uniform approach to breathing, support and breath management which he calls

...appoggio (from the appoggiare, to lean against, to be in contact with) is a form of breath management coordination that must be learned if the singer is to unite energy and freedom for successfully meeting the tasks of professional vocalism (Miller, 2000, p. 32).

“Appoggio is a system for combining and balancing muscles and organs of the trunk and neck, controlling their relationships to the supraglottic resonators, so that no exaggerated function of any one of them affects the whole” (Miller, 1986, p. 23).

Miller states that appoggio is based on physical fact related to the actions of the respiratory anatomy and physiology: He describes respiration in the following terms:

On inspiration the diaphragm contracts downwards and the expansion of the intercostals increases the volume of the lungs. Miller believes that the action of the diaphragm is misunderstood by most singers since the central tendon of the diaphragm is attached to the pericardium where the heart is housed which means that the movement of the diaphragm is less drastic than most singers think. Miller also states that the diaphragm is not locally controlled and that it is basically passive during expiration and phonation (Miller, 2000, p. 33). Miller goes on to report that the diaphragm has three positions:

- Low, when the sternum is at a high point when the rib cage is the most expanded
- Mid, as the sternum lowers when the subglottic pressures are equating with atmospheric pressure
- High, when the sternum falls and the rib cage collapses (Miller, 2000, p. 33).

Miller states that in appoggio the aim is to retain the inspiratory position of the sternum and rib cage for longer periods than in normal respiration, thus retarding the diaphragmatic ascent (Miller, 2000, p. 34).

Miller's description of the inspiratory phase has a number of significant flaws. He describes the intercostal muscles as expanding which is not physiologically possible. Muscles can contract (i.e. shorten) but they can only then relax from their contracted state. Muscles cannot expand (i.e. lengthen beyond their relaxed state). Respiratory physiology tells us that to decrease the alveolar pressure sufficiently for air to flow into the lungs the thoracic cavity must be increased in size. This can be achieved by lowering the diaphragm or by using accessory muscles of inspiration to increase the size of the rib cage. More recent research (described previously) suggests that the intercostal muscles stabilise the rib cage wall rather than expand it.

Miller correctly places emphasis on the diaphragm as a primary muscle of inspiration but he seems to ascribe to the rib cage, and more specifically to the sternum the role of principal determiner of the diaphragm's position. That there is a relationship between the rib cage and the diaphragm there is no doubt but Bunch (1997) and Rubin (1998) believe that the action of the diaphragm has a greater effect on the ribs (especially the lower ribs) than the rib cage would have on it. Bunch (1997) also reminds us that the position of the rib cage, in well trained singers is more dependent on posture than on the act of inspiration (p. 35).

Miller correctly identifies lung volumes as being controlled by pressures:

Volume in the lung is controlled partly by intra-abdominal pressures below the diaphragm (which separates the respiratory from the digestive systems) and partly by what happens above the diaphragm, interacting forces of the lungs and the chest wall determine changes in lung volume and subglottic pressures" (Miller, 2000, p.35).

He then goes on to state that the elongation of the breath cycle for singing depends on a learned technique (*appoggio*) "...that results from the concerted action on diaphragmatic movement from the muscles of the thorax and the abdominal wall" (Miller, 2000, p.36). The basis of Miller's concepts about breathing are that the muscles of the thoracic cage and abdominal wall can be co-ordinated to retard or accelerate the

reflex expiratory action and that the diaphragm is passive but can be acted on by the rib cage/sternum.

In his 2000 book *Training Soprano Voices* Miller makes a fleeting reference to some more recent research that suggests that the diaphragm has a greater voluntary role to play in managing breath: “Limited recent research suggests that the passivity of the diaphragm may be less marked than earlier research suggests” (Miller, 2000, p. 37). Does this mean that the diaphragm is more active? Does this mean that the basis of his breath system ‘appoggio’ is not now valid? Miller quickly dismisses this research (he does not even mention the papers by name) and goes on to restate his position that the basic function of the diaphragm is involuntary, “...there is no way in which a singer can consciously control the action of the diaphragm” (Miller, 2000, p. 38).

Miller then begins to discuss the abdominal muscles and their involvement in the out breath stating that the singers’ task is to develop dynamic rather than static equilibrium over the aerodynamic-myoelectric instrument (Miller, 2000, p. 38). His goal for efficient breath management is to allow the exiting air to be turned into tone through natural phonatory resistance. He believes that this process is stabilised via the appoggio which does have its source in the antagonistic muscles of the abdominal wall. “Appoggio relies on the natural antagonism of these muscles at the moment of inspiration” (Miller, 2000, p.39).

“For the tasks of singing it is necessary to retain the inspiratory gesture as long as possible and to reduce the increase of subglottic pressure that normally occurs during the expiratory gesture” (Miller, 2000, p.40). He believes that the reduction of excessive air flow and the increase of subglottic pressure are achieved by remaining for as long as possible in the inspiratory gesture so that the muscles of the torso are trained to delay the customary exhalation movement (Miller, 2000, p. 40).

In many ways Miller is correct in his assessment of the situation. The air flow must be held constant and not allowed to be too high when the lungs are full of air, otherwise the singing tone could not be even, sustained and prolonged. His desire to stay in the

position of inhalation is therefore sensible but his method of achieving this has some problems. Requiring the abdominal/torso muscles to delay their natural exhalation movement will lead to excessive tension and a possible “locking” of the abdominal wall. This could cause the respiratory system to be unbalanced and may lead to a reduction in airflow over the glottis which could hamper rather than improve tone. Chapman (2006) believes that correct, physiologically accurate movement of the abdominal wall increases the intra-thoracic pressure encouraging the diaphragm to maintain its action (could this be the correct maintenance of the inspiratory posture?) and activates the mechano-pressure receptors in the intercostal muscles so that they continue their braking action for longer, reducing subglottic pressure and thus sustaining and prolonging the tone.

Miller believes that the process of increasing the duration of the breath cycle (vitally important for good singing) is accelerated by training the appoggio coordination with methodical training of the inspiratory muscles through brief onset patterns, renewing immediately at the moment of release the small amount of breath used for each onset. “Short onset exercises drill the capacity to remain at a stable position during the cycle of phonation and breath renewal” (Miller, 2000, p. 41).

Again this appears to be a sensible concept. Problems arise when we recall that the primary muscle of inspiration is the diaphragm and Miller states categorically that the singer has no voluntary control over this muscle. The basis of his method therefore appears to be the training of the one respiratory muscle he doesn’t believe can be controlled by the singer.

Miller makes further confusing pronouncements concerning muscle interaction: as the abdominals, pectorals and neck muscles develop through use and as coordination between the larynx and breath motor develop, phonation can be extended (Miller, 2000, p. 40). What do these muscle groups actually do? He has primary expiratory muscles (the abdominals) and secondary/accessory inspiratory muscles (pectorals and neck muscles) grouped together, yet he does not give clear information on how, if at all, these muscles are to interact.

Miller maintains that the singer must remain as close to the original inspiratory posture as possible. By maintaining the position of inspiration (he never really tells us how) the transverse abdominus, the internal and external obliques and to a lesser extent the rectus abdominus accomplish the appoggio; tonic, dynamic muscle contact permits immediate renewal of the inspiratory gesture (Miller, 2000, p. 40). Miller is again confusing the actions of these muscles. They are primary muscles of expiration but he appears to be ascribing some sort of inhalatory function to them. Miller also states that following a proper onset there is almost no displacement of the abdominal wall. Miller is the main proponent of the 'neither-the-one-or-the-other' school of breathing as he seems to want activity but no movement of the abdominal wall.

In the exercise section of his 1986 book Miller provides a number of exercises to encourage the development of the appoggio technique. What is very interesting is that the exercises do not seem to follow his dictates that the abdominal wall is not to consciously move inwards on exhalation. In one exercise where he requests the student to prolong an /s/ sound he asks for no abdominal movement until the very end of the breath cycle. This is in keeping with his position on the abdominal wall. In other exercises, the panting exercise and in the exercise using short /f/ sounds he actually asks the student to give definite abdominal movements to accompany each small exhalation. This is of course completely correct physiologically but this does not agree with his earlier comments about the movement of the abdominal wall. Finally in one of his exercises which he describes as being a very old one associated with the Italianate school of teaching the student is required to take a single breath and then phonate using separate abdominal pulses. This is very similar to some of the Accent Method exercises that will be examined later, but it appears very antagonistic to a school of breath management that wants to remain in the posture of inhalation and that states that the abdominal wall is not to be allowed to move inwards too vigorously on exhalation.

Miller believes that the vocal folds act as an additional valve to the outgoing air stream; he states that; in extended singing, especially at high pitches, vocal fold closure is of greater duration than during speech which offers increased resistance to the airflow. "For that reason, during singing the inward movement of the epigastric-umbilical region,

which is so characteristic of brief bursts of speech, must be delayed not encouraged” (Miller, 2000, p. 41).

Once again Miller is asking the singer to do something that does not appear to be physiologically accurate. Scientific data informs us that the abdominal wall moves inward to assist exhalation and Miller himself recognises this fact but he wants the singer to resist this natural urge. There is a real danger that such resistance could lead to excessive muscular tension, especially in the abdominal wall which could lead to a locking of those muscles. Hixon (1987) reports on a small study (six subjects) of highly trained singers using respiratory kinematics. He found that all of the singers used a so called “belly-in” strategy for singing (i.e. inward abdominal movement on expiration) despite very different singer perceptions of how the breath was taken and used. “Unanimous use of this strategy by the subject group suggests that it may have a collection of advantages for the singer toward which he or she naturally migrates with performance experience” (Hixon, 1987, p. 370). Results of EMG and other kinematic studies also support the use of the abdominal wall for exhalation. Miller appears to strongly reject such a premise:

The appoggio approach to breath management stands in opposition to techniques of “breath support” that control breath exit through induced abdominal wall movement (inward abdominal thrusting, known as the “in and up” method), or, conversely, through outward pushing on the abdominal wall (the “down and out” method, also termed “belly breathing”). (Miller, 2000, p. 42)

Miller continues to insist that the muscles can expand and clothes his argument in pseudo-science. The muscle fibres of the abdominal wall originate in the pelvic region and insert into the rib cage, including the lowest back ribs (rib numbers 11 and 12) so that “the muscular expansion is tactually discernible” (Miller, 2000, p. 42). While it is true that the abdominals do have such origins and insertions it is the contractions of some of the muscles that are tactually discernible not their expansions! Contractions of the internal and external obliques lead to a “bulking up” of these muscles that can be

easily felt with the fingers near to their insertion points. Miller goes on to correctly state that the best place for breath management to be felt is with the fingers at the sides of the torso just below the rib cage and immediately above the hip bone with the fingers in light contact with the anterior, lateral and dorsal regions of the abdominal wall, with his explanation of the breath cycle as follows:

During complete inhalation, with the thumbs placed at the twelfth rib (the costal that defines the base of the rib cage dorsally) and the fingers placed laterally below the frontal tenth rib (bottom of the thoracic cage anteriorly), the singer becomes aware of outward movement of the lowest ribs – both dorsal and anterior – but, more important, of expansion in the lateral abdominal and low dorsal walls of the torso. The systematic onset – release – renewal cycle increases the expansion possibilities of these musculatures, which will grow progressively as the exercises are routined. (Miller, 2000, pp. 42-43)

Miller is also incorrect in his statements about the ribs. The lower ribs do indeed move and swing outwards on inspiration but this movement is controlled by the action of the diaphragm as it pulls downwards and slightly forwards on inspiration as described by Rubin and Bunch in the previous chapter. Abdominal or intercostal muscles are not responsible for this rib movement. These ribs are not really capable of movement independent of the diaphragm.

Tactile awareness of the retention of this contact among muscle groups during a breath cycle is possible even in the absence of phonation. The intense sense of contact felt in the region between the bottom of the rib cage (the tenth rib in front, the eleventh and twelfth ribs in back) and the crest of the iliac (hip bone) is maintained. This is the appoggio posture. (Miller, 2000, p, 43)

What does Miller mean by a sense of contact? Is he describing a sensation of tension in the abdominal muscles? As he insists that there is no inward pulling of the hypo-gastric



(pubic) or epigastric area, nor is there any pushing outwards just maintenance of the appoggio posture the abdominal wall must become quite immobile and stiff with tension. If this is the case how is air flow mediated? We know that increases in abdominal pressure lead to increases in intra-thoracic pressure encouraging air flow from the lungs. If the abdominal wall is locked into a position, secondary muscles must take charge of the outgoing air stream. Excessive tension in the neck, shoulders and vocal folds are known to be detrimental to good voicing (Boone, 1983. p. 106) so singers who use a Miller style of breath management would be in greater danger of phonation imperfections caused by this excessive neck, shoulder or vocal fold tension.

Miller himself does appear aware of this possibility because he then states that “the natural function of light laughter produces slight articulatory motion in the umbilical-abdominal area while the singer retains, without tension, the inspiratory posture of the abdominal wall” (Miller, 2000, p. 44). This degree of free movement would assist in the reduction of excessive tension but this “slight articulatory movement” seems to be in opposition to what he has said previously about there being ideally no movement in the areas using the appoggio technique. He also states:

This is not to suggest that the inspiratory posture of the torso never alters during a phrase of long duration...As the end of a long phrase approaches, there may be some slight inward motion in the region of the epigastrium but it is at a rate greatly reduced from that which occurs even in energized speech. (Miller, 2000, p. 46)

Two important points need to be considered here in relation to Miller’s appoggio breath. If the ideal is to have limited or no movement of the abdominal wall on expiration why does Miller advise the singer to have “slight articulatory movement” of the abdominal wall and to practise panting and other exercises that encourage active abdominal wall action? If the abdominal wall moves inwards despite the best efforts of the singer to maintain the abdomen *alla appoggiato* aren’t we fighting the natural functions of the respiratory system?

Miller raises a number of valid points in his discussion about breathing but some fundamental errors in his explanations of physiology exist. He also has a number of inconsistencies in his argument that make it difficult to take his words on breath management as law. Nevertheless his summary at the end of the chapter “The Supported Singing Voice – Breath Management in Singing” in his 1986 book *The Structure of Singing – System and Art in Vocal Technique* aptly outlines the needs of a breath management system for singing:

- Breath Management is partly determined by the singer’s concept of physiology. Therefore we ought to base a method of “support” on correct physical processes.
  - Same breath co-ordination (of appoggio) occurs whether a complete or partial breath is taken.
  - Cultivation of a partial breath is as essential to a good vocal technique as a “full” breath.
  - Good physical condition is required but breath management is largely determined by skill and not through enlargement of organs and muscles.
  - Efficient inhalation is silent.
  - Tension is not support.
  - Relaxation is a relative term. Breathing involves muscle antagonism.
  - During “La Lutte Vocale” suppleness, agility and flexibility characterise the activity of the diaphragm, epigastrium and the muscles of the thorax and neck. Such precision may be acquired through the systematic drills of breath management, breath pacing and exercises.
- (Miller, 1986, p. 38-39)

It certainly appears that Miller, a pedagogue of high reputation, has an excellent vision for respiration during singing but he appears to be strongly attached to a breath management system that is not consistent with current anatomical and physiological knowledge. Miller attempts to couch his breathing pedagogy in scientific terms but

more recent kinematic and EMG studies of singers do not support his premises. Indeed, some of the significant differences observed in use of the abdominal wall and in the singers' perceptions of how they manage their breath for singing that were reported in the Watson and Hixon (1985) study could be related to 'Milleresque' respiratory concepts.

James McKinney is another member of the 'belly in' school of breathing. His book *The Diagnosis and Correction of Vocal Faults: A Manual for Teachers of Singing and Choir Directors* was initially published in 1982 and then revised and somewhat expanded in 1994.

McKinney also believes that breathing is a vital component of the singer's technique. In his introductory chapters he provides us with a number of systems to help classify vocal difficulties, one of which is "according to the physical processes involved in the singing act: that is, (1) faults related to respiration, (2) faults related to phonation, (3) faults related to resonance and (4) faults related to articulation" (McKinney, 1994, p. 17).

McKinney goes on to say that he has found this system of classifying faults based on the physical processes the most convenient and logical. He also appears, by placing it as first physical process to be examined, to be highlighting the importance of respiration in the act of singing. McKinney was himself a student of Vennard and the link between these two pedagogues is obvious. McKinney because of his focus on faults in singing has attempted to take the earlier work of Vennard further, but he is not always able to offer a better scientific basis for some of his statements.

McKinney provides a summary of normal respiration with basic anatomical and physiological information. He does not mention many of the respiratory muscles in detail but provides other sources that can be consulted. McKinney states clearly that the diaphragm is the main muscle of inspiration and that expiration is a combination of elastic recoil forces and the action of the abdominal muscles. He describes respiration in correct anatomical and physiological terms which he then links to his breathing pedagogy. He does make an interesting statement about the lungs, however, which supports the notion that abdomino-diaphragmatic breathing will be the most efficient for singing.

The lower half of each lung is much better equipped with capillaries than the upper half. This means that the lower half is more efficient at taking oxygen out of the air and removing carbon dioxide from the blood stream. (McKinney, 1994, p. 47)

McKinney also makes a clear distinction between natural or normal breathing and breathing for singing. He believes that natural breathing has three stages: breathing in, breathing out and rest or recovery. McKinney believes that these stages are not under conscious control (McKinney, 1994, p. 48). Whereas:

Breathing for singing has four stages (1) a breathing in period (inhalation), (2) a setting up controls period (suspension), (3) a controlled exhalation period (phonation), and (4) a recovery period; these stages must be under conscious control until they become conditioned reflexes. Many singers abandon conscious controls before their reflexes are fully conditioned and inherit chronic problems thereby. (McKinney, 1994, p. 48)

McKinney believes that inhalation for singing is quicker than in natural breathing and that a greater amount of air is inhaled. He also states that the inhaled breath goes deeper into the lungs (McKinney, 1994, p. 48). McKinney uses imagery to help the singer to coordinate the conditioned reflexes that are needed for efficient breathing by providing what he calls a “proper mental preparation”. Images such as: smelling a flower, pretending to begin to yawn or pretending to drink a glass of water are used to help the singer breathe in correctly.

The use of imagery has long been used in singing pedagogy. The vocal instrument is impossible to see without special equipment, difficult to feel accurately and has both voluntary (singing) and vegetative (eating and breathing) functions, which makes instruction by imagery almost a necessity. At the present time we do not know if the images that McKinney suggests actually make changes to the respiratory system’s function but it appears that they can be used to achieve a desired result. Interestingly, McKinney discusses the anatomy and physiology of each stage of the breath before

presenting the images that he has found helpful in achieving these functions. This is quite different to singing pedagogues who provide the image and then attempt to justify it with anatomy.

McKinney also reminds us that postural considerations prior to breathing are important. “The chest should be comfortably high, the lower abdomen comfortably in and the upper abdomen free to move” (McKinney, 1994, p. 49).

McKinney’s statements about the lower abdomen being comfortably in prior to breathing are somewhat unclear. It is most likely that he is requesting the singer to maintain their core stability during the breathing cycle (the lower abdominal muscles being actively recruited for this task by being comfortably in) or it could be that he is setting up the exhalatory phase by having tone in the lower abdominals in preparation for the coordinated effort of the entire abdominal region in the out breath. McKinney is certainly not advocating tightness or tension of the abdominal muscles as evidenced by the following statement.

When you inhale the breath seems to move into the body, down to the lungs and out around the middle of the body. This expansion around the middle of the body is both natural and desirable; it has been identified as the displacement of the abdominal organs by the descent of the diaphragm. (McKinney, 1994, p. 49)

McKinney reaffirms physiological fact by reminding us that when the diaphragm moves down there is expansion all around the body, but this expansion is greatest in the front of the body where there is greater elasticity. This frontal expansion is encouraged by the attachments of the diaphragm to the rib cage and spinal column and the greater mobility of the abdomen at the front. McKinney also makes a point about pedagogues who believe that back, rib or lateral expansion is the main focus of the in-breath.

Some teachers have made such a fetish of back expansion or rib expansion that the more normal frontal expansion is limited or even eliminated. This is a case of partial truth being established as the whole truth, which is an ever present danger in all facets of teaching singing. (McKinney, 1994, p. 50)

The suspension phase of McKinney's breathing pedagogy has no correlate in natural breathing. Suspension occurs just prior to exhalation and McKinney believes that its purpose is to prepare the breath support mechanism for the phonation to follow (McKinney, 1994, p. 50). McKinney believes that this suspension allows "an almost effortless inception of vocal tone without any major readjustment of the mechanism involved" (1994, p. 50). He goes on to state that since this suspension phase is not a part of natural breathing the singer must consciously acquire it.

Unfortunately McKinney provides us with no scientific evidence for the suspension phase in the breath cycle for singing. Review of other literature also failed to obtain evidence for this component, though it may relate to the transitions between inspiration and expiration that were described by Watson and Hixon (1987) where there was a shift of volume from the abdomen to the rib cage just prior to phonation. Watson and Hixon describe this setting up of the system ready for phonation. It may also be however, that this portion of the respiratory cycle in singing has not been specifically evaluated. There is also the possibility that the suspension phase becomes so rapid in fully trained singers that it has escaped the attention of researchers who are not actively looking for it.

The controlled exhalation of the singer is vital to the maintenance of good tone. McKinney believes that the breath should be released quite slowly as the diaphragm gradually releases its tension, so that the diaphragm acts as a releasing brake (McKinney, 1994, p. 50). He also states that the best way to achieve this gradual release of the diaphragm is to try to maintain the expansion around the middle of the body. This statement does seem at odds with current respiratory theory about exhalation, but McKinney then definitively states that the actual expansion around the middle of the

body will decrease as the breath is expelled with the abdominal girth significantly decreasing throughout the breath cycle. He maintains that the reduction in girth is so gradual that the singer always feels expanded (McKinney, 1994, p. 50). This is a good example of a pedagogical instruction based on sensation rather than fact.

McKinney is again attempting to use an image based on the feelings that many singers report, one of expansion, even though he acknowledges that the opposite actually does happen. This is consistent with the findings of Hixon and co-workers when they discovered that singers' perceptions of how they breathed and how they actually breathed during singing were often at odds with each other (Hixon, 1987, p. 369). McKinney's suggestion that the diaphragm acts as a releasing brake is certainly diametrically opposed to Miller's belief, as Miller believes that the diaphragm relaxes as soon as inspiration is completed. Work as reported by Sundberg (1987), Leanderson and Sundberg (1988) and Watson et al (1989) tends to support McKinney's view of the diaphragm as a releasing brake, particularly when the lung volumes are quite high.

McKinney's final phase of breathing for singing consists of recovery. McKinney desires a relaxation of all the muscles at the end of each breath so that tension is not increased or carried from one breath to another. It appears that there is a split second in time that this relaxation occurs. Once the breath is expelled through the action of the abdominal muscles they release and just prior to the activation of the diaphragm and its descent for the next in-breath there would exist a state of relaxation. This relaxation phase would equate with the transition from expiration to inspiration noted by Watson and Hixon (1985). They believe that there is a reduction in the activity of the abdomen just prior to the reactivation of the diaphragm for the next in-breath. At that time the rib cage is continuing its expiratory function and so there is a brief moment of paradoxical movement, when the abdomen is assuming its inspiratory posture while the rib cage continues its expiratory work. The relaxation of the abdomen could be felt by the singer as an overall relaxation of the respiratory system prior to the next in-breath.

McKinney goes on to define breath support for singing as something slightly different from just inhalation and exhalation.

Breath support is a dynamic relationship between the breathing in muscles and the breathing out muscles, the purpose of which is to supply adequate breath pressure to the vocal folds for the sustaining of any desired pitch or dynamic level. When a person establishes the correct posture, breathes in properly, and then suspends the breath a balanced tension is set up between the muscles of inhalation and exhalation. (McKinney, 1994, p. 53)

McKinney believes that by trial and error the singer learns to adjust this balanced tension as required. “Only time and disciplined practice will bring the support mechanism to its full potential for supplying fine adjustments of breath pressure to the vocal folds” (McKinney, 1994, p. 54).

McKinney makes an important point about breath support when he states that only time and disciplined practice will develop the support system fully. In the “Bel Canto” period singers worked with a master for approximately seven years before being allowed to sing publicly. It can be postulated that during this time the breath support system was trained by a combination of instructions from the master, input from the sound produced and by trial and error on the part of the singer.

McKinney completes his chapter on breathing and breath support by providing a summary of his breathing concepts. He states that the separate components of breathing must be brought together into a unified whole and that breathing techniques need to be kept under conscious control until they become habitual. He lists the following as concepts that will assist the development of good breathing,

1. Good posture precedes good breathing.
2. Breathe in as if smelling a rose.
3. Breathe in as if beginning a yawn.
4. In-down-out round the middle [how the breath flows].



5. Comfortably up [the chest], comfortably in [lower abdominals], free to move [upper abdominals and epigastrium].
6. Inhalation, suspension, controlled exhalation, recovery.
7. Breathe in as if drinking a glass of water.
8. Breathing is effortless and noiseless.
9. For a catch breath, drop the jaw and breathe as if surprised.
10. The chest is comfortably high before, during and after taking a breath.

(McKinney, 1994. p. 55-56)

McKinney's summary of breathing concepts contains imagery for teaching as well as some sound physiological precepts. His comments about posture, abdominal movement, freedom and chest position fit well with current understanding about how the respiratory physiology is used for singing. It is probably safe to assume therefore that his images will encourage the engagement of the correct physiology when breathing for singing.

McKinney also comments on four other styles of breathing that he labels as incorrect. These are Upper Chest (Clavicular) breathing, Rib (Rib Reserve) breathing, Back breathing and Belly (Belly pushed out on exhalation) breathing (1994, p. 56). McKinney goes on to say that most of these so called methods have some element of truth in them since in a correct breath components of each technique will be activated, but he states it is the focus exclusively on this single component of the correct breath for singing which is erroneous.

Upper chest or Clavicular breathing is not usually taught to students but it is the style of breathing that many beginning students demonstrate. The chest heaves visibly on both inhalation and exhalation and there is marked activation of the secondary muscles of inspiration in and around the chest. McKinney points out that babies and young children do not show this type of breathing but he attributes its development to sitting at a desk at school for a number of hours each day so that posture influences the breathing

method. He also feels that this type of breathing where the chest rises on inhalation and falls on exhalation is more common in women than men (McKinney, 1994, p. 56).

McKinney states that upper chest breathing is undesirable for the following reasons:

1. It limits (inhibits) the downward travel of the diaphragm.
2. It is visually distracting to the audience.
3. It wastes energy and is physically tiring because of the effort expended in raising the chest.
4. It is often associated with poor posture.
5. Tension in the muscles of the chest and shoulders may be transmitted to the neck area and the vocal mechanism itself.
6. It is inefficient, tending to be shallow. (McKinney, 1994, p. 57)

Although this method of breathing is unlikely to inhibit diaphragmatic descent, as the diaphragm is active in all forms of inhalation (unless of course the diaphragm is itself paralysed), McKinney is correct in identifying inefficiency, reduced capacity and tension creation as the main faults with this type of respiration. Upper chest breathing is certainly not recommended for singing.

Rib breathing unlike upper chest breathing rarely occurs naturally, it is usually a method that is directly taught to the student by their teacher. The rib breathing method certainly contains elements of truth. “The rib cage should expand during inhalation. In rib breathing the rib cage does expand; the problem is that it is made the sole object of the act of expansion” (McKinney, 1994, p. 58). McKinney believes that this focus on only one area of the body limits the necessary expansion in other areas, particularly the abdomen. He does admit that rib breathing is often associated with good posture but he also warns that this posture can be the over done 'military bearing' which can add tension to the vocal instrument.

According to McKinney, rib breathing is undesirable, for the following reasons:

1. It limits (inhibits) the downward travel of the diaphragm.
2. It wastes energy and is physically tiring because of the effort expended in forcing the ribs outward.
3. Tension in the muscles of the chest, ribs and shoulders may be transmitted to the neck area and the vocal mechanism.

(McKinney, 1994, p. 58)

The use of rib breathing may affect the limits of travel for the diaphragm but the diaphragm is certainly active in this type of inhalation. The ribs, particularly at the base are greatly influenced by the action of the diaphragm. The focus of attention on the lateral flaring of the ribs probably inhibits the release of the abdominal wall to allow the diaphragm a quick and easy descent but it does activate and descend to some degree to assist or even to drive the lateral expansion of the ribs. McKinney's other comments about rib breathing are probably accurate.

Back breathing is very similar to rib breathing and McKinney states that it could be seen as merely a form of rib breathing. In back breathing the student attempts to expand not the rib cage at the sides but the back itself. McKinney states that "there is nothing wrong with expanding the back, unless the act is done in such a way the needed expansion in other areas is limited or eliminated" (1994, p. 58-59). He goes on to say that too concentrated an effort on the expansion of the back tends to have just that undesirable effect with virtually no upper abdominal expansion occurring.

"Paradoxically, concentrating attention on the expansion of the back or ribs will virtually eliminate frontal expansion, but concentration on frontal expansion will result in full and free expansion of the back and the ribs at the same time" (McKinney, 1994, p.59). Some teachers also advocate a rounding of the shoulders to encourage back expansion this is poor in terms of posture and also further inhibits frontal expansion according to McKinney (19894, p. 59).

McKinney believes that back breathing is undesirable for the following reasons:

1. It limits (restricts) the downward travel of the diaphragm.
  2. It wastes energy and is physically tiring because of the effort expended in spreading the back.
  3. Tension in the muscles of the back and shoulders may be transmitted to the vocal mechanism.
  4. If the shoulders are pulled forward, it is posturally weak.
- (McKinney, 1994, p. 59)

There is probably more opportunity for the diaphragm's movement to be restricted by back than by rib breathing. Back breathing appears to rely on more of the secondary muscles of inhalation so that air can be drawn into the body with less diaphragmatic involvement. This style of breathing certainly generates more tension than correct abdomino-diaphragmatic respiration due to use of more secondary muscles in the inhalation phase of the breath.

McKinney states that belly breathing is in a class all of its own. This style of breathing for singing is also known as the 'belly out' school. Rather than inhibiting or restricting the diaphragm's downward travel on inhalation, belly breathing hinders the diaphragm's upward movement during exhalation and inhibits the use of the abdominal muscles to aid exhalation.

Students of this method are instructed to "take a deep breath and then push out against your belt while you sing". This has the effect of locking the diaphragm in the lowest position to which it has descended and not allowing it to make its return as air is expended. (McKinney, 1994, p. 60)

McKinney also reminds us that in correct breathing for singing, muscles of inspiration continue to function during the expiration phase to help balance and maintain correct air pressure and flow. The inspiratory muscles usually play a subservient role to the muscles of expiration. In belly breathing the inspiratory muscles are so prominent during expiration that the singer has to find other ways of maintaining the air flow and pressure

during the duration of the sung phrase (1994, p. 60). Singers are often forced to use chest and back muscles to achieve control of the air stream which can greatly affect their vocal quality and tone.

McKinney sees the disadvantages of belly breathing as:

1. It restricts the upward travel of the diaphragm during phonation.
2. It results in poor posture-sunken chest and protruding abdomen.
3. It severely limits breath support for the upper voice.
4. It can result in tone quality and vibrato problems.

There are still a significant number of singing teachers who teach a belly out approach to breathing. Since the advent of kinematic research into breathing, this school has fallen somewhat from the mainstream of vocal pedagogy. It is rarely advocated in modern books on vocal pedagogy as an appropriate method and is usually mentioned, as McKinney, Vennard and Miller have done, as a fault that requires correction. It is interesting to note that this type of breathing is still widely taught and written about in pedagogies for the teaching of wind and brass instruments, so it may be that the lower air pressure generated by this type of breathing is advantageous to the wind and brass players or it may be that performers on these instruments have the luxury of being able to use the larynx as merely a valve to help control air flow rather than as a tone generator as the singer does. Of course it may just be that there has been insufficient research into breathing for playing of wind instruments to justify one method of breathing over another.

For singing this belly out method of breathing is generally not considered appropriate. Janice Chapman (2006) also believes that this belly out style of breath support locks the air flow rather than enhances it, which has a significant impact on the production of vocal tone. This breathing style certainly builds up inappropriate muscular tension in the chest wall that can be easily transmitted to the neck.

Many singing pedagogues are attempting to change or modify their method of instruction about breathing based on the more current scientific research. Some teachers are now using almost purely mechanistic descriptions of the breath to help student singers towards an efficient breath management system for singing, whilst others use imagery and concepts to get physiological facts across to the student in a way that they can understand and use. Robert White (1988) believes that singing teachers have certain responsibilities in relation to scientific knowledge.

Teachers of singing bear two major responsibilities. The first is to achieve a thorough understanding of the physiological-mechanical processes through which the singing voice is produced....The second responsibility for teachers of singing is to formulate concepts [images] based on their understanding of the physiological-mechanical processes and present them to the students in terms they can understand and apply towards the development of a singing technique. (White, 1988, p. 26)

White also reminds us that although there may be only one basic way for a breath to be taken or used, there are a myriad of ways of teaching these concepts which can be driven by a changing imagery that is limited only by the teacher's imagination. White does not advocate teaching the action of every muscle to the student, but he does insist that the teacher has that knowledge at a level that allows him or her to produce meaningful but physiologically correct images to help the student. White uses a five step model for the breathing-singing process.

1. Establish an upright, but not tense, posture emphasizing a comfortably high chest position.
2. Encourage an intake of breath by means of the activation – flattening of the diaphragm, with a corresponding relaxation – expansion of the abdominal wall, including the flanks and back and also an expansion of the lower ribs. ...

3. On the intake of the breath encourage the sensation of “open throat”, which is indicated by a slight drop or comfortable suspension of the larynx.
4. Initiate the singing tone with a slight, almost imaginary aspiration (“h”), with a simultaneous feeling of firmness (or resistance against collapse) in the mid-lower body muscles while the larynx is still in the comfortably suspended position.
5. Maintain a constant feeling of firmness or resistance in the mid-lower body throughout the musical phrase, increasing this firmness when the musical phrase: (a) calls for upward interval movement, (b) calls for increased volume, (c) calls for decreased volume, and (d) when the phrase is coming to an end. (White, 1988, p. 27)

White's model has taken on board much of the current scientific research, he understands the connection between posture and breathing, he gives the diaphragm the role of prime mover for inspiration with concomitant relaxation of the abdominal wall to allow its quick and easy descent and also gives correct activity to the abdomen in its role of tuning the system and supporting the singing voice. White's model is easy to understand and clearly follows the dictates of physiology. White goes on in his article to list the images he has found useful in achieving these aims. He is similar to McKinney in that he matches the images to the physiology rather than attempting to match the physiology to the image.

Emmons (another well-known American pedagogue) agrees with White in suggesting that “teaching is probably more productive when the concept is matched to the facts” (1988, p. 30). However she does believe that psychological concepts may be in opposition to physiological facts stating “each singer who uses the system [respiratory system] successfully describes his or her “method” in terms of the two or three muscles that are perceived to be in use” (Emmons, 1988, p. 30). She also believes that although the teacher or student may have anatomically accurate information it is no guarantee that the air will be used efficiently for singing. “Frequently a working concept (even an anatomically faulty one) is more useful” (Emmons, 1988, p. 30). This type of statement

is of some concern since she seems to be advocating a style of teaching that pays only lip service to the scientific facts. It would be far better to take the approach of McKinney or White who would either discard or modify an image that can not be supported scientifically. Emmons is an example of a modern pedagogue who does have a degree of scientific knowledge, but she appears reluctant to modify or discard some of the long standing traditions in vocal pedagogy, even if they do not appear to have a basis in scientific fact.

This inability to discard or modify concepts about breathing continues today. Leon Thurman states that:

The profession of singing teaching is currently in a decades-long historic transition from pre-scientific vocal pedagogy to science based voice education. During this transition , mixtures of pre-scientific and science-based concepts, terminologies, and practices are inevitable. (Thurman, 2004, p. 28)

Thurman goes on to identify seven pre-scientific concepts about breathing that continue to exist and be used in voice studios today.

Concept One: “There is a natural way to breathe for skilled speaking and singing, and it is involuntary” (Thurman, 2004, p. 30). This is the type of respiratory pattern that is used by infants. The thought is, that if this natural type of breathing can be recovered or remembered, singing will be fine.

The main problem with this concept of breathing is the word 'natural'. Does natural mean, prescribed by genetics? Does it mean physiologically most efficient? Certainly it is true that the respiratory system has a natural, or physiologically driven way of behaving. Breathing strategies that are based on the body's own normal or natural functions are sure to be more efficient than those which are physiologically possible but unusual or inefficient, or that use muscles whose prime functions are not respiratory.



Whilst it is true that breathing for life (tidal breathing) is involuntary, we do it when asleep, it occurs even in the womb (for practice) and that the rate and extent of breathing is regulated by the respiratory neurones based on the level of oxygen in the blood, not all breathing is involuntary. Breathing for vocalisation of any description requires a departure from this state which is voluntary. Thurman (2004) reminds us that although learned breathing coordinations can be experienced often enough to allow the details of their timing, sequence and intensity of muscle coordinations to be transferred to the subcortical motor areas of the brain, it is still the frontal cortex that initiates the required respiratory pattern at a chosen time, enabling the subcortical motor areas to enact the details (p. 34). This means, that once trained, the singer may feel that the breathing is essentially involuntary as everything works correctly with merely the thought of the breath.

Singers need to develop breath management systems that follow the physiological rules of the respiratory system, and to practise those patterns until they programmed into their subcortical motor systems, feeling almost involuntary.

Concept Two: “Actions of the diaphragm muscle are involuntary and not subject to learned voluntary action” (Thurman, 2004, p. 30). Those who ascribe to this school of thought believe that the sensory innervation of the diaphragm does not allow the singer to get feedback to properly control the diaphragm.

Although the diaphragm does not have sensory innervation that allows discrete control over the parts of the muscle, subtle variations in breath flow and pressure are required for singing. Thurman states that:

One way that these subtle variations can be produced is to simultaneously co-contract: (1) the abdominal muscles as one driving force for creation of lung-air pressure and breath flow, and (2) the thoracic diaphragm muscle as a checking force. This oppositional counterbalancing provides more potential for fine-tuned motor coordinations.... (Thurman, 2004, p. 32)

This type of counterbalancing is in many ways an unnatural act, and is learned, suggesting that proficient singers do have conscious control over the diaphragm, at least to some degree.

Concept Three: “During inhalation, the inhalation muscles of the lower ribs and back (e.g., external intercostals, latissimus dorsi) are prominently involved while the abdominal and pelvic diaphragm muscles are passive” (Thurman, 2004, p. 30). The diaphragm's inhalatory action is admitted but de-emphasised. This is the belly out school of support, where exhalation is also supposed to be controlled with the muscles of the back while the diaphragm and abdominal muscles are concerned with maintaining the belly out posture.

Concept Four: “A variant of the previous perspective [concept four] does emphasise diaphragm muscle action during inhalation with a passive expansion of the uncontracted abdominal muscles and a passive depression of the uncontracted pelvic diaphragm” (Thurman, 2004, p. 31). This variation of the belly out school also insists that the abdominal and pelvic floor muscles do not control expiration, it is the role of the back and lower rib muscles, although the abdominal and pelvic diaphragm are thought to spring back passively during exhalation.

Both concepts three and four are relying on the use of the abdominal and pelvic floor muscles in their roles in defaecation and expulsion of waste from the body rather than in their roles as expiratory muscles. As McKinney points out these styles of breathing tend to lock the diaphragm in its lower position. Thurman states that this prevents the diaphragm from performing its role as the main muscle of inhalation, particularly during inter-phrase breaths (Thurman, 2004, p. 34). There is also the issue that during forced defaecation and other types of exertion, the larynx is tightly closed to maintain the intra-thoracic pressure, this is not an efficient setting of the larynx for singing.

Concept Five: “During inhalation, the rib cage is held 'up and open' in order to optimise; (1) expansion of the lungs when the diaphragm muscle contracts to lower the

thoracic diaphragm; and (2) outward movement of the lower ribs when their inhalation muscles are contracted” (Thurman, 2004, p. 31). During exhalation the ribs are supposed to maintain their high posture while the muscles of the abdomen are responsible to contracting against the abdominal contents and expelling the air. As the air is expelled from the chest lower rib muscles are also involved to maintain a steady flow. This is the belly in and up school of support (Thurman, 2004, p. 31).

The use of concept five does appropriately recruit the abdominal and pelvic floor muscles into their expiratory functions but Thurman has some concerns that the demand for the high rib cage could distort the postural alignment of the singer, which is also not good for voice production. “Typically, a 'hold the sternum up' instruction results in a contraction of spinal flexor muscles so that the upper chest and head are tilted backward and the lumbar and thoracic vertebrae of the spine become compressed together” (Thurman, 2004, p. 35).

Concept Six: “When singing, an optimum or balanced interactive coordination occurs between the postural and the respiratory muscles. This breathing coordination was described by Miller .... and is conveyed in the Italian concept of appoggio [described above]” (Thurman, 2004, p. 31). Teachers in the appoggio school often say to students that when the breath is properly balanced, the abdomen and chest will not move very much and that there will be no sense of muscular work in the abdomen merely a sense of 'tensile energy'.

Although the recommendation to have a sense of tensile energy in the abdomen and chest is a good one, in that it can prevent the singer from using too much muscular force and over pressurising the lungs, the insistence that the singer remain in the position of inhalation means that the rib cage, which is the major controller of breath pressure in singing, is prevented from participating in the generation of appropriate lung pressures (Thurman, 2004, p. 35). Miller, the most well-known proponent of this method, states quite unequivocally that the diaphragm relaxes immediately after contraction and takes no real part in maintaining airflow, breath pressure or support.

This does not agree with the concept that the diaphragm can form the function of a releasing brake (checking force) against the action of the expiratory abdominal muscles.

This concept, that there is a balanced interaction between the postural muscles and the respiratory muscles, is an excellent one, well grounded in physiological fact, but unfortunately the details of this concept, how it is taught and perceived does not continue to follow these physiological dictates.

Concept Seven: “Good breath support and good breath connection are hallmarks of skilled singing” (Thurman, 2004, p. 31). Proponents of this concept often only give broad instruction on breathing such as 'You need to learn diaphragmatic breathing', 'Breathe from your diaphragm', and Breathe with your stomach muscles' (Thurman, 2004, p. 31).

Unfortunately many of the techniques used by this school to develop breathing are not specific enough. Often they do promote a better breath but because the actual process of breathing for singing is not properly explained, “they all can lead to myth-conceptions about the process or they can lead to inefficiencies in other equally important voice coordinations” (Thurman, 2004, p. 35).

Thurman concludes by summarising some important criteria for breathing for singing:

1. Breathing concepts and teaching methods for the inhalation and exhalation coordinations of skilled singing and speaking need to be based on science-derived findings from the anatomical, physiological, neuropsychobiological, and voice sciences, not in the culturally handed-down pre-scientific assumptions of the past.
2. Muscles that make a primary contribution to the inhalation function need to be used for that function with minimal or no interference from other muscles.

3. Muscles that make a primary contribution to exhalation function need to be used for that function, with co-operation from inhalation muscles when needed.
4. No aspect of breathing coordination should induce encumbrances or interferences with physical and acoustic efficiency in any other aspect of speaking or singing coordination.

Many modern pedagogues are attempting, as White insists in his 1988 article, to use the newly acquired scientific knowledge to develop a breathing strategy that is not only physiologically accurate, fulfilling Thurman's criteria, but that is also easy to teach and learn. Janice Chapman in her book *Singing and Teaching Singing – A Holistic Approach to Classical Voice* (2006), outlines a breathing and breath support system that is based in physiological fact but has also been trialled over a long period in her vocal studio.

Chapman believes that all singing should be supported by the muscles of the abdominal girdle and those that attach to the lower abdominal pubic symphysis (LAPS). She also believes that the diaphragm must be free and unhindered in its descent to allow a full, but natural inhalation for singing. In her pedagogy inhalation is based on the 'SPLAT' manoeuvre. SPLAT has been described thus:

Breathe out through pursed lips...as though through a drinking straw to the end of available breath without losing posture. Hold this position for a couple of seconds while noticing where the tension is in the body i.e. check with hands on waist band, xiphoid area (apex of sternum and ribs), and the lower abdominal/pubic symphysis (LAPS). Then release all tension and notice how the air is drawn in to the lungs automatically. The reason for this is that the diaphragm is free to contract and descend quickly creating a vacuum in the lungs. Be aware of maintaining postural alignment during this release. i.e. (if postural alignment is lost this rapid diaphragmatic descent is less efficient). This is the basis of the SPLAT breath. (Chapman, 2006, p 42)

In Chapman's pedagogy, the emphasis of control of the outward flow of air is with the abdominal and pelvic floor musculature. Immediately after the diaphragmatic in-breath, the singer is requested to draw the umbilicus in, thus activating the muscles of the abdominal girdle and LAPS and increasing the intra-abdominal pressure. The ribs are left free, not held in any specific position, so that they can control the pressurisation of the lungs. Chapman's pedagogy is consistent with many of the features of breathing for singing that were identified previously by Watson and Hixon (1987).

In my pedagogy, the SPLAT in-breath is followed immediately by movement of the belly wall towards the spine, which brings about the activation of the abdominal girdle and LAPS. This raises the intra-abdominal pressure and the intra-thoracic pressure and is synchronised with the onset of phonation. This gives the singer the ability to use the compressed air with complete control. It is as though the singer has both accelerator (anterior abdominal wall and LAPS) and brakes (abdominal girdle, sides and back and consequently the diaphragm) under the same foot. (Chapman, 2006, p 41)

Chapman is also concerned about the interaction between the muscles of postural support and the muscles of respiration. She feels that there is significant interaction between these systems that can greatly influence the singer.

The interaction between postural alignment, breathing and support is not fully understood. The muscles of active expiration also have significant postural functions. We can increase awareness of some of their expiratory functions by changing posture. For example crouching in a monkey-type position will make the waistband activity more obvious and allow direct palpation of the muscles in the back of the waistband. Conversely standing with a lordotic posture (swayed back) will reduce these sensations greatly. It appears that the postural functions of the muscles are engaged in a crouched position due to the shift in the centre of gravity in the body. When expiratory demands are added, the movement of these muscles is

greater and more obvious to palpation. It may be argued that the more efficient use of these muscles in a crouched position is related to the fact that man became fully upright relatively recently in his evolution. The interactions between the respiratory system and primal sound probably evolved during this period of less-upright posture. (Chapman, 2006, p 45)

Chapman continues on to give a set of exercises to promote the use of the respiratory physiology in the way that she has described. She uses the concept of primal sound to underpin her breathing technique. Primal sounds, such as laughing, crying, sobbing and wailing, are thought to be under the control of the emotional motor system. Production of these primal sounds calls on a response from the respiratory system that is neurologically hard-wired, based deep in our animal brain. The singer learns to develop control over these connections and muscular interactions by repeated stimulation of the link, raising the sensations to conscious awareness and practice of the required movements (Chapman, 2006).

Chapman's pedagogy does meet Thurman's criteria for an acceptable breathing system. Respiratory muscles are called upon to act in accordance with their primary functions, there is a scientific basis to the pedagogy, there is an understanding of the interaction between breathing, support and posture and the breathing method does not interfere with other components of the vocal instrument.

Chapman also recommends some breathing exercises, which can be carried out separately from singing. Specifically, she suggests the use of Accent Method to assist the student to make the necessary connections and to achieve the necessary practice to develop, strengthen, and coordinate the breath support system for singing.

Examining the approaches of a number of key pedagogues of the past five decades, many have made changes to the way in which they teach breathing, breath support or breath management. These changes in approach have been based on the research into breathing and breathing for singing that has been carried out since the 1950s. However, some pedagogues, such as Emmons, continue to use pre-scientific images or concepts as

the basis for their teaching. Others, for example Miller, use a type of pseudo-science, or are selective as to the attention that they pay to scientific knowledge. It would seem that of the schools of breath management that were identified at the beginning of this chapter, only the 'belly-in' school has a real scientific basis. It is still uncertain as to the exact mechanism that should be used for singing but any pedagogy that does not meet the criteria set out by Thurman (2004) can, on the basis of the findings in the previous chapter, be discarded as unscientific.



## Chapter Four The Accent Method of Breathing

As we have seen, much pedagogy for singing contains a set of exercises, or a set of concepts that the singer uses to ensure adequate breath management and support. The use of breath in voice therapy to assist patients whose voices are deviant, abnormal or disordered is also common practice, and most voice therapists will assess and treat breathing related deficits as part of the production of voice in their patients. Even so, the exercises that are commonly used appear to be limited in number and scope. Very few methods or hierarchies, ranging from simple to more complex, that relate specifically to breathing, breath management or breath support have been reported in the literature. The Accent Method of Breathing addresses this need by having a firm hierarchy and a set of exercises to complement it.

“The Accent Method can be viewed as a technique to develop optimal voice and speech function by creating a perfect dynamic balance between subglottal air pressure and the glottic activity, which will increase the acoustic flexibility of the voice” (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 3). Although this is the stated aim for the speaking voice, it applies with even more accuracy to the singing voice. Singers aim to have a delicate balance of subglottal air pressure and glottic activity to maintain pitch and loudness (Leanderson and Sundberg, 1988, p. 3) so any method that promotes this will be advantageous for singing. Thyme-Frøkjær and Frøkjær-Jensen's other stated aims of the Accent Method also sit well with the requirements for singing. They claim that Accent Method results in:

- A rich and beautiful timbre,
- Excellent intelligibility with clear articulation.
- Full dynamic range of soft to loud.
- A lively intonation.
- A voice that is sustainable through vocally stressful and challenging situations without succumbing to voice strain. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 3)

The Accent Method claims to rely on sound physiological principles and has been described as an holistic and rational therapy.

It is well known that efficient voice production is based upon the activity of the abdominal muscles. The Accent Method therefore uses exercises with a rhythmic change in the activity of these muscles as a central part in training. These exercises encourage control of the abdominal muscles to produce large or small contractions voluntarily. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 3)

Given the results of experiments that have evaluated breathing for singing it would appear that this type of voluntary control of the abdominal musculature would greatly assist the singer in their management of breath for singing.

The Accent Method was developed by Professor Svend Smith. Smith was a well-known speech pathologist and voice researcher in the 1920s and 30s. It was from his extensive studies into speech physiology and his knowledge of the theories and practices of the day, that in the 1930's, he saw a need for a new set of therapy activities for pathological voices (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 5). Prior to 1935, most exercises for patients with voice disorders were based on the theories for singing training and on non-pathological voices, which Smith found ineffective for many of his patients. As a clinician, Smith had the luxury of trialling his new theory and practice on his patients, which quickly lead to an organised set of exercises.

.... in 1937, his theory was formulated in detail and he was able to build up the complete system of treatment for pathological voices which incorporated: breathing exercises at rest, the transfer from expiration at rest to expiration for phonation and various voice exercises matching the prosody of speech. A year later, an uncomplicated set of drum exercises was created which exactly fits the voice exercises. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 5-6)

Smith continued to consolidate his method through research and clinical practice and in 1967, the collaboration with Kirsten Thyme-Frøkjær began. Thyme-Frøkjær was particularly interested in the generalisation of the skills learnt by the patients in clinical voice training into spontaneous speech. She was instrumental in adding prosodic speech exercises that encouraged transfer of the skills through reading to spontaneous speech and defined the main goal of the Accent Method as follows:

to resolve pathological symptoms by optimising normal functions and to do this by achieving the best possible co-ordination between breathing, voicing, articulation, body movement and language for each individual.  
(Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 7)

Accent Method does not treat vocal pathology or inefficiency directly, but rather it aims to train normal patterns of speech and voice production. It is this goal of training normal patterns of speech and voice production that makes the method so appropriate for singers. Studies into breathing for singing make it clear that the singers must use a natural, i.e. physiologically accurate and appropriate breath for singing. Accent Method, with its focus on training normal patterns, including normal breathing patterns, is theoretically well suited for this purpose.

“The Accent Method relies on kinaesthetic feedback to control and co-ordinate body movement, breathing, phonatory and articulatory patterns” (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 8). Initially, training begins with slow, gross movements that are followed by quicker, finer movements once the patient has sufficient control over the slower ones. Accent Method begins with minimal tension which is considerably increased before returning to its original state (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 8).

In normal 'at rest' breathing, the body can be observed to move slightly forward during inhalation and slightly backwards during exhalation. These movements are produced automatically as the centre of gravity is shifted. During the breathing cycle, contraction of the diaphragm

alternates with the contraction of the abdominal muscles. The pressure on the abdomen created by the contraction of the diaphragm moves the abdominal wall downwards and forwards during inhalation, thus shifting the centre of gravity forwards. During exhalation, the abdominal muscles in conjunction with the relaxation of the diaphragm returns the abdomen to its resting position, thus shifting the centre of gravity back again.

(Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 9)

Thyme-Frøkjær and Frøkjær-Jensen show the direct link between Accent Method and the physiological facts, with an explanation that is consistent with the structure and function of the respiratory system as described by Hixon and others.

Accent Method exercises commence in a slow rhythm to train the correct abdominal breathing pattern without any excessive muscular tension in the upper chest and to allow sufficient time to develop a perfect balance between expiration which creates the subglottal pressure and the tension in the larynx that is required to resist that pressure for voicing (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 9).

The fundamental principles of accent method; that during the breathing cycle contraction of the diaphragm alternates with contraction of the abdominal muscles and that training should move from slow, gross and more simple towards fast, fine and more complex appear to be applicable to singing. Singing is a complex biomechanical process and training following the correct physiological dictates and building a technique from simple to complex should ensure a solid foundation for the expression of musical ideas.

Accent Method has a defined set of exercises that move the student from breathing at rest to breathing for phonation.

Respiration at rest is usually commenced with the student in the supine position with a small pillow under the neck and knees to enhance comfort. At this stage very little instruction is given to the student. Merely placing the body in the correct posturally

aligned position will usually result in natural abdomino-diaphragmatic breathing. The student may be told that breathing can be seen as a three part action with inspiration, expiration and a pause. In reality there is no pause between inspiration and expiration, but as expiration takes usually twice as long as inspiration the student will easily accept as a pause the decrease in effort as the expiration transitions into the next inspiration (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 95). Once abdominal-diaphragmatic breathing is established the student is made consciously aware of it by placing one hand on the abdomen to feel the rise and fall of the abdomen which occurs in each breath cycle.

The student can also be made aware of the lack of movement in the upper chest during a correct abdomino-diaphragmatic breath by placing the other hand on the upper chest and noting the lack of movement there in contrast to the active movement in the abdomen (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 95).

The student is then requested to make a breathy /w/ sound on the outgoing air-stream, this is a transitional stage between breathing at rest and breathing for speech. At this stage, in the supine position, inspiration is active, under the control of the diaphragm, while expiration is passive and predominantly driven by the elastic recoil of the respiratory system (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 96).

When the exercises in the supine position are mastered, the same exercise can be carried out while lying on the side, which is somewhat more difficult than in the supine position, because in this position the weight of the abdominal content does not support the expiration and therefore the abdominal muscles must be somewhat active. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 96)

Once the exercises are performed to a satisfactory level of efficiency in the side lying position, the student is moved onto a stool or straight backed chair. More active involvement of the abdominal muscles will be required for all the expiratory exercises as gravity no longer assists expiration but inspiration instead. The next stage is in the

standing position with the addition of some body movements (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 98).

In the standing position, to facilitate the exercise and to emphasise natural breathing the student is encouraged to allow the body to move slightly backwards and forwards as the centre of gravity shifts. The student is also encouraged to breathe deeply without lifting or over tensing the chest. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 99).

Voiced exercises are introduced once respiration is firmly established in the standing position, at rest. The phonation that is used is low and breathy to promote improved elasticity and flexibility of the mucosa. Each exercise is performed with low intensity in the beginning, increased intensity in the middle and again with low intensity at the end (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 106). Kotby suggests that voiceless and voiced fricatives can be used here, almost as a prephonatory stage, to ensure that the airflow is sufficiently high. He also suggests using these fricatives to develop appropriate accentuations (Kotby, 1995, p. 63). Once this is established the first set of the true rhythmic exercises can be commenced. These are usually trained on close vowels with a slightly breathy voice quality to ensure that there is no excessive tension in the articulators or larynx. Largo exercises are usually performed at about 58 beats per minute (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p108).

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**Tempo I, Variation I**

Clinician:	$\frac{3}{4}$																																																																																																																																																																																																																																																																																																																																																																																																					
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### Tempo I, Variation 2

Clinician:	3/4	
Client:	3/4	

**Figure 10.2** Variation 2 in Tempo I – Largo, the most important voice exercise in the whole theoretical system of the Accent Method

### Tempo I, Variation 3

Clinician:	3/4	
Client:	3/4	

**Figure 10.5** Music notation showing how variation 3 in Tempo I – Largo is performed by the clinician and the client alternately

Figure 5 Rhythmic notation for the three patterns of Largo (Tempo I) from Thyme-Frøkjær, K. & Frøkjær-Jensen, B. 2001, p 106 and p 110.

As the other patterns in Largo (the first tempo) are introduced, the “voice quality will be changed to a clear and sonorous timbre, with distinct articulation and without any signs of breathiness or glottal fry” (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 109). As the airflow is controlled voluntarily by the student, a change in the movement of the whole chest wall can be discerned.

In contradistinction to the respiration at rest, where the chest must not move, it is important that the chest moves upwards during the accentuated phonation. But this movement must always be a passive one, caused

exclusively by the compression of the air in the lungs during the abdominal muscle contraction necessary for the accentuated phonation. This movement can be observed in the exercises as a raising of the sternum during each accentuation. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 109)


Arm and body movements can also be added to the Largo patterns to assist the airflow out of the lungs and to activate the accentuated voice patterns. The quiet inspiration and calm swinging rhythm with the arms is also thought to promote relaxation (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 111).


Once the student has good control over the respiratory function and has an improvement in the sonority of the vocal timbre, the second rhythmic pattern of Andante can be introduced.

Andante is essentially a march rhythm with four beats to the bar. The exercise usually begins at around 70 beats per minute but may be gradually increased to 80 beats per minute (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 113). The exercises are performed with a quick inspiration followed by an unaccentuated upbeat which precedes the accentuated beats. “Variations in Tempo II [Andante] are introduced to reinforce coordination between respiration, phonation and articulation, and to promote general elasticity and mobility” (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 113).




**Tempo II, Variation I**


Clinician: 4/4   
 > > > P a u s e > > >

Client: 4/4   
 P a u s e > > > P a u s e

a the basic exercise with an upbeat and three accentuated beats

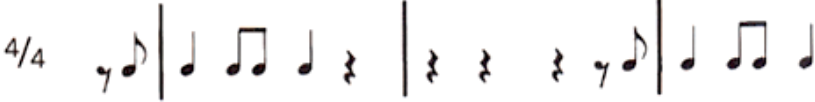
**Tempo II, Variation 2**


Clinician: 4/4   
 >> > > P a u s e >> > >

Client: 4/4   
 P a u s e >> > > P a u s e

b the first accentuated beat is subdivided into two accentuated eighths

**Tempo II, Variation 3**

Clinician: 4/4   
 > >> > P a u s e > >> >

Client: 4/4   
 P a u s e > >> > P a u s e

c the second accentuated beat is subdivided into two accentuated eighths

**Figure 10.7** continued overleaf

Figure 6  
*Rhythmic notation for the three patterns of Andante (Tempo II) from Thyme-Frøkjær, K. & Frøkjær-Jenson, B. 2001, p 114 and p 115.*

Once again arm and body movements can be added to the exercises to assist accentuation and develop strength and flexibility.

Tempo III, or Allegro, has four beats to the bar, as does Andante, but the tempo is somewhat faster at about 88 beats per minute. The main difference between Andante and Allegro is that the first two beats of each bar are subdivided. “The entire exercise consists of a short and deep active inspiration directly followed by an unaccentuated eighth [quaver] as an upbeat, four accented eighths and an accented quarter [crotchet]” (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 116).

**Tempo III, Variation I**

Clinician: 4/4   
 Client: 4/4

**Figure 10.8** The basic exercise in Tempo III, performed alternately by the clinician and client

**Tempo III, Variation 2**

Clinician: 4/4   
 Client: 4/4

**Figure 10.9** The faster variation 2: two bars with an upbeat followed by 13 accentuations

Figure 7 Rhythmic notation for the three patterns of Allegro (Tempo III) from Thyme-Frøkjær, K. & Frøkjær-Jensen, B. 2001, p 116 and p 117

Thyme-Frøkjær and Frøkjær-Jensen point out that the purpose of the Allegro patterns is to increase the number of accentuations on each breath. “By training rapid strings of accentuations the client or actor also trains the mobility and fine co-ordination of respiration, phonation and articulation” (2001, p. 117).

In tempo III variations, the single movements of the abdominal wall and the chest cannot be seen clearly, because the number of accentuations follow quickly after each other. Therefore the two variations described will be seen rather as a continuous inward movement of the abdominal wall and a continuous, weaker outward movement of the chest. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 118)

Body and hand movements can again be added to the Allegro patterns but it is also possible to combine the patterns of both Andante and Allegro patterns since both are based on a 4/4 march time. Classically, Accent Method has concentrated on using closed vowels initially, followed by the more open vowels and then consonant-vowel babble. Thyme-Frøkjær and Frøkjær-Jensen also indicate that some of the voiced fricatives such as /z/ or /v/ or other voiced consonants such as /j/ can also be used in place of the closed vowels (2001, p. 11).

Once the voice and respiratory movements are correct in all of the tempos work can be commenced with words and phrases as a bridge into reading aloud texts and transfer into spontaneous speech. Thyme-Frøkjær and Frøkjær-Jensen state that the enhancement of prosody also improves articulation and intelligibility. The rhythmic patterns should be modified to fit the patterns of speech but a connection to the accentuated vowels and consonant-vowel babble is maintained (2001, p. 128).

The course of instruction in Accent Method is clearly defined and the hierarchy of tasks is also well ordered. These are some of the major deficits with other types of breathing instruction. In revisiting the results of scientific work on singing and the requirements for a breathing pedagogy that arose from them, it can be seen that Accent method, because of its focus on abdomino-diaphragmatic breathing, voluntary control of

respiration and repetitive rhythmic exercises is able to fulfil these requirements well. The use of the repetitive exercises first with closed vowels or fricatives and later with vowels and consonant-vowel babble ensures high breath flow and gradual strengthening of the respiratory muscles. The use of rhythm also encourages the development of co-ordination and flexibility.

Accent Method would give singers the necessary repetitive practice to allow them to develop the fine interactions between inhalation and exhalation that constitute breath support. Singers are also given specific instructions to encourage development and use of the necessary muscles in the abdomen. This would allow the abdomen to take its function in tuning the respiratory system for action while allowing the rib cage to be free to control the pressurisation of air within the respiratory system. It could also be postulated that the exercises could aid the development of the function of the diaphragm as a releasing brake.

Kotby also stresses that the training of breathing is considered to be the basis of Accent Method. He also points out that Accent Method actively trains respiratory support by focussing on the abdominal control of the outgoing air-stream. “Coactivation of the abdominal and flank muscles is, however, the main target of the expiratory exercises used in the Accent Method. These exercises are effective in reaching the goals of better respiratory support”. (Kotby, 1995, p. 57).

## **Research into Accent Method**

The Accent Method has been extensively studied both in clinical populations of patients with disordered voices and in those who have undergone training programmes in order to teach Accent Method. Thyme-Frøkjær and Frøkjær-Jensen have recorded some 400 clinicians, students of logopaedics (speech therapy) as well as large numbers of dysphonic patients. The recordings and analysis of the normal voices were made in connection with intensive courses, workshops and regular training in the Accent Method and therapy (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 144). The recordings and studies performed on subjects who had normal larynges provides some insight into the

possible changes that could occur to the voices and breath management systems of young singers. The subjects for this present study will have, in all likelihood, normal larynges.

Thyme-Frøkjær and Frøkjær-Jensen report on two studies of vital capacity and peak flow measures made before and after a one week intensive Accent Method course. They found a significant increase in the peak flow rate (measured in litres per second) for both studies following the Accent Method course. This would suggest that the subjects were better able to make sudden and strong contractions of the abdominal and chest muscles following this short but intensive training programme (2001, p. 145). Although vital capacity measures only improved significantly in one of the two study groups, there was a clear tendency towards improvement. Thyme-Frøkjær and Frøkjær-Jensen conclude:

Thus improved respiratory function is shown by a minor increase in the vital capacity and by an increased peak airflow rate; that is, both the lung capacity and the ability to make a sudden strong expiratory muscle contraction are increased during the therapy. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 146)

In another series of studies, electroglottography was recorded from a class of 15 students who were studying speech therapy. They received Accent Method training over a 10 month period and duty cycle measures were obtained from the electroglottographic recordings. The duty cycle measure provides an estimation of the closed phase of the vocal folds' vibration cycle. Prior to training the students' voices were evaluated subjectively as either hypofunctional (breathy), in 10 students, or hyperfunctional (pressed or creaky) in five. All of the students had normal healthy larynges according to the otolaryngologist. Following Accent Method training the duty cycle for the hypofunctional voices had decreased (suggesting improved vocal fold closure) while those of the hyperfunctional students had increased (suggesting looser closure). Unfortunately due to limited numbers in the hyperfunctional group these data were not statistically significant. Thyme-Frøkjær and Frøkjær-Jensen concluded that:

The balance between subglottal air pressure and vocal fold activity is adjusted to the greatest efficiency in relation to the energy used; that is, hypofunctional voices get a longer closure phase and hyperfunctional voices get a shorter closure phase. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 147)

Thyme-Frøkjær and Frøkjær-Jensen also reported on data from a group of female clinicians who were rated as having hypofunctional voices prior to an intensive Accent Method course. They showed similar reductions in the duty cycle of the electroglottogram but they also showed a significant reduction in mean airflow rate through steady state vowels. This was accompanied by a small but statistically significant increase in maximum phonation time. Mean flow rate dropped from 173 ml/sec to 137 ml/sec, where mean flow rates between 100 and 140 ml/sec are considered normal (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 149). Maximum phonation times increased from 20 seconds to 21.5 seconds. These changes occurred over the duration of a one week intensive Accent Method course.

The main effect of the training of the phonatory system is improved balance between the expiratory activity (the airflow and subglottal air pressure) and the adjustment of the vocal folds (tension, thickness, length and adduction). This is due partly to improved mobility and elasticity of the vocal fold tissue and mucous membranes, and a better fixation of the mucous membrane to the underlying tissue, and partly to improved control of the respiratory and phonatory muscles taking part in voice production caused by the unconscious training of the feedback loops used for speech production. (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 150)

Thyme-Frøkjær and Frøkjær-Jensen also report significant acoustic changes in voices post Accent Method training. They studied 20 clinicians who attended for an initial week intensive Accent Method course and then returned 12 to 24 months later to take part in an advanced course. They found significant changes to their phonetograms ( a

measure of the softest and loudest volume at each semitone of the pitch range) following the initial training course, with an average increase in total pitch range of 3.3 semitones and an increase in the dynamic range of 10.6 dB (Thyme-Frøkjær and Frøkjær-Jensen, 2001, p. 150). When the phonetograms were again taken, 12 to 24 months after the initial course, it was found that there was again some increase in both pitch and dynamic range. It appears that the effects of Accent Method are maintained well over a lengthy period, though it must be noted that these clinicians did continue to train and treat patients in their own clinical practice, meaning that they were regularly practising Accent Method in the gap between recordings.

The results of these studies, performed on subjects with essentially normal speech and voice production suggest that Accent Method is able to enhance both respiratory and phonatory function even if no significant vocal pathology is evident. This provides solid evidence for the claim that Accent Method trains normal functions of respiration, phonation and articulation by enhancing the strength, efficiency and co-ordination of movement in the respiratory and phonatory systems.

The efficacy of Accent Method has also been studied in relation to pathological or disordered voices. Kotby reported on a study by himself, El-Sady, Bassiouny, Abou-Ross and Hegazi in 1991 which examined a number of aerodynamic and perceptual measures that were taken pre and post Accent Method therapy. They studied patients with non-organic (functional) voice disorders, vocal nodules and vocal cord paralyses. Following 20 sessions of Accent Method, they found significant positive changes to voice quality in the vast majority of their patients. This perceptual improvement was also mirrored in the aerodynamic measures with significant improvement in maximum phonation time, mean flow rate, subglottal pressures, and glottal efficiency. “Kotby et al (1991) concluded that the Accent Method is therapeutically effective in non-organic (functional) voice disorders, vocal nodules and paralysis of the vocal folds” (Kotby, 1995, p. 85).

Fex, Fex, Shiromoto and Hirano (1994) evaluated the efficacy of Accent Method in patients with functional voice disorders. They examined a series of 10 consecutive

patients who were referred to the speech pathologist. Seven patients had normal larynges, whilst three had moderate sized vocal nodules. They assessed a number of acoustic parameters: pitch perturbation quotient, amplitude perturbation quotient, normalised noise energy for 0-4 kHz and for 1-4 kHz, fundamental frequency and level differences. Patients were given ten 30-minute Accent Method sessions, the timing of which did vary according to patient requirements. Statistically significant changes were noted in pitch perturbation quotient and amplitude perturbation quotient for all the subjects. Normalised energy changes in the 1-4 kHz range and in fundamental frequency were statistically significant for the female patients only. These results confirm that Accent Method is effective in making changes to pathological voices. The changes in the acoustic parameters towards more normal values agreed with the perceptual analysis of the voices that also suggested improvements. Accent Method by increasing airflow and normalising vocal fold function was able to make statistically significant changes to a number of acoustic measures.

Bassiouny (1998) also studied the efficacy of the Accent Method. He used 42 patients who presented with a variety of vocal pathologies. He randomly assigned the patients to one of two treatment groups. Group one received Accent Method instruction in addition to advice about vocal hygiene, while group two received vocal hygiene advice only (they were scheduled to receive active voice treatment at a later date). Apart from the auditory perceptual analysis and videostroboscopic examination all of the patients were also assessed with a number of acoustic and aerodynamic measures. Patients were assessed pre-therapy, half way through therapy and post-therapy.

Aerodynamic measures consisted of: vital capacity, maximum phonation time, phonatory quotient, mean flow rate, subglottal pressure, glottal efficiency and a phonetogram. Acoustic analysis included: average pitch, pitch and amplitude perturbation quotients and the harmonic to noise ratio.

Auditory perceptual analysis results suggested that patients in the treatment group showed a greater degree of improvement than those in the hygiene only group. Similarly videostroboscopic findings were highly significant in favour of the treatment group, with



the hygiene only group showing no significant changes in stroboscopy data (Bassiouny, 1998, p. 153).

“The difference in improvement of aerodynamic measures between pre and post test evaluation of both groups was highly significant in favour of group one in the following parameters: SPL range [phonetogram data], subglottal pressure, glottal efficiency and glottal resistance” (Bassiouny, 1998, p. 154). Other aerodynamic measures showed significant improvements depending on the aetiology of the vocal disorder with hyperfunctional voices showing significant improvements in mean airflow while the vocal fold paralysis group showed increased maximum phonation time, mean flow rates and a greater phonation quotient, which would be consistent with better vocal fold approximation. “There was a non-conformity of improvement of all the three parameters of acoustic analysis in between the groups. The aetiological subgroups showed an additional inconsistency in the trend of improvement among the computed parameters of acoustic analysis” (Bassiouny, 1998, p. 163). Bassiouny believes that the lack of consistency in the acoustic data may be because the measures taken were not sensitive or specific enough (1998, p, 163). Overall Bassiouny concluded that the treatment group who had Accent Method exercises in addition to the vocal hygiene advice showed significantly greater improvement. This suggests that Accent Method exercises are effective in bringing about vocal change.

The results of studies on the efficacy of the Accent Method, both with normal and pathological voices, suggest that it is an effective tool for voice change. A significant improvement in the volume and pitch ranges (phonetograms) and a normalisation of parameters such as: mean airflow, vocal fold closure, glottal efficiency and subglottic pressure have been reported. Pathological voices also often show changes in acoustic parameters such as frequency and amplitude perturbation quotients and fundamental frequency, depending on the aetiology of the voice disorder.

The positive results obtained with subjects who had normal voices or larynges are particularly of interest to singers and students of singing. Singers need to produce their voices in as efficient way as possible, over a wide variation of pitches and volumes. It

appears that Accent Method exercises would assist them in the acquisition of these skills. Unfortunately no studies have been published that evaluate the use of Accent Method for developing good respiratory (breath management and breath support) habits for singing, but it would appear, when evidence from studies into breathing for singing are taken into account, that Accent Method would be a valuable pedagogical tool. Chapman in her book, (2006), certainly uses Accent Method exercises, albeit slightly modified, as the basis of her breathing and support technique.

This current study aims to evaluate the changes, if any, that will occur in student singers' voices and breath management systems following on from Accent Method training. Given the results obtained from the studies carried out by Thyme-Frøkjær and Frøkjær-Jensen on subjects with normal larynges, Accent Method should prove beneficial to young classical singers.

## Chapter Five Methodology

### The Experiment

The aim of the experiment was to evaluate the effects of Accent Method instruction on a group of young students of classical singing.

A Control and Experimental group was used, singers, in the same years of their music degrees, acted as controls. This Control group did not receive Accent Method training but were seen for 45 minutes each week, by the examiner, to carry out a sight singing programme. Both the Experimental and Control groups continued to receive the usual programme that is offered to all student singers of that year level. Accent Method training should have been the most significant variable operating in the experimental group.

Subjects for the experimental study were drawn from First Year and Second Year students of classical singing at the Guildhall School of Music and Drama (London). All students in these earliest years of their singing training at tertiary level were eligible to join the study. Students were recruited by the Head of Vocal Studies. Students were randomly assigned to either the experimental group or to the control group. The groups were equivalent in terms of numbers of first and second years and numbers of male and female students in each group. Accent Method was currently taught by only a limited number of teachers at The Guildhall School of Music and Drama and their students were not eligible for inclusion in either the control or experimental groups.

All students were assessed using an auditory perceptual analysis of their speaking voice by the experimenter to ensure that no subject with overt vocal pathology was included in the study. The students' voices were judged only for voice quality, so that any student with a significant huskiness, harshness or breathiness was excluded. Scores for voice quality greater than a '1' on a modified Oates Voice Profile (Oates, 1986) were the exclusion criterion (scores of 0 represent completely normal voice, 1 represents minimal or intermittent deviation from normal voice).

## Measures Assessed

Following the initial interview and auditory perceptual analysis students were scheduled for the initial acoustic and aerodynamic assessments. The following measures were taken:

- Phonetogram – Physiologic Range
- Maximum Phonation Time – Vowels /a/ and /i/
- Mean Airflow through Steady State Vowels – Vowels /a/ and /i/ at modal speaking pitch and one octave higher

Subjects were also recorded singing *Caro Mio Ben* by Giordani, unaccompanied, in Italian, in a key appropriate for their voice type. The choice of key was determined by the student's singing teacher.

Phonetograms represent the voice in terms of pitch and loudness. Subjects are required to sing as loudly and as softly as possible in semitone intervals throughout their vocal range. Subjects were encouraged to use their entire physiological range on this assessment. Male singers were encouraged to use their Falsetto (Laryngeal Mechanism 2) and female singers were encouraged to use both their Chest (Laryngeal Mechanism 1) and Whistle (Laryngeal Mechanism 3) voices. This allowed the calculation of their pitch range and provided a measure of their dynamic range of loudness, throughout this pitch range. Studies of Accent Method on both normal and disordered voices indicate that Accent Method is effective in increasing the subjects' phonation area, usually resulting in an increase in both pitch and dynamic range. Singers, even student singers, usually use more of their pitch and volume ranges than a speaker would so any differences in phonetograms pre and post training will be of interest.

Maximum phonation times provide an indirect measure of voice/breath efficiency. Subjects are asked to sustain a sound, at their modal speaking pitch, for as long as possible. Accent Method has been shown to be effective in increasing the maximum phonation times of both normal and disordered voices. Phonation times in singing are

significantly longer than in speech, being dictated by the length of the musical phrase, so increased phonation times should be of benefit to the singer. Maximum phonation time for each sound will be calculated as the average of three trials. Subjects will be requested to take a deep breath and sustain the following sounds at a comfortable level of loudness, for as long as possible: /a/ and /i/. This range of sounds provides an open vowel /a/ and a closed vowel /i/.

Mean airflow through steady state vowels was measured via a face mask. Subjects were not required to blow through a tube or have a tube inserted into the mouth, simply to take a breath and sustain a vowel for at least 10 seconds. The following vowels were used: /a/, and /i/. Measurement was taken at modal pitch and at one octave above modal pitch. Mean airflow was again taken as the average of three trials of each vowel. Accent Method has again been found to normalise mean airflow in subjects with normal larynges. Mean airflow within the average range is thought to be a sign of breath/voice efficiency. Sundberg (1987) also suggests that the development of flow phonation (airflow closer to the upper limit of normal) is important to the development of resonant voice which is of prime concern to the singer (p. 32).

Subjects were recorded singing *Caro Mio Ben*. The opening section of this song was performed unaccompanied, in a key appropriate to the student's voice type. This recording was made with the subject a standard distance from the recording microphone. The subjects were requested to sing at a comfortably loud level

### **Instrumentation**

Phonetograms were taken using the Wevosys Phonetogram Light System which was connected to a Toshiba Satellite Pro A120 lap top computer. A Creative Sound Blaster X-Fi Surround 5.1 external sound card was also used to ensure a high quality recording (as per Wevosys instructions). Phonetograms were taken in accordance with the Wevosys recommendations with the subjects singing an /a/ vowel 30 cm from the recording/analysing sound level meter. /a/ is an open vowel that should have allowed singers access to their entire pitch range. Some singers do prefer more closed vowels, such as /i/ or /e/, but by making each subject vocalise the same vowel differing

formant values should not have contaminated the results. Measurements were taken in the John Hosier Practice Annexe of the Guildhall School of Music and Drama in a sound treated practice studio. Ambient noise levels were on average less than 45 dBA, which was in accordance with the Wevosys recommendations.

The sustained vowels for Maximum Phonation Time assessment were recorded using Wavesurfer software via the sound level meter/microphone and sound card that were used in the phonetogram analysis. Initially some measures were taken using a Røde USB microphone but it was found to be too difficult to maintain a standard recording distance so the sound level meter/microphone of the Wevosys system was used as it had a standard 30 cm operating distance. All measures analysed were recorded using the sound level meter/microphone.

Airflow measures were taken using an Aerophone II (F-J Electronics Copenhagen) which was attached to the same Toshiba Satellite Pro A120 laptop computer. Standard data acquisition techniques as per the Aerophone manual were used for the /a/ and /i/ vowels at modal pitch but the subjects were also asked to repeat these vowels one octave above modal pitch. Each subject's modal pitch was calculated based on the average pitch of their voice during the reading of a standard passage and on the pitch used for sustained vowels. This pitch was recorded and then a tone was played at this pitch for the modal pitch vowels. The subjects were then presented with a tone one octave higher than their recorded modal pitch for the vowels sustained at one octave above modal pitch. The subjects were requested to vocalise at a comfortably loud level.

The recording of *Caro Mio Ben* was made through the sound level meter/microphone combination that was used for Phonetogram acquisition. This system has a recommended operating distance of 30 cm which was used for all of the recordings.

## **Intervention**

Subjects in the control group had ten 45-minute sight singing sessions with the examiner. These sessions were taught in a group and followed the *New Approach to Sight Singing* (Please see below for structure and content of the sessions). Assessment and recording sessions were repeated towards the end of the academic term. Subjects in the

control group continued to receive the usual programme for student singers in their First or Second years including regular lessons with their assigned voice teacher. There were no limitations or restrictions placed on the teaching these students received. For example should their teacher have wished to provide some Accent Method style instruction as part of their weekly singing lesson, this would have been noted but would not have excluded the student from the study. In fact there were no instances of any Accent Method type instruction being given to the subjects in the control group.

Subjects in the experimental group received ten 45-minute Accent Method instruction sessions. The Accent Method was taught in a group situation with fifteen students in the group. The instruction they received was based on the Accent Method course that was taught to classical singing students in their second year at Queensland Conservatorium Griffith University by the examiner (this course of study has now been moved to the first year at Queensland Conservatorium Griffith University). There are slight modifications to classical Accent Method instruction, that in practice, have been found useful for developing appropriate abdominal support in singers. The structure and content of these sessions including the variations in content and rhythmic patterns are also detailed below.

Towards the end of the academic term both groups were reassessed using the same series of assessment tasks that were performed at the beginning of the term.

At a later date the recording of their song singing was presented to a panel of experts for judging. The two recordings of the song were randomised for each singer and presented to the panel as sample A and B. The experimental and control group samples were combined and randomised to help eliminate rater bias. The judges were asked to rate the samples based on an overall perception of the voice and voice production, just as they do when marking student singing examinations. The judges were asked to use a two-step process for judgement. Initially, they decided which sample they preferred, A or B. . Once a preference was expressed they used a simple two point scale: the preferred sample is slightly better than the non-preferred one (a score of 1) or the preferred sample is significantly better than the non-preferred one (a score of 2) to

assign an amount of preference. The judges recorded their preference; A or B, and the amount of their preference as 1 or 2 for later analysis.

### **Teaching Sequence for the Control Group (Sight Singing)**

The control group will receive 10, 45 minute sessions of instruction on sight singing.

This has been chosen as the activity for a number of reasons:

- The students will be singing/vocalising during the classes so they will assume that the classes have some vocal benefit.
- The use of solfeggi was an important part of the Bel Canto tradition, indeed some records of pedagogy of the time suggests that up to two years could be spent in the practice of these exercises. They appear to be primarily exercises in musicianship rather than singing technique however.
- Many singing students do have weaknesses in their sight singing ability so that these classes will be of some benefit to the development of their musicianship skills.
- These exercises can in no way be detrimental to their singing, unlike the teaching of some other breathing technique which could impact negatively on their singing technique.

The classes followed materials contained in *A New Approach To Sight Singing (3<sup>rd</sup> Edition)* (1986) by Berkowitz, Frontrier and Kraft. This approach has been used for some time at the Aaron Copeland School of Music at Queens College of the City University of New York and consists of five sections and a set of Supplementary Exercises. The Supplementary Exercises are a set of drills on intervals, scales and the development of a sense of tonality, where rhythmic patterns are also gradually increased in difficulty. Section One consists of melodies that gradually increase in complexity. The earliest sections (those that will be used in this programme) focus on the basic aspects of diatonic harmony using both the major and minor modes. Section Two consists of exercises with a simple piano accompaniment. The provision of the accompaniment not only provides the student with the experience of singing with a piano accompaniment but also the presence of the piano should help overcome intonational difficulties



(Berkowitz et al, 1986, p. 119). Section Three consists of Duets to give the student the experience of singing one part while listening to another, this assists both rhythmic and melodic precision (Berkowitz et al, 1986, p. 188). Section Four uses the concept of theme and variation to give the student the chance to sing more extended musical compositions while still moving from a melody that they establish prior to the use of the variations while Section Five consists of theme and variations for both voice and piano.

The programme of instruction is organised so that exercises from each of the sections are used concurrently. The authors note that there are more of the melodies than any other section as these will form the basis of the instructional programme but frequent use of the other sections serves to allow a variety of approaches to the subject, offers a desirable change of pace within the lesson and shows the student how skills acquired in one area can be applied to other musical situations (Berkowitz et al, 1986, p. x).

#### Session One

- Brief introduction to the programme and the reasons for choosing it.
- Explanation of the group and individual format.
- All exercises to be sung using the Solfeggio syllables. The ascending diatonic scale is as follows: Do, Re, Mi, Fa, Sol, La, Ti, Do.
- Group listens to, then sings Supplementary Exercise Nos 1 to 5 which focus on the major scale and the major triad using treble, alto and bass clefs in C, D and E $\flat$ .
- Each student then sings a melody from the Melodies Section at sight, with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies Nos 1 to 10 will be used for this session. These use only treble and bass clefs in the keys of F, G and E $\flat$  major.
- The students will sing as a group the Sing and Play exercise No 1 a few times until it is accurately rendered.
- Nos 1 and 2 from the Duets section will also be sung. Initially by the students with the group divided into two parts and then by the students in pairs.

- The first theme, from theme and variations section one, will be practised by all of the students as a group with variation I and II sung by the students individually.
- Students will be asked to practise the Supplementary Exercises and the Sing and Play exercise for homework.

### Session Two

- Revision of the Supplementary Exercises Nos 1-5 and of the Sing and Play exercise No 1 by the whole group.
- Group listens to and then sings the Supplementary Exercises Nos 6-9 which continue to focus on the major scale and triads in A $\flat$ , E $\flat$  and D, using the treble, alto and bass clefs.
- Each student then sings a melody from the Melodies Section at sight, with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies Nos 11-20 will be used, the latter of which emphasise movement within the tonic triad.
- As a group the students will sing the Sing and Play exercises Nos 2 and 3. These will also be sung individually if time permits.
- Nos 1 and 2 from the Duets section will be sung as a group. No 3 will also be sung initially as a group and then with the students in pairs.
- Theme No 1 will be revised and then the students will sing the five variations individually.
- The students will be asked to practise the Supplementary Exercises Nos 6-9 and the Sing and Play exercises Nos 1-3 for homework.

### Session Three

- Revision of the Supplementary Exercises Nos 6-9 and the Sing and Play exercise No 3.
- The group then listens to and sings Supplementary Exercise No 10 which aims to contrast major and minor keys.
- Each student then sings a melody from the Melodies Section at sight, with that melody then repeated by the whole group. Each student will sing at least two

melodies in the course of the session. Melodies Nos 21-30 will be used with a dotted rhythm introduced in No 30.

- The group will sing No 4 of the Sing and Play exercises.
- No 3 of the Duets section will be sung as a group with Nos 4 and 5 sung by the students in pairs
- Theme and variations one will be sung both individually and by the whole group.
- The first theme and variations one and two of the voice and piano variations will be performed by the whole group.
- Students will be asked to practise Supplementary Exercises No 10 and the Sing and Play exercise No 4 for homework.

#### Session Four

- Revision of the Supplementary Exercise No 10 and the Sing and Play exercise No 4
- The group listens to and then sings Supplementary Exercise No 11 which continues to focus on the differences between the major and minor scales.
- Each student then sings a melody from the Melodies Section at sight, with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies Nos 31-40 will be used. These continue to focus on the use of dotted rhythms.
- The group will sing Nos 5 of the Sing and Play section, which will also be used for some additional Duets singing practice.
- Nos 4 and 5 of the Duets section will be sung by the whole group with Nos 6 and 7 sung in pairs.
- Theme Two of the Theme and Variations section will be learnt by the whole group with the first and second variations sung by the students individually.
- The whole group will sing the theme first theme and all four of the variations for voice and piano.
- The students will be asked to practise Supplementary Exercise No 11 and the Sing and Play exercise No 5 for homework.

#### Session Five

- Revision of the Supplementary Exercise № 11 and the Sing and Play exercise № 5.
- The group listens to and then sings Supplementary Exercise № 12. This exercise continues to focus on major and minor but using the alto clef.
- Each student sings a melody from the Melodies Section at sight with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies №s 41-50 will be used. These melodies all use the alto clef.
- The group will sing №s 6 and 7 from the Sing and Play section
- The whole group will sing №s 6 and 7 of the Duets section with № 8 and 9 sung in pairs.
- The second theme with variations I and II from the Theme and Variations section will be sung by the whole group with variations III and IV sung by students individually.
- The whole group will learn the second theme from Themes and Variations for Voice and Piano.
- The students will be asked to practise Supplementary Exercise № 12 and №s 6 and 7 of the Sing and Play section for homework.

#### Session Six

- Revision of Supplementary Exercise № 12 and Sing and Play exercises №s 6 and 7.
- The group listens to then sings Supplementary Exercises №s 13, 14 and 15 where first and second time bars are introduced.
- Each student sings a melody from the Melodies Section at sight with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies №s 51 - 60 will be used. These melodies either use alto clef or are in minor keys.
- The group sings Sing and Play exercises №s 8 and 9.
- №s 8 and 9 of the Duets section will be sung by the whole group with №s 10, 11 and 12 sung by the students in pairs.

- The second theme and all five variations from the Theme and Variations section will be sung by the whole group and then by students individually, each student singing one variation alone.
- The whole group will sing the second of the themes from the Themes and Variations for Voice and Piano with students individually singing variations I and II.
- The students are asked to practise Supplementary Exercises Nos 13, 14 and 15 and the Sing and Play exercises Nos 8 and 9.

#### Session Seven

- Revision of Supplementary Exercises Nos 13, 14 and 15 and the Sing and Play exercises Nos 8 and 9.
- The group listens to and then sings Supplementary Exercises Nos 16 - 20 where compound time is introduced for the first time.
- Each student sings a melody from the Melodies Section at sight with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies Nos 61 – 70 will be used that focus on leaps within the tonic triad.
- The group then sings Sing and Play exercises Nos 10 and 11.
- The whole group revises Duets Nos 10, 11 and 12, with pairs of students singing Nos 13, 14 and 15.
- The second theme from Themes and Variations for Voice and Piano will be sung by the whole group with individual students singing each of the variations.
- The students are asked to practice Supplementary Exercises Nos 16 – 20 and Sing and Play exercises Nos 10 and 11 for homework.

#### Session Eight

- Revision of Supplementary Exercises Nos 16 – 20 and the Sing and Play exercises Nos 10 and 11.
- The group listens to and then sings Supplementary Exercises Nos 21 -24 where triplets are introduced.

- Each student sings a melody from the Melodies Section at sight with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies Nos 71 – 80 will be used. These melodies are all in compound time.
- Sing and Play exercises Nos 12, 13 and 14 will be sung by the whole group.
- Duets Nos 16, 17 and 18 will be sung by students in pairs and then repeated by the whole group.
- The whole group will learn the third theme from the Themes and Variations section with students singing variations I and II individually.
- The students will be asked to practise Supplementary Exercises Nos 21 – 24 and Sing and Play exercises Nos 12, 13 and 14 for homework.

#### Session Nine

- Revision of Supplementary Exercises Nos 21 – 24 and Sing and Play exercises Nos 12, 13 and 14.
- The whole group will listen to and then sing Supplementary Exercises Nos 25, 26 and 27 which focus on leaps.
- Each student sings a melody from the Melodies Section at sight with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies Nos 81 – 90 will be used. These melodies include rests for the first time.
- The whole group performs Sing and Play exercises Nos 15 and 16.
- Duets exercises Nos 18, 19 and 20 will be sung by students in pairs and then by the whole group.
- The whole group will sing the third theme and variations I and II from the Themes and Variations section with variations III, IV and V sung by students individually.
- The whole group will learn the third theme from Themes and Variations for Voice and Piano.
- The students will be asked to practise Supplementary Exercises Nos 25, 26 and 27 and Sing and Play exercises Nos 15 and 16 for homework.



## Session Ten

- Revision of Supplementary Exercises Nos 25, 26 and 27 and Sing and Play exercises Nos 15 and 16.
- The whole group listens to and then sings Supplementary Exercises Nos 28, 29 and 30.
- Each student sings a melody from the Melodies Section at sight with that melody then repeated by the whole group. Each student will sing at least two melodies in the course of the session. Melodies Nos 91- 100 will be used. These melodies start on either the 5<sup>th</sup> or the 3<sup>rd</sup> of the tonic chord, rather than on the tonic itself.
- The whole group performs Sing and Play exercises Nos 17 and 18.
- Revision of Duets Nos 18, 19 and 20 sung by the whole group.
- Duets exercises Nos 21, 22 and 23 will be sung in pairs and then by the whole group.
- The whole group will sing the third theme and all of the variations from the Theme and Variations section.

The third theme from the Themes and Variations for Voice and Piano will be sung by the whole group, with individual students singing the variations.

## Teaching Sequence for the Experimental Group (Accent Method)

### Session One

The classes begin with an explanation of the method, its anatomical correlates and how the classes will be structured.

- Students commence in an Alexander Technique semi-supine position, knees bent, feet flat on the floor and the head resting on a book. Students do not wear shoes for their AM classes and clothing such as that worn for movement classes is encouraged.
- Once in this position the arms are bent at the elbows so that the finger tips rest



on either side of the belly button. Students are encouraged to allow the weight of their shoulders, back and legs to 'fall' onto the floor (legs fall down onto the pelvis and through the feet).

- Students are encouraged to breathe quietly. In this position the body will automatically move into tidal breathing. Tidal breathing is the amount and type of breath that the body uses at rest, it is ALWAYS abdomino-diaphragmatic in type and no upper chest movement will be seen.
- Students are encouraged to feel this breath both with the fingers and internally.
- Students are then reminded that most of the respiratory muscles are under our voluntary control so it is possible for them to take charge of this abdominal breathing.
- A voluntary in breath is taken with the students reminded to only use the abdominal expansion as seen in the tidal breath.
- The out breath is a gentle sigh (unvoiced) and again the action of the abdomen is focused on.
- Once this is established a slightly deeper breath is requested but again the focus should be on the abdominal excursion. At this point one hand is moved to the lower ribs so that the students can feel the expansion at this point.
- The action of the diaphragm is raised and its tendency to pull the lower ribs out as it descends is emphasized.
- Students are now reminded that the abdominal muscles we want to use for supported respiration are under our voluntary control. This is demonstrated by having them raise and lower the bellybutton without taking a breath. The students are then asked to raise and lower the chest without taking a breath and

without using back or arm muscles. This clearly demonstrates that whilst the ribs may be active during respiration, we cannot control them voluntarily so they are not an appropriate site for breath management.

- Expiration on fricatives is commenced with the students encouraged to feel how the abdominal wall moves as the fricatives /s, ʃ, f and θ/ are sighed out.
- Voiced fricatives /z, ʒ, v, ð/ are then attempted with the students reminded not to grip with the neck or upper chest once voice is added. The use of a breathy sigh will ensure this is correct.
- Students are then asked to go back to tidal breathing. In this state they should be able to identify a “tummy neutral” position where there is little or no muscle activity in the abdominals. (They are not acting to stabilise or have a postural support function when lying in semi supine). This is a conceptual rather than a real position since as soon as the muscles begin to have a postural function tummy neutral does not exist! Development of this concept is vital however as it provides a “target” to release towards during the later rhythmic exercises.
- Students are then asked to sit in a chair and using good postural alignment to gently sigh all the fricatives used. Activation of the abdominal muscles is required and the navel should move towards the spine.
- Gently sighing of all the fricatives can also be practised in the standing position with care again taken to ensure good postural alignment.
- Students are asked to practise for 10 to 15 minutes daily.

#### Session Two:

- Material from the previous session is revised and practised. Much of this session is also spent on the floor to encourage correct breathing patterns and to promote

good postural alignment.

- In addition to the fricatives that are gently expired the use of a breathy /w/ and the close front vowel /y/ is also introduced, this allows a more vowel like vocalization.
- To develop strength for support a more vigorous abdominal movement is required and students are asked to ‘waste’ the air, getting the air out as quickly as possible by pulling the tummy muscles in (ie belly button to the floor when lying on the back). This is done on voiceless /f/ and then voiced /v/ sounds. It is important to ensure that the air flow through the voiced fricatives remains high, that no constriction occurs in the neck and that no excessive tension occurs in the shoulders and upper chest. This is a deviation from traditional or classical Accent Method where this vigorous use of the abdominal muscles for expiration is not specifically taught. This step has been added into the teaching sequence to ensure an early and explicit connection between the use of abdominal musculature and the notion of support. This is consistent with the pedagogy of Janice Chapman as detailed in her 2012 book.
- At this point the students roll onto their sides one hand under their ear still resting on their books. The knees can be bent or straight – whichever the student finds most comfortable. This side lying position exerts a gravitational advantage on the in breath but requires more abdominal work on the out breath. SPLAT is taught in this position. SPLAT is a term coined by Janice Chapman to refer to the rapid in-breath required for singing. It is now also described as an acronym Singers Please Loosen Abdominal Tension (SPLAT)
- Students breathe in (tummy out) and then ‘waste’ the air (vigorous tummy

movement) usually on /j/ at first. They are then required to maintain the muscle tension in the abdominal wall (resting on empty) until asked to release it. In this position the abdominal wall falls quickly out during the next inspiration allowing the breath to quickly flow into the lungs. This 'release and breathe' phenomenon is SPLAT where the in breath is actually almost unconscious and the diaphragm is allowed to descend freely and rapidly.

- This manoeuvre is practised with all the fricatives both voiced and unvoiced and with the semi vowel and close vowel as before, with the students 'resting on empty' in between. The drum may be used to keep the class together if required.
- The students return to the semi-supine position and repeat the SPLAT manoeuvre using all the fricatives again. It is usually important to note that the gravitational advantage in semi-supine is for the out breath not the in breath so the SPLAT will be smaller in this position. SPLAT is not an active distension of the abdominal wall merely a release of the abdominal muscles from their engaged position during expiration.
- The students are then moved to a sitting posture and the SPLAT manoeuvre is repeated with the 'waste' of air on all of the fricatives. Good postural alignment in the chair is vital if the breathing exercises are to be done properly. The student must sit with feet flat on the floor, backside firmly on the seat while the back does not rest on the chair's back rest but springs upward. Chest is open, not collapsed and the head and neck should be straight and well aligned. Once again the posture required for sitting in the Alexander Technique is ideal.
- Care must be taken in the more upright positions of sitting and standing that the chest does not collapse as the abdominal musculature releases in the SPLAT.

The chest should remain in a slightly elevated position driven by posture (Bunch)

- One hand is placed on the belly button and one on the chest and tidal breathing is started. Care must be taken that only abdomino-diaphragmatic breathing is used as a return to a more upright posture may encourage return of old, inappropriate breath habits
- Once breathing is correctly established in the sitting position the student is asked to stand and repeat both tidal breathing and wasting of air on all of the fricatives.
- In the standing position it is possible to identify the principal muscle junctions that represent support. Janice Chapman refers to a 'diamond' of support that can be felt at the sides (Waistbands), pelvic floor (Lower Abdominal Pubic Synthesis) and just below the Xyphoid process (Chapman 2012). It is also possible to identify the 'Collar Connection' which is an interaction of muscle and breath that can be seen in the throat (Chapman 2012).
- Students are encouraged to practice their new breathing patterns for 15 minutes each day.

### Session Three

- Material from the previous two sessions are revised and practised.
- The new concept of the first accent bounce (the initial accentuation) is introduced on the floor. Students are required to produce an accentuated sound by increasing abdominal effort (e.g. /s-S/).
- The students are required to breathe in as they have before using a SPLAT breath, so one breath in, but two abdominal movements are used to expel the air. The air must continue to flow, though at a reduced rate and pressure,

between the beats (accentuations)

### 1st Accent Bounce



Figure 8

#### *Study patterns First Accent Bounce*

- This is practised with all the sounds used thus far, with side lying position used first as it is often easier to ensure the correct movement and air flow on the side. Activity in the waistband support junction can also be more easily felt in this position.
- Once the movement is well established on the side the student is asked to repeat the movement in the semi-supine position.
- Body movement is also introduced for the first time at the level of the first accent bounce.
- The students stand in pairs beside each other rather like skaters or dancers on foot in front of the other. They then begin swaying with the shift in the centre of gravity generated by their tidal breathing pattern. This swaying movement is also enhanced by increasing the excursion of the sway and ensuring that the hips release during each excursion. As the student sways forward the front knee bends and the pelvis aligns slightly forward and under.

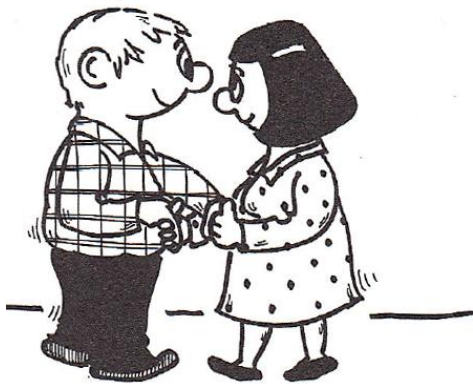


**Figure 10.3** Clinician and client perform the exercises together with the same rhythm and simultaneous movements

Figure 9

*Diagram of Side by Side Swaying from Thyme-Frøkjær, K. & Frøkjær-Jenson, B. 2001, p 105*

- The students then produce sounds, with the silent in-breath as they sway forward and the out breath with the appropriate abdominal movement and sound as they sway back. All of the sounds used thus far are vocalized both singly and in the first accent bounce pattern.
- The swaying is also carried out with the students in pairs, facing each other. This aims to promote a more rapid in-breath via the SPLAT as in this position the cycle of breathing in and breathing out is more rapid.



**Figure 10.4** Turntaking by clinician and client

Figure 10

*Diagram of Face to Face Swaying from Thyme-Frøkjær, K. & Frøkjær-Jenson, B. 2001, p 105*

- The students are then asked to move to the chair where both the single and first accent bounce patterns are practised with all the sounds. Care must again be taken that postural alignment remains good and that the action of the abdominal muscles for both the in and out breaths do not distort or compromise good postural alignment.
- Practice is also carried out whilst standing for both the single and first accent bounce patterns and the support muscle junctions are again identified.
- Students are requested to practise these exercises for 10 to 15 minutes at home each day.

#### Session Four

- Revision and practice of the previous sessions' work is carried out.
- The students practise all of the fricatives singly and at the first accent bounce on the floor and swaying.
- The first tempo of drum patterns 'Largo' is introduced. This is introduced with the students lying on their sides on the floor. The tempo is initially very slow (around 58 beats per minute).



Largo

The image shows two musical staves for a 'Largo' tempo. The top staff is for Tenor (T) and the bottom for Soprano (S), both in 3/4 time. The first measure shows a quarter note followed by a half note. The second measure shows a quarter note, a quarter note, and a half note. The third measure shows a quarter note, a quarter note, and a half note. The fourth measure shows a quarter note, a quarter note, and a half note. The fifth measure shows a quarter note, a quarter note, and a half note. The sixth measure shows a quarter note, a quarter note, and a half note. The seventh measure shows a quarter note, a quarter note, and a half note. The eighth measure shows a quarter note, a quarter note, and a half note. The ninth measure shows a quarter note, a quarter note, and a half note. The tenth measure shows a quarter note, a quarter note, and a half note. The eleventh measure shows a quarter note, a quarter note, and a half note. The twelfth measure shows a quarter note, a quarter note, and a half note. The thirteenth measure shows a quarter note, a quarter note, and a half note. The fourteenth measure shows a quarter note, a quarter note, and a half note. The fifteenth measure shows a quarter note, a quarter note, and a half note. The sixteenth measure shows a quarter note, a quarter note, and a half note. The seventeenth measure shows a quarter note, a quarter note, and a half note. The eighteenth measure shows a quarter note, a quarter note, and a half note. The nineteenth measure shows a quarter note, a quarter note, and a half note. The twentieth measure shows a quarter note, a quarter note, and a half note. The notation includes 's' and arrows indicating breath or articulation points.

Figure 11

Largo Patterns used in the study

The rhythmic patterns used in the Largo tempo differ slightly from those described by Thyme- Frøkjær (2001) having a shorter rest prior to the next up-beat. There is also a longer pattern more similar to that of the first accent bounce included

- The students ‘rest on empty’ while the teacher vocalizes, then in rhythm, they respond with the pattern. A single SPLAT in breath is taken and the abdominal muscles pulse, maintaining the airflow between the accentuations.
- All of the sounds used thus far are practised. Initially each pattern is practised with each of the fricative sounds, once well established the patterns and fricatives are varied to assist in the development of flexibility.
- Once the rhythmic patterns are well established they are practised with the students sitting in a chair and then standing up.
- Arm movements are added for the first time, in the standing position.

- Students stand with feet shoulder width apart, knees unlocked in good postural alignment. A pattern of 3 beats with one beat of rest is used (Largo pattern for movement). The students SPLAT the in-breath and then three equal out-breaths are used. The airflow must continue between the outward pulses as is done with the first accent bounce and Largo patterns, /∫/ are usually used until the patterns are established. Once the abdominal movements and the breath flow are correct the arms are added, right, left and together. The arm movement is a gesture from the centre of the body outwards so that the movement finishes palm up.

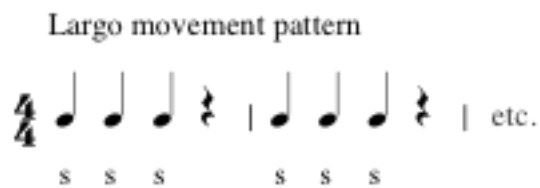


Figure 12

*Study patterns Largo Movement*

- All the sounds are practised with arm movements.
- Students are introduced to the 'cool down' phase for the first time. In the chair, Largo patterns are again used, followed by first Accent bounce and then wasting of air.
- Students are requested to practise their Accent exercises for 15 to 20 minutes daily.

Session Five:

- Revision of the floor position, wasting of air and the first accent bounce are performed fairly quickly. Largo patterns are revised on the floor in the side lying position.
- Swaying, both side to side and face to face are practised with single sounds and with the first Accent Bounce.
- Movement using the Largo pattern for movement, as before is practised and then a stepping leg movement is also added. Right arm, right leg, left arm, left leg, both arms, right leg. This is carried out with all the fricatives, semivowel and vowel standing on one spot, before the students are asked to step out and move around the room.
- These stepping and arm movements aim to challenge the students' core stability and to ensure that their breath management is not disturbed or altered by the addition of movement.
- The students then move to the chair where Largo patterns are practised.
- The second tempo 'Andante' patterns are introduced, using fricatives and the /w/ and /y/ sounds. Andante patterns (at about 68 beats per minute) are practised in the chair until stable.

Andante Pattern

Similarly

Figure 12

*Study Patterns Andante*

- Additional patterns in Andante tempo are also added. These have a sub-division of the first two beats of the bar as well as an additional pattern with a long minim as the first two beats of the bar
- Largo and Andante patterns are then practised standing up.
- Cool down again occurs in the chair from Andante through Largo and first Accent Bounce to wasting of air.
- Connections to singing exercises are commenced with the students practising voiced fricatives and fricatives releasing to vowels on single pitches in a comfortable middle part of the voice. Correct connection to the support

junctions are described and monitored both by the student and the teacher.

- Students are requested to practise their Accent exercises for 15 to 20 minutes daily.

Session Six:

- A brief revision of floor positions, wasting of air and the first Accent Bounce are performed. Largo patterns are also practised in the side lying position of the floor.
- Swaying, side to side and face to face are practised with single sounds and first Accent Bounce patterns.
- Largo pattern arm and leg movements are practised using all of the fricatives and /w and y/.
- An Andante pattern for movement is introduced consisting of a 6 beat pattern, 4 beats of vocalization and 2 of rest.

Andante movement patterns



Figure 14

*Study Patterns Andante Movement*

- Once this pattern for movement is established marching feet (right, left, right, left etc) are introduced. The feet continue throughout the entire 6 beats but the breathing and therefore the abdominals have 2 beats of rest.

- Once the movement of the feet are well established marching arms are added and all of the sounds are practised whilst marching on the spot. Finally movement around the room is added.
- The students then go to the chair to practise all of the patterns learnt thus far.
- No new patterns are introduced in this session but vowel sounds other than /y/ are used for the first time. Vowels are released from a voiced fricative on the last beat of the Largo patterns. Support and airflow through the vowel should be the same as through the voiced fricative alone and can be easily monitored at the support junctions by both teacher and student. The five cardinal Italian vowels (/i, e, a, o and u/ are used, released from the voiced fricatives /z, ʒ, v and ð/ and the semi vowel /w. Once this is well established vowels and diphthongs from other languages including English are used.

Largo release to vowels

z z zah  
z z zee

z z z zah  
etc.

z zah →

Figure 15

*Study Patterns Largo Release onto Vowels*

- Andante patterns are practised with the fricatives and with /w and y/. Both Largo and Andante are practised both sitting and standing.
- Cool down occurs again in the chair moving through Andante, to Largo with vowel release, to Largo with fricatives, first Accent Bounce and finally wasting air.
- Connection to singing continues with the use of fricative-vowel syllables on single pitches and over a pentatonic scale. Students are encouraged to feel support at the abdominal support junctions as the abdominal wall continues to move inwards. Janice Chapman's 'Hey-Hah' exercise is also introduced.

## Exercise

1. Stand well with hands firmly on waistband muscle junctions.
2. Shout “hey” as if to someone across the street noticing the bulking up of the muscle junction.
3. Sing “hey-ha” on single pitch repeated though a comfortable range checking for full release between each sung note. (i.e., the waistband muscles must disengage).

### “Hey-Ha” exercise



Figure 16

*Chapman's Hey Hab Exercise from Chapman, 2006, p.270 & 271.*

- 15 to 20 minutes of daily practice is again requested.

### Session Seven:

- Revision of the early sessions is now quite brief, but a few minutes are spent on the floor revising first Accent bounce and Largo patterns both in semi-supine and side lying positions.
- Work continues with swaying and arm and body movements as describes above before moving to the chair for pattern practice.
- Largo patterns are practised with fricative babble using any combination of voiced fricative consonant or /w/ plus the vowel.



**Largo Fricative Babble**

zah zah zah  
etc.

Figure 17

*Study Patterns Largo Fricative Babble*

- Andante patterns are practised with release onto vowels from a voiced fricative (as described above for the Largo patterns).

**Andante patterns release to vowels**

z z z zah  
similarly with other andante patterns

Figure 18

*Study Patterns Andante Release to Vowels*

- The final tempo Allegro (about 80 beats per minute) is introduced with fricatives and the sounds /w/ and /y/.

### Allegro Pattern



Figure 19

### *Study Patterns Allegro*

- This is practised in the chair and once stable used in a standing position.
- Marching is practised at two speeds, around 65 beats per minute and around 75 beats per minute.
- Cool down again occurs in the chair moving backwards from Allegro to waltzing of air on fricatives.
- Connection to singing is now using syllables over the whole octave. Glides on fricatives are introduced to encourage connection to the low support muscles. Semi-occluded vocal tract tasks such as rolled /r/ are introduced.

4. Sing up a major scale “hey” (release) “ha” (release). On the ascending scale, each note of the scale activates the support and each rest indicates the release. On the descending scale the support is maintained under a single “hah” with the release after the end of the phonation (see Figure 4-4).

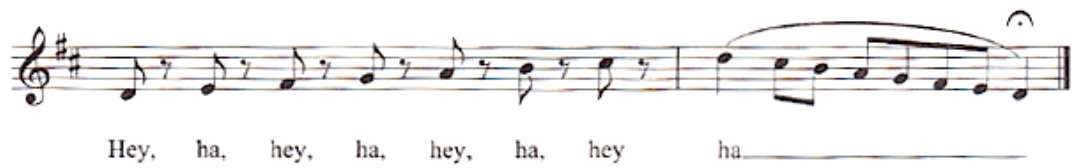
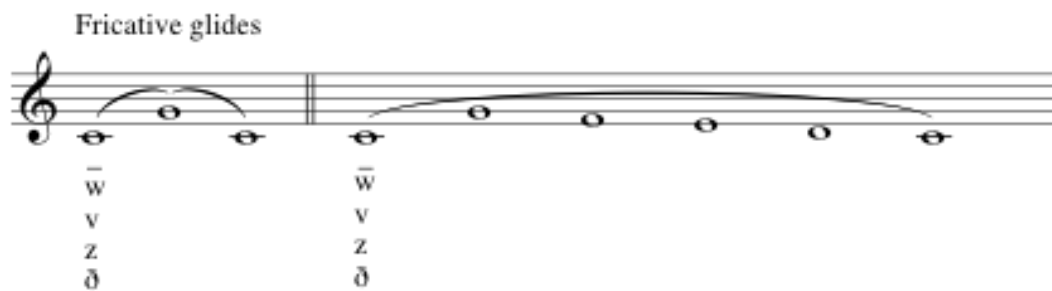


Figure 20

*Chapman's Hey Hab Exercise from Chapman, 2006, p.270 & 271.*



Throughout comfortable vocal ranges for all singers.

Figure 21

*Fricative Glide Exercise*

1. Unvoiced trilled “r” on a single sustained breath:  
This should be a light unvoiced tongue flutter without phonation being engaged. This promotes airflow and tongue flexibility.
2. Add modal voice with easy glides:  
The goal is to have similar airflow and tongue flexibility with phonation engaged. Singers with excessive tension in the the speaking voice or in the articulators may find this stage difficult. Deficits in airflow and tongue flexibility should be addressed at this point with additional work on support. For singers who appear to have physical articulatory restriction the opinion of a speech therapist should be sought.
3. Scale of an octave + 1 (9th scale):  
Starting at the bottom of the vocal range sing scales of an octave +1 up and down while maintaining the “lightness” of tongue use and easy phonation.

- Tongue root and floor of mouth tension should be checked by a thumb under the chin. There should be no downward pressure of the floor of the mouth.
- Phonation should be easy and free. Pressed phonation must be avoided.
- Support must be engaged throughout the exercise. Particular emphasis should be placed on the downward scale as support is more likely to disengage in this portion of the exercise.
- The abdominal wall should be soft and flexible throughout.
- The mouth and the muscles of facial expression (especially the obicularis oris) must be free of tension. Tension in the face and lips can refer through to the floor of the mouth and then into the base of the tongue and the larynx creating a bottled tone.

Rolled “r” scale



Full pitch range all voices.  
Gradually extended up to 4 or 5 scales in one breath over time.

4. Sing the scales with the tonic ascending in semitones.  
These scales can be taken upward safely into the extreme top of the range.

Figure 22

- Once again, daily practice of 15 to 20 minutes duration is requested.

Session Eight:

- Revision of the early sessions is again quite brief, but a few minutes are spent on the floor revising first Accent bounce and Largo patterns both in semi-supine and side lying positions.
- Some work with movement, including swaying both side by side and face to face, arm and leg movements in Largo and marching in Andante is carried out.
- In the chair, Largo patterns are practised with syllable babble where any consonant is combined with any vowel. This ensures that the air flow and connections achieved with fricatives are carried to other consonant sounds. Stops, glides and nasals are all used and any monothong vowel or diphthong is used. Vowels and consonants may now vary within a single rhythmic pattern.

Largo Pattern any consonant



Figure 23

*Study Patterns Largo Babble with any Consonant*

- Andante patterns are practised in the chair with fricative babble similar to the fricative babble used in Largo



Figure 24

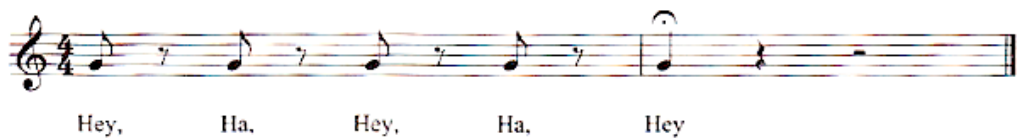
*Study Patterns Andante Fricative Babble*

- A small number of Allegro patterns are practised with release onto vowel sounds from voiced fricatives.
- Cool down occurs as before.
- Connection into singing continues with the octave syllable exercises extended

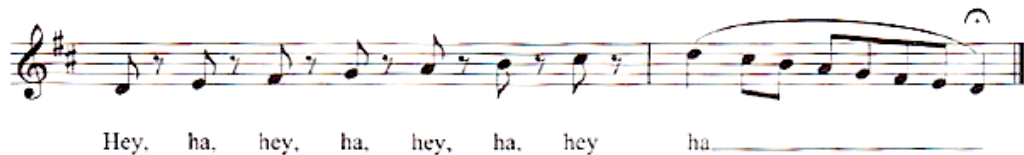
## Exercise

1. Stand well with hands firmly on waistband muscle junctions.
2. Shout “hey” as if to someone across the street noticing the bulking up of the muscle junction.
3. Sing “hey-ha” on single pitch repeated though a comfortable range checking for full release between each sung note. (i.e., the waistband muscles must disengage).

### “Hey-Ha” exercise



4. Sing up a major scale “hey” (release) “ha” (release). On the ascending scale, each note of the scale activates the support and each rest indicates the release. On the descending scale the support is maintained under a single “hah” with the release after the end of the phonation (see Figure 4-4).



**NOTE:** The impulse for the engagement of this muscle junction must be the movement of the belly wall toward the spine, as occurs in primal sound-making (see Chapter 4 on Breathing and Support). It is possible for singers to consciously “flare” the waistband muscles, but this can become a counterproductive maneuver if it is not allied to breath flow.

5. Repeat step 4, but add as many scales on the legato “ha” as the student has air for. This trains the system to achieve more strength and flexibility.

Figure 25

*Chapman’s Hey Hab Exercise from Chapman, 2006, p.270 & 271.*

- Glides and semi-occluded vocal tract exercises are practised over more extended ranges (i.e the 9<sup>th</sup>).

- Students are again requested to practise for 15 to 20 minutes daily.

Session Nine:

- A brief revision of the floor work is carried out.
- Swaying both side to side and face to face is practised with both single fricatives and with the first Accent Bounce.
- Release from a voice fricative to vowels is also introduced during the side by side swaying

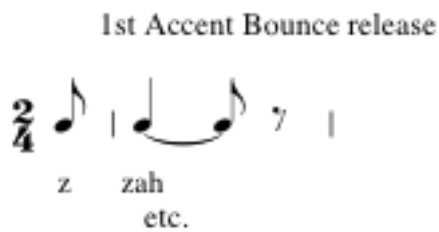


Figure 26

*Study Patterns 1<sup>st</sup> Accent Bounce Release to Vowels*

- Practice of arm, leg and body movements continues with patterns in both Largo and Andante tempi.
- Whilst standing work with arms extended, bent at the elbow with the elbow held at shoulder height is introduced. This ensures an appropriate slightly elevated chest posture throughout the whole breath cycle. This exercise helps the student to develop rapid flexible in-breaths that do not disturb the overall singing posture.
- In the chair all the patterns are practised with consonant and vowel syllable





### Vowel Legato

The image displays a musical score for a 'Vowel Legato' exercise. It consists of three systems of music, each with a vocal line and a piano accompaniment. The key signature is one flat (B-flat) and the time signature is 4/4. The first system (measures 1-5) features the vocal line singing the vowels 'a', 'e', 'i', 'u', and 'o' on a series of notes, with the piano accompaniment providing harmonic support. The second system (measures 6-11) continues with the vocal line singing 'a', 'e', 'a', 'a', 'e', and 'i'. The third system (measures 12-17) concludes with the vocal line singing 'u', 'o', 'a', 'e', and 'a'. The piano accompaniment throughout consists of chords and moving lines in both hands, often using slurs to indicate legato playing.

Figure 28

*Chapman's Vowel Legato Exercise from Chapman, 2006, p. 279.*

- Students are again requested to practise for 15 to 20 minutes daily.

Session Ten:

- No new work is added in this final session.

- All patterns are practised with syllable babble and Largo and Andante patterns are also practised with exclamations.
- Isolated vowel sounds and pitch intonations are also integrated into some of the patterns.
- All forms of movement exercises are revised to ensure that the student is able to use the correct breathing pattern in a variety of postures and situations.
- Cool down occurs as before.
- Connection into singing exercises are carried out as for Session Nine.
- Students are again requested to practise for 15 to 20 minutes daily.
- At this final session students are also reminded to use some Accent Method exercises as part of their daily warm up routine even if they no longer do 15 to 20 minutes of dedicated Accent Method practice each day.

### **Study Participants**

30 Subjects were initially enrolled in the study, divided randomly into two groups, Control and Experimental groups with 14 and 15 participants in each group respectively following the selection process. There were no drop outs from the Experimental group but there was one drop out from the Control group and one other of the control group was not able to complete all of the airflow tasks at the second testing session in March due to illness. The drop out from the Control group occurred early, with the participant not attending any of the intervention sessions planned for this group. This participant also could not be contacted to perform the final assessment so those results have been eliminated from the study, though they have been used when the whole group was analysed at the initial assessment point (January)

## Data Management and Analysis

The results of the data collection were analysed using the SSPSV19. In addition to descriptive analyses (e.g. Frequencies, Descriptives and Crosstabs), Paired and Independent t-tests and Chi-Squared tests were used to assess if there were significant differences between the Experimental and Control groups.

The results are presented to 2 decimal places for means and standard deviation and to 3 decimal places for the results of statistical tests such as  $t$  values and significance. In carrying out Statistical Analyses, 2-tailed tests of significance were used, assessing whether differences were noted. Significance was set at  $\alpha=0.5$  with the following used to indicated significance level: \*  $p < .05$ ; \*\*  $p < .01$  and \*\*\*  $p < .001$ .

## Chapter Six Results

The results have been divided into the four areas relating to the measurements being taken, as detailed in Chapter 5 to facilitate easy presentation: Maximum Phonation Times, Aerodynamic studies, Phonetograms and Perceptual Judgements. Results are presented by Control and Experimental group in most instances but for some situations the total group is considered.

Following the participant selection process 29 participants were included in the study – 14 in the Control group and 15 in the Experimental group. It should be noted that one participant from the Control group was not able to participate in all of the final assessments.

A consideration of the demographics and the vocal function characteristics of the participants by group was then carried out to assess any differences between the two groups. These results are presented in Tables 1 and 2 below.

Table 1 *Demographics*

Group/Demographic	Control	Experimental
Age Range	18 - 23	18 - 25
Males	6	7
Females	8	8
First Year	6	9
Second Year	8	6

The demographic characteristics of the two groups are essentially balanced (Table 1) although there are three more first year singers in the Experimental group ( $N = 29$ . Control:  $n = 14$ . Experimental:  $n = 15$ ).

Table 2 *Assessment levels for different measures for the Control and Experimental group at initiation with differences assessed using Independent t-tests.*

Measurement	Group	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig. (2-tailed)
MPT /a/	Control	20.33	6.01	1.240	27	.226
	Experimental	17.94	4.30			
MPT /i/	Control	23.34	6.86	2.081 *	27	0.47
	Experimental	18.93	4.37			
Av DR	Control	21.56	5.90	-.020	27	.984
	Experimental	21.61	6.32			
Max Semi	Control	37.57	3.48	1.631	27	.115
	Experimental	35.73	2.55			
MFR /a/	Control	155	69	-.170	26	.866
	Experimental	159	55			
MFR /a/8va	Control	243	77	-.585	26	.564
	Experimental	265	117			
MFR /i/	Control	153	74	-.732	26	.471
	Experimental	171	54			
MFR /i/8va	Control	223	72	.088	26	.931
	Experimental	220	104			

Note. MPT = maximum phonation time in seconds, Av DR = average dynamic range in decibels, Max Semi = maximum number of semitones sung, MFR = mean flow rate in mls/sec, 8va = one octave above modal pitch. \* =  $p < .05$ .

A *t*-test for equality of means was then performed to identify any significant differences between the two groups regarding vocal function characteristics. There was only one significant difference identified. The MPT of the /i/ vowel was longer in the control group than in the experimental group at the  $p < .05$  level of significance. All other pairs of results evaluated showed no significant differences and the groups were felt to be appropriately randomised and equivalent prior to the experiment.

## Maximum Phonation Times

Maximum phonation times (MPT) were recorded in two ways. Initially the subjects were requested to take a breath and sustain the required vowel for as long as possible, at a comfortable level of loudness, with the recording being made via a standard microphone. MPTs were also recorded during the Mean Flow Rate (MFR) assessment, as they are vital to the calculation of the MFR. These MPTs were taken via the Aerophone II face mask. The instructions were the same, i.e. take a breath and sustain the required vowel for as long as possible at a comfortable level of loudness, but it was immediately obvious from observations during the data collection that there were

differences between the two methods of recording and so both acquisition methods are detailed below separately (Tables 3 and 4).

Table 3 *Maximum Phonation Times in Seconds via the Microphone for recordings /a/ and /i/, with results from paired t-tests assessing difference across the intervention*

Group/Task	Mean	SD	t	df	Sig. (2-tailed)
<b>Control</b>					
/a/ Pre	20.33	6.01	-1.561	13	.142
/a/ Post	22.22	7.02			
/i/ Pre	23.34	6.86	-.706	13	.493
/i/Post	24.18	6.91			
<b>Experimental</b>					
/a/ Pre	17.94	4.30	-.255	14	.803
/a/Post	18.19	3.91			
/i/ Pre	18.93	4.37	-.933	14	.366
i/ Post	19.63	4.87			

Note. Pre = January (pre-intervention), Post = March (post-intervention).

There were no significant differences observed post-intervention using the microphone within either the Control or Experimental Groups. Both groups showed a slightly longer phonation time post-intervention than at the initial assessment but these differences were not statistically significant. Analysis of the results between groups showed a longer phonation time for the /i/ vowel in the control group at the post-intervention recoding, ( $t = 2.058$ ,  $df = 27$ ,  $p = .049$ ). This difference is very similar to that observed between the two groups pre-intervention and suggests that the difference seen on initial assessment has continued to exist.

Table 4 *Maximum Phonation Times in seconds via the Aerophone II Face Mask for recordings /a/ and /i/, with results from paired t-tests assessing difference across the intervention*

Group/Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig. (2-tailed)
Control					
/a/ modal Pre	16.39	6.56	-.645	12	.531
/a/ modal Post	18.26	9.12			
/i/ modal Pre	18.27	7.96	-.260	12	.799
/i/ modal Post	19.03	8.35			
/a/ 8va Pre	12.08	5.84	-.776	12	.453
/a/ 8va Post	13.88	4.86			
/i/ 8va Pre	12.03	5.71	-1.044	12	.317
/i/ 8va Post	15.30	5.53			
Experimental					
/a/ modal Pre	13.01	3.36	2.420 *	14	.030
/a/ modal Post	10.35	2.83			
/i/ modal Pre	13.66	4.24	2.412 *	14	.030
/i/ modal Post	10.37	3.40			
/a/ 8va Pre	10.93	4.39	2.350 *	14	.034
/a/ 8va Post	8.06	3.07			
/i/ 8va Pre	11.70	4.26	2.599 *	14	.021
/i/ 8va Post	8.35	3.44			

Note \* =  $p < .01$

When assessing using the face mask there were no significant differences in the control group between the two testing points but in the experimental group MPT was significantly shorter on all of the assessment tasks post-intervention when compared to the initial pre-intervention assessment (significant at the  $p < .05$  level).



Significant differences were also seen when comparing the control and experimental groups at the post-intervention assessment. This is to be expected given the significant differences in the experimental group's results at this assessment. Results from *t*-tests for the equality of means at the post-intervention assessment are as follows: Modal /a/;  $t = 3.440$ ,  $df = 27$ ,  $p = .002$ ; Modal /i/;  $t = 3.971$ ,  $df = 27$ ,  $p = .000$ , /a/ 8va;  $t = 4.118$ ,  $df = 27$ ,  $p = .000$  and /i/ 8va;  $t = 4.098$ ,  $df = 28$ ,  $p = .000$ . These results confirm shorter MPPT for the experimental group via the Aerophone II face mask post-intervention.

This difference was then explored across all subjects at the two time periods (Table 5.

Table 5 *Differences in Maximum Phonation Times by Acquisition Method in Seconds for all Subjects*

Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
/a/ Pre Mic	18.99	5.31	3.961 ***	27	.000
/a/ Pre Mask	14.58	5.28			
/i/ Pre Mic	20.91	6.09	4.201 ***	27	.000
/i/ Pre Mask	15.80	6.55			
/a/ Post Mic	20.13	5.89	3.513 **	28	.002
/a/ Post Mask	14.36	7.64			
/i/ Post Mic	21.83	6.27	4.506 ***	28	.000
/i/ Post Mask	14.83	7.73			

Note. Pre = Pre-intervention, Post = Post-intervention, Mic = standard microphone, Mask = Aerophone II face mask, \*\* =  $p < .01$  level, \*\*\* =  $p < .001$

Assessment of the whole group (Table 6) indicates that maximum phonation times were significantly shorter for both vowels and for both testing points when acquired via the face mask of the Aerophone II system than by the microphone – confirming the initial assessment of the difference in results by the two acquisition methods.

Table 6 *Differences between the Maximum Phonation Times in Seconds by Octave for all Subjects using the Face Mask*

Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
/a/Modal Pre	14.58	5.05	4.764 ***	27	.000
/a/ 8va Pre	11.46	5.28			
/i/ Modal Pre	15.80	6.55	3.712 **	27	.001
/i/ 8va Pre	11.98	4.90			
/a/ Modal Post	14.36	7.64	4.008***	28	.000
/a/ 8va Post	11.01	5.01			
/i/ Modal Post	14.83	7.73	4.373 ***	28	.000
/i/ 8va Post	11.70	5.71			

Note \*\* =  $p < .01$  level, \*\*\*  $p < .001$

Assessment of the whole group indicates that maximum phonation times were significantly shorter for both vowels at both testing points at one octave above the modal pitch. These MPTs were all taken via the face mask of the Aerophone II system as MPT via the microphone was only acquired at modal pitch.

## **Aerodynamic Studies**

The normative values for mean flow rates (MFR), taken in a steady state vowel /a/ at modal pitch, have been reported by Thyme- Frøkjær (2001) as 120 ml/sec  $\pm$  20, giving a normal range of 100 to 140 ml/sec. Initial assessment of the subjects in this study suggested a significantly higher value as can be seen below in Table 7.

Table 7 Mean Flow Rate in Millilitres per Second for all the Subjects Pre and Post Intervention

Condition	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
/a/ Modal Pre	152	57	-5.069***	26	.000
/a/ 8va Pre	254	101			
/i/ Modal Pre	159	61	-3.515 **	26	.002
/i/ 8va Pre	222	90			
/a/ Modal Post	168	50	-6.845 ***	27	.000
/a/ 8va Post	248	74			
/i/ Modal Post	176	63	-3.271 **	27	.003
/i/ 8va Post	224	83			

Note. \*\* =  $p < .01$ , \*\*\* =  $p < .001$

MFRs were significantly higher in the whole group than those reported by Thyme-Frøkjær (2001). The averages reported for the whole group are higher at both the pre and post-intervention assessments.

MFRs were significantly higher for the vowels sung one octave above modal pitch. This difference occurred at both assessment points. There were no significant differences between the /a/ and /i/ vowels however.

Table 8 Mean Flow Rates in Millilitres per Second Experimental and Control Groups Pre and Post Intervention

Group/Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
Control					
/a/Modal Pre	155	70	-1.271	12	.228
/a/ Modal Post	183	62			
/i/ Modal Pre	154	75	-1.431	12	.178
/i/ Modal Post	189	73			
/a/ 8va Pre	243	77	-.066	12	.949
/a/ 8va Post	251	79			
/i/ 8va Pre	223	72	-.738	12	.475
/i/ 8va Post	247	93			
Experimental					
/a/ Modal Pre	159	55	-.421	14	.680
/a/ Modal Post	163	52			
/i/ Modal Pre	171	54	-.189	14	.853
/i/ Modal Post	173	62			
/a/ 8va Pre	265	117	.429	14	.674
/a/ 8va Post	254	77			
/i/ 8va Pre	220	104	.778	14	.450
/i/ 8va Post	204	67			

There were no significant differences between the groups at either testing point and neither group showed significant change across the testing points. The differences between the modal voice and one octave higher recordings are in agreement with the statistics from the whole group of 29 subjects, with mean flow rates through the higher pitched vowels being significantly greater.

A crosstab of percentage of change was also carried out, evaluating movement around the mean. Change away from the normal range, one standard deviation on either side of the mean, was considered deterioration whilst change towards the normal range was considered improvement.

Table 9 *Percentage of the Subjects showing Change by Group.*

Group	Deterioration	No Change	Improvement
Control	6	4	3
Experimental	5	4	6

These results (Table 9) suggest that the Experimental group showed more improvement and less deterioration than the Control group. Analysis however indicated that these results were not statistically significant (Pearson Chi-Square Value 4.998,  $df = 4$ ,  $p = .358$ ).

All data used for the above statistical analysis consisted of the Mean Flow Rate through steady state vowels. Further detail is provided through qualitative assessment of the Aerophone II tracings (see Figures 29 - 32), which demonstrate some significant differences in tracing morphology, that would not appear when mean flow measures were taken.

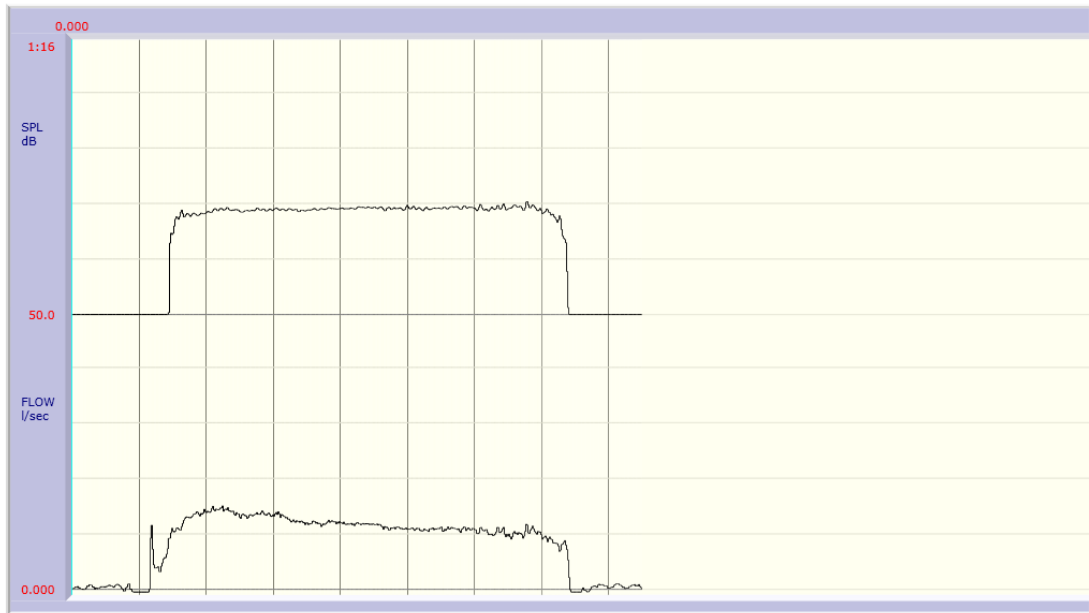


Figure 29

*MFR tracing / a/ 8va from a female subject showing typical morphology*

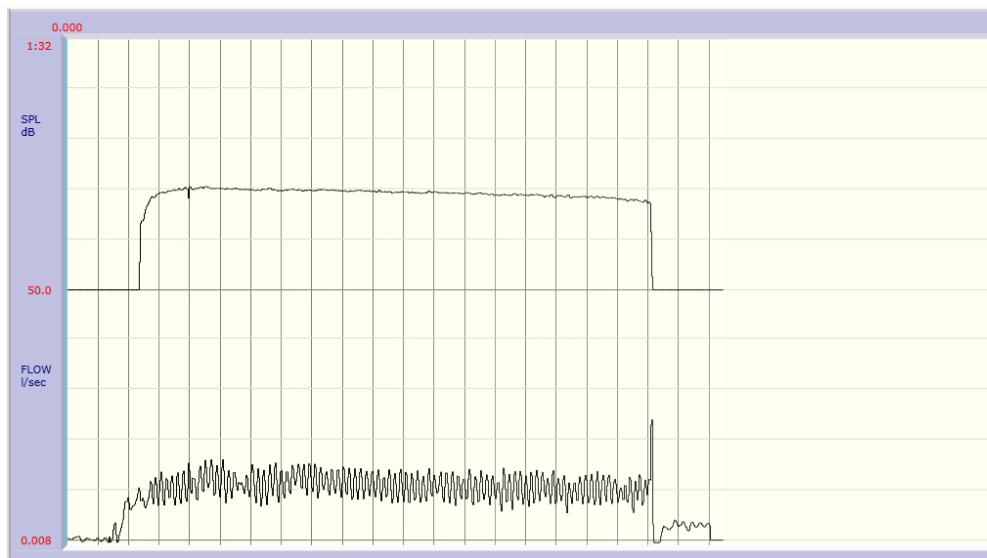


Figure 30

*MFR tracing / a/ 8va from a female subject showing atypical morphology*

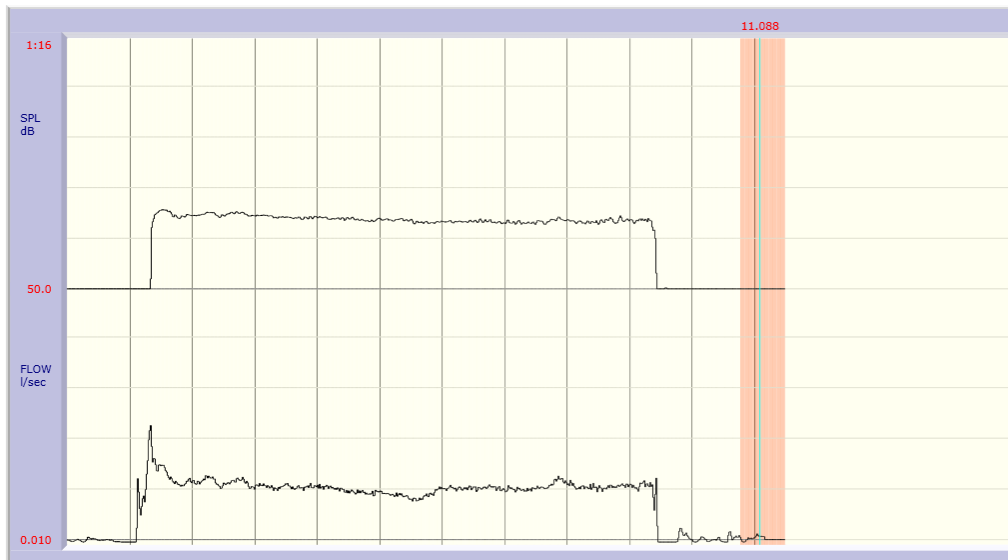


Figure 31

*MFR tracing /a/ 8va from a male subject showing typical morphology*

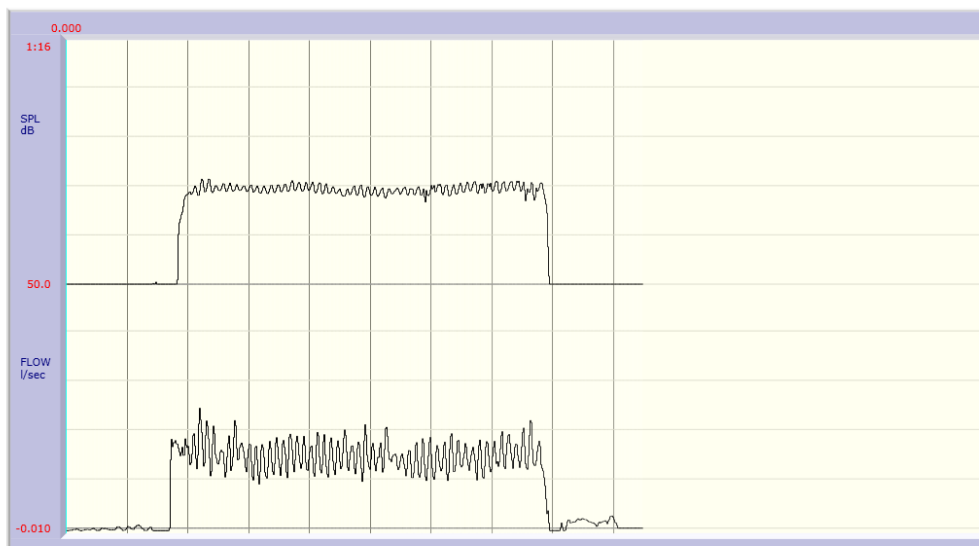


Figure 32

*MFR tracing /a/ 8va from a male subject showing atypical morphology*

As these four MFR tracing show there are two rather distinct patterns of air flow emerging. In the typical samples there is a relatively steady flow of air which supports a steady volume level for most of the sustained vowel. This pattern is that expected from the literature and from the Aerophone II manual and can be considered to represent normal airflow traces. In the atypical tracings there is a rapid perturbation in the airflow traces which is not shown in the actual MFR value since it is averaged. There is still a relatively steady volume level in the resultant sustained vowel, though in the male tracing (Figure 32) some perturbation in the SPL (volume trace), matching that of the airflow can be detected. This atypical morphology appeared to be more obvious when the subject was sustaining a vowel one octave above modal pitch, when the MFR was always higher. These atypical tracings were seen in five subjects of the control group at the initial pre-intervention assessment and in an additional two of the control group at the second post-intervention assessment (total of seven subjects). There were four subjects from the Experimental group who had these atypical morphologies at the initial assessment but only one of them still demonstrated this atypical morphology at the second, post-intervention assessment.

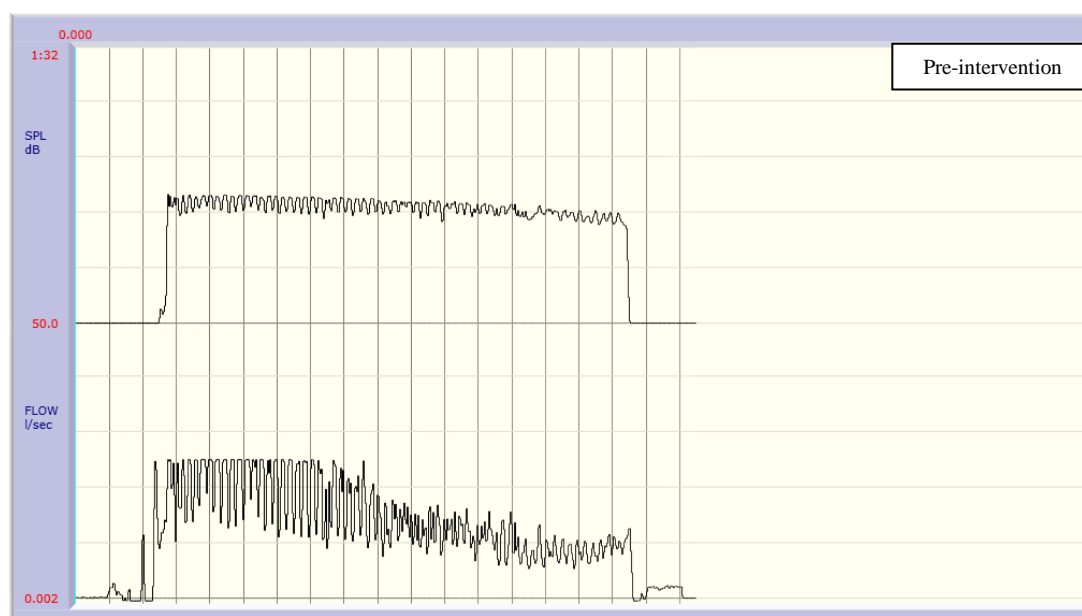






Figure 33

*MFR tracing /a/ 8va from Subject 1 (Experimental group male) showing atypical morphology Pre-intervention but typical morphology in Post-intervention*

At the initial assessment pre-intervention this subject showed a very atypical pattern of airflow which was also affecting the steadiness of the SPL trace. Post-intervention with Accent Method this subject is now showing a normal pattern of results with both steady airflow and steady SPL traces.

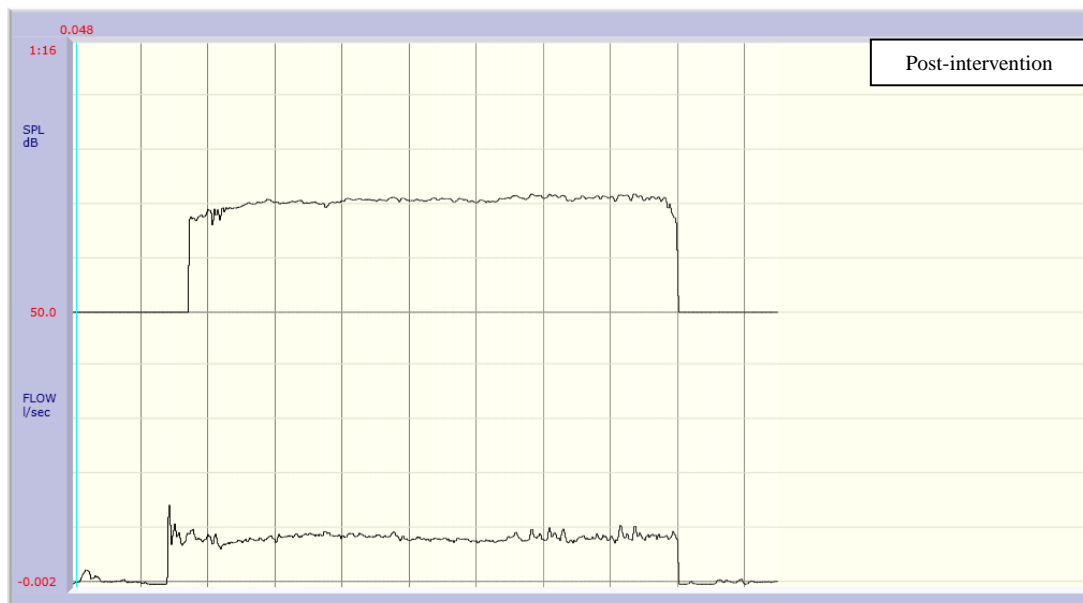
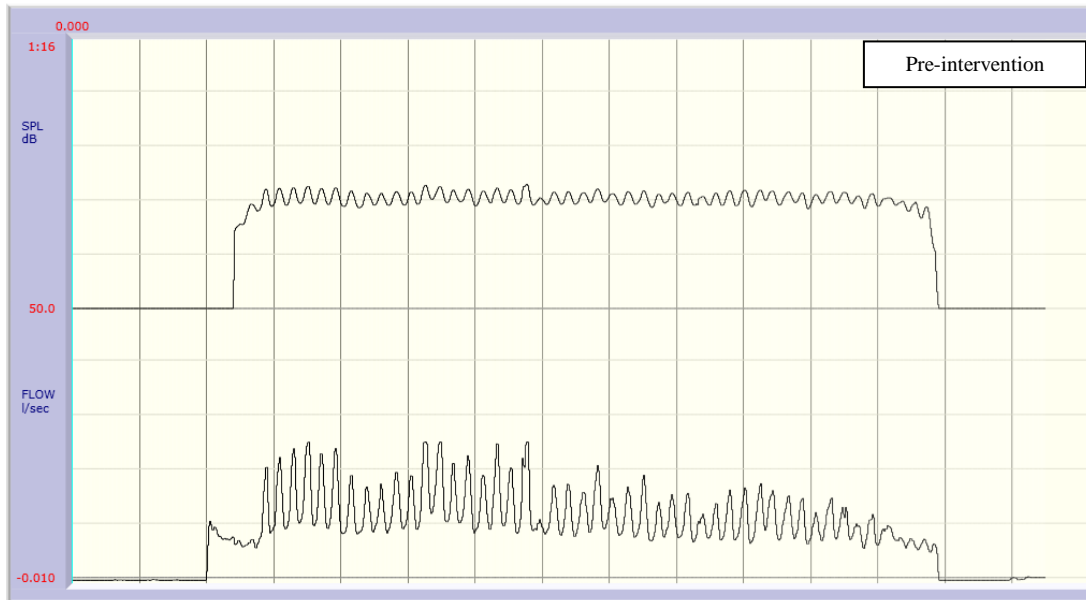


Figure 34

*MRF tracing / a/ 8va from Subject 3 (Experimental group female) showing atypical morphology Pre-intervention but typical morphology Post-intervention*

Subject 3's airflow traces (Figure 34) again show an atypical pattern at the initial assessment but typical airflow and dB SPL patterns at the second assessment following intervention with Accent Method. This subject showed a marked fluctuation in the dB SPL trace initially but this was eliminated in the post-intervention tracing.

As none of the subjects in the Control group who had atypical patterns at initial assessment changed towards more typical patterns at the second post-intervention assessment it appears that the intervention with Accent Method was instrumental in bring about change towards a more typical pattern. Two additional subjects from the Control group showed atypical patterns at the post-intervention session after showing typical patterns initially but no subjects from the Experimental group changed from a typical to an atypical pattern.

## Phonetograms

The results of the phonetograms were averaged to allow easier statistical analysis (Table 10). Averaging dynamic ranges and the maximum number of semitones sung allow the male and female singers, who have different pitch ranges, to be analysed together.

Table 10 *Average Dynamic Range in Decibels for the all Subjects*

Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
Av DR Pre	21.59	6.01	-4.462 ***	28	.000
Av DR Post	26.47	4.33			

Note. \*\*\* =  $p < .001$

These results show significant increase in the average dynamic range at the second assessment session compared to the initial one. This suggests that the singers' dynamic ranges, the difference between the loudest and softest tones produced, became larger over the 10 weeks of the study.

The maximum number of semitone sung were also assessed (Table 11).

Table 11 *Maximum number of Semi-tones sung for all Subjects*

Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
Max Semi Pre	36.62	3.12	-3.351 **	28	.002
Max Semi Post	38.86	2.84			

Note. \*\* =  $p < .01$

The results show a significant increase in the total number of semi-tones sung by the whole group at the second assessment session compared to the initial assessment. This suggests that the singers' actual pitch ranges became greater over the 10 weeks of the study. Additional analysis was carried out to evaluate the differences within the two groups, results can be found below in Table 12.

Table 12 *Average Dynamic Range in Decibels by Control and Experimental Groups*

Group/Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
Cont Pre	21.56	5.90	-1.843	13	.088
Cont Post	24.40	4.32			
Exp Pre	21.61	6.32	-4.757 ***	14	.000
Exp Post	28.41	3.45			

Note. Cont = control group, Exp = experimental group, \*\*\* =  $p < .001$ .

The Experimental group had a significantly wider dynamic range post-intervention than they did at their initial pre-intervention assessment. The Control group showed no statistically significant differences across the two testing points. This suggests that the intervention received by the Experimental group was responsible for bringing about change. It is most likely that the increase in DR shown by the Experimental group was a

significant cause of the whole group showing an increase in dynamic range at the later testing point.

The maximum number of semitones was also assessed by group (Table 13).

Table 13 *Maximum number of Semi-tones sung by Control and Experimental Groups*

Group/Task	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
Cont Max S Pre	37.57	3.48	-1.415	13	.180
Cont Max S Post	39.00	2.03			
Exp Max S Pre	35.73	2.54	-3.437 **	14	.004
Exp Max S Post	38.73	3.49			

Note. Max S = Maximum number of Semi-tones sung, \*\* =  $p < .01$ .

These results (Table 13) indicated that the experimental group sang significantly more semi-tones post-intervention than they did initially. There were no significant differences for the control group. It can be supposed that the intervention received by the Experimental group was responsible for bringing about change. The difference shown by the Experimental group would also account for the differences seen in the whole group statistics for the two testing points.

Average dynamic ranges were used in the statistical analysis of the data. This allowed for easy comparison between the two groups as differences in the amount of semitones sung would not affect the outcome. It is also possible to look graphically at the phonetograms that were obtained for each group, presented in Figures 7-9. Average minima and maxima for each semitone sung were calculated and male and female singers were combined to provide a single phonetogram based on each group's data.

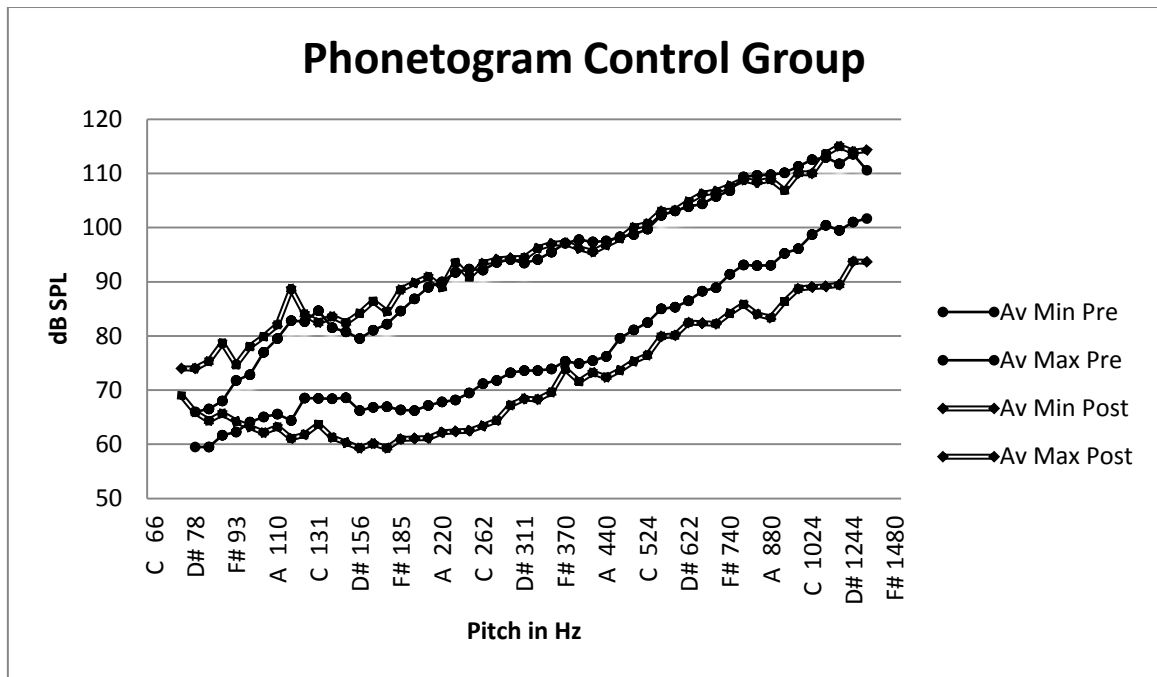


Figure 35

*Phonotogram for the Control Group Pre and Post Intervention showing average minima and maxima for intensity across the entire frequency range Pre and Post intervention*

This phonetogram (Figure 35) shows that there was some change in the dynamic ranges for the singers in the control group. These changes were not statistically significant but they do show some ability to sing more softly at the post-intervention assessment than was possible initially ( $t = -1.843$ ,  $df = 13$  and  $p = .088$ ).

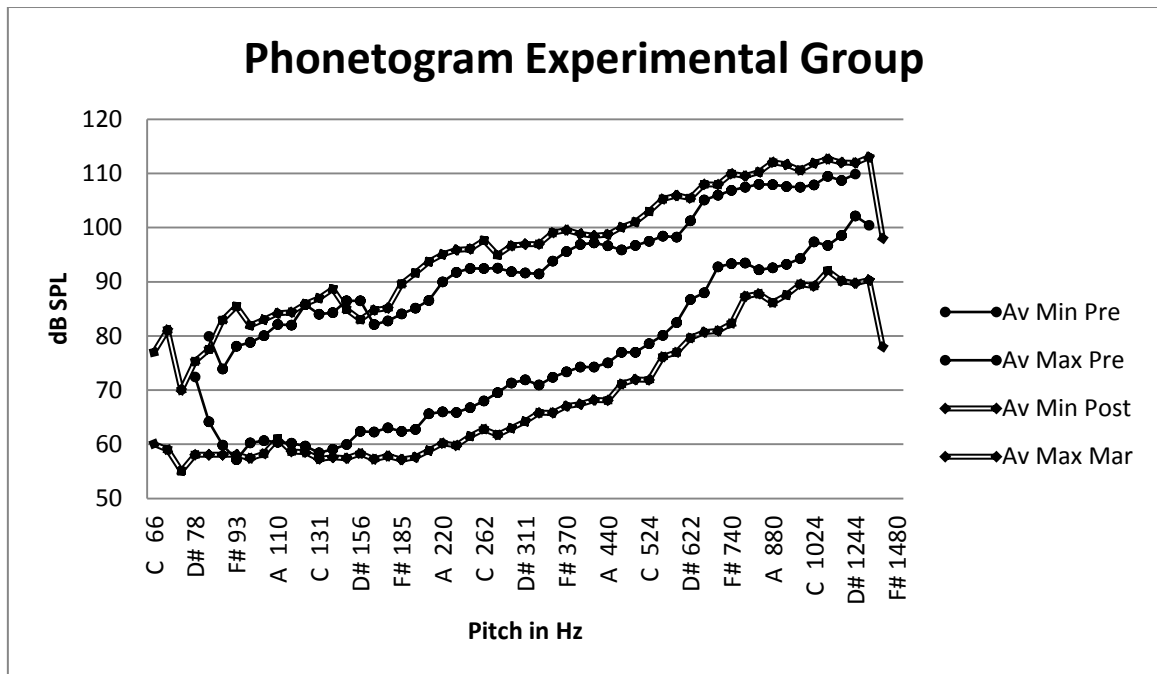


Figure 36

*Phonetogram for the Experimental Group showing average minima and maxima for intensity Pre and Post Intervention with Accent Method*

Figure 36's phonetogram shows a clear difference between the Pre and Post recordings. There was a very highly significant difference seen in the average dynamic range measures ( $t = -4.757$ ,  $df = 14$  and  $p = .000$ .) with the subjects in the Experimental group improving in their ability to sing both softly and loudly. The total number of semitones sung was also significantly greater ( $t = -3.437$ ,  $df = 14$ ,  $p = .004$ ).

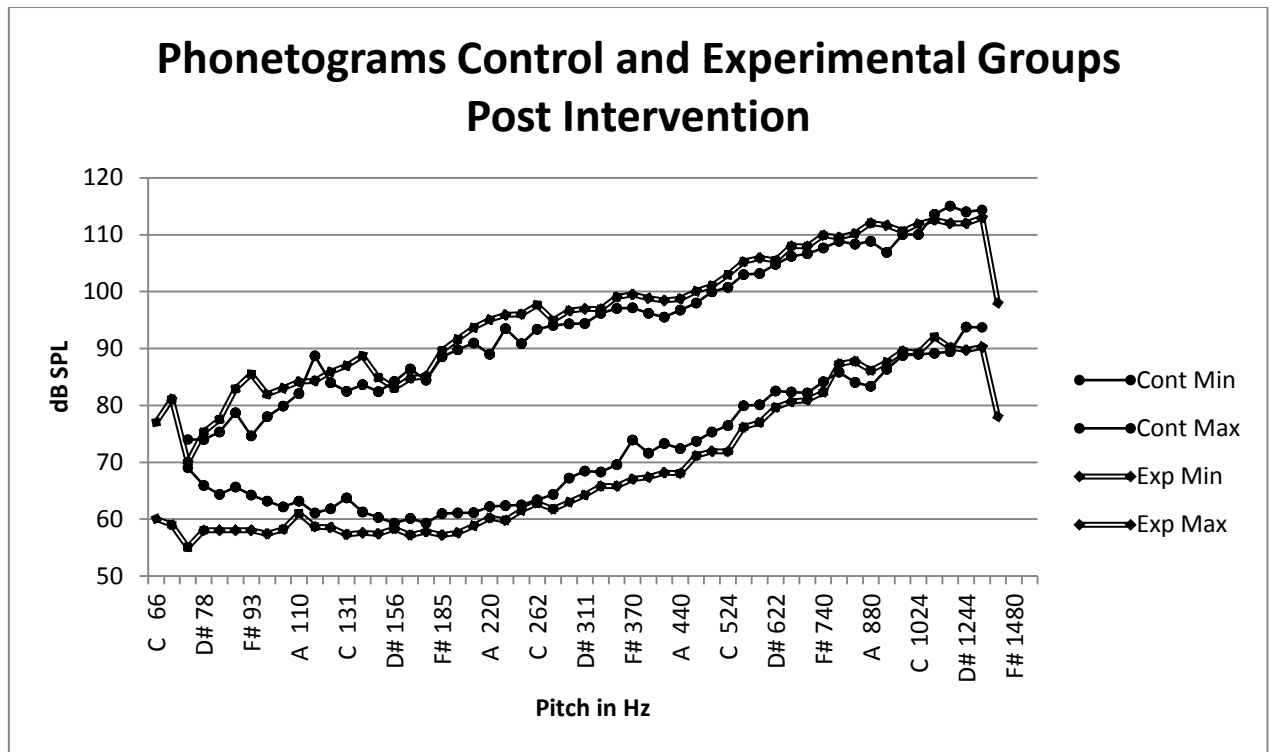


Figure 37

*Comparison of the Control and Experimental Group Phonetograms Post Intervention showing minima and maxima for intensities*

The phonetogram (Figure 37) for the experimental group is larger overall with both soft and loud tones showing an advantage. The mean dynamic ranges were statistically significant ( $t = -2.768$ ,  $df = 27$  and  $p = .010$ ).

There were also considerable variations in the phonetograms of individual singers. No subject's phonetogram was smaller at the post-intervention assessment than it was initially. The phonetograms shown below (Figure 38-41) represent the degree of change seen in the Experimental group for two male and two female subjects.



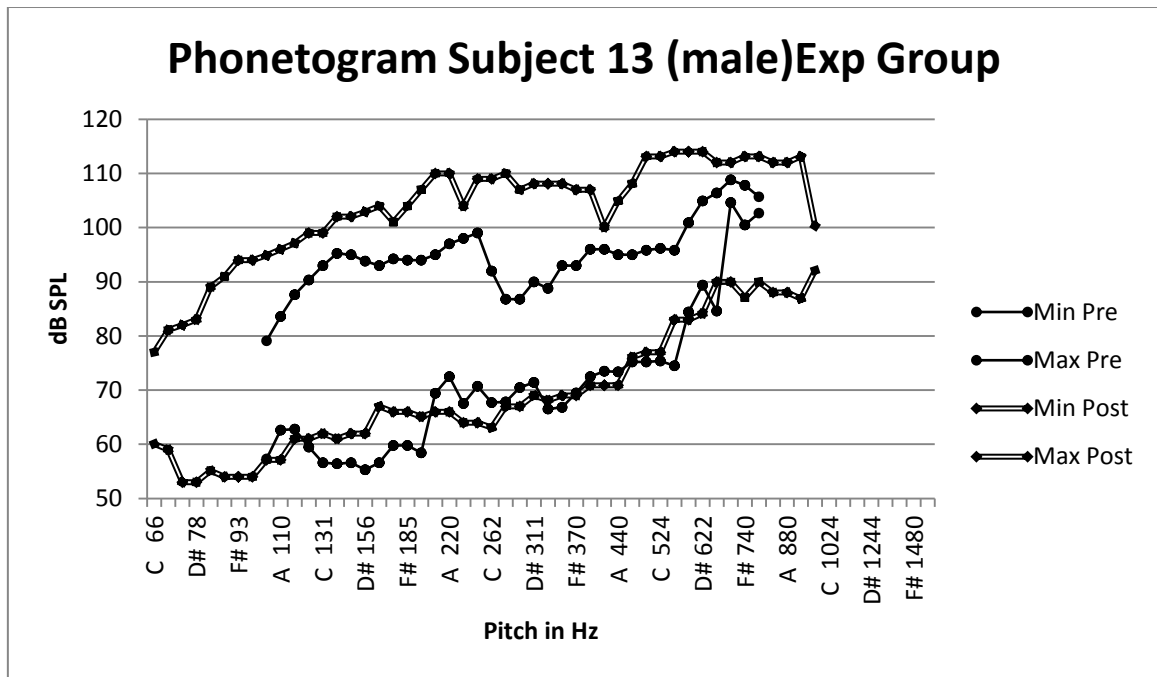


Figure 38 *Phonetogram of a male subject from the Experimental group showing a large degree of change*

The phonetogram for Subject 13 (Figure 38) shows an increase in both the dynamic range and in the maximum number of semitones sung. This subject shows a clear advantage for the louder tones throughout the frequency range with his average dynamic range increasing by 10dB. An additional eight semitones were available at the lower end of his range; with four more available in his highest register.

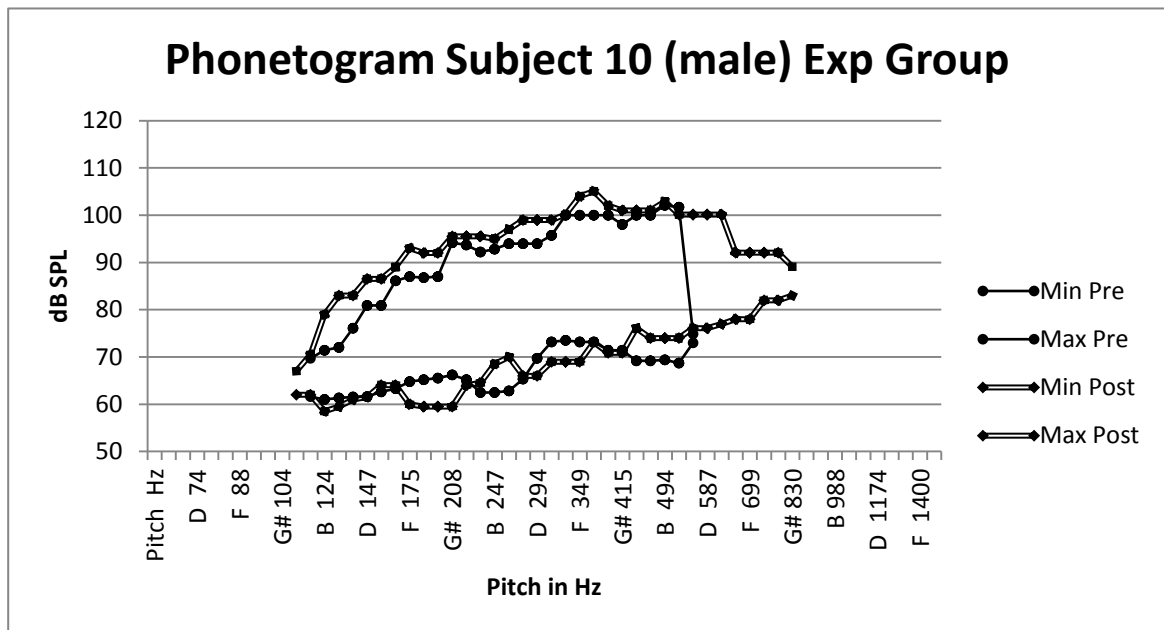


Figure 39 *Phonetogram of a Male Subject from the Experimental Group showing a Lesser Degree of Change*

Subject 10's phonetogram (Figure 39) does show improvement between the two testing points though the difference is not as great as that for subject 13. Subject 10 shows an increase in the average dynamic range of less than 1 dB but there was an increase of 8 semitones in the higher registers.

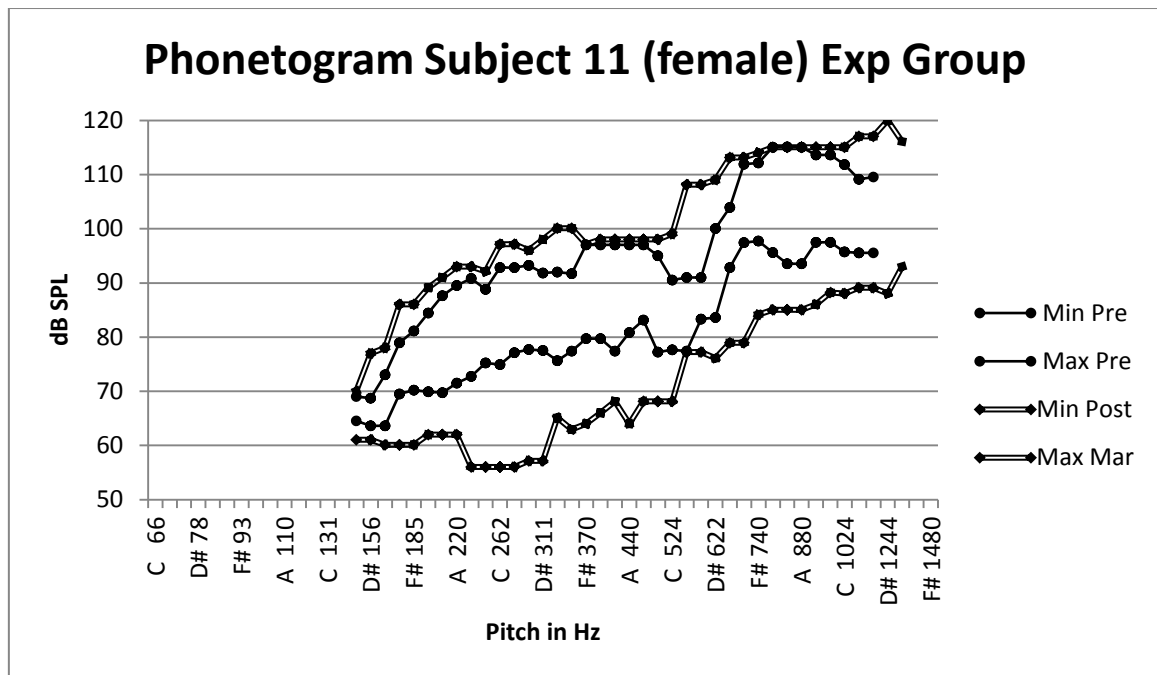


Figure 40  
*Phonetogram of a Female Subject from the Experimental Group showing a Large Degree of Change*

Subject 11 again shows a large increase in the dynamic range across the two testing points (Figure 40) with an increase in the average dynamic range of 15 dB. Her improvement in the total number of semitones sung was less with only two additional semitones sung.

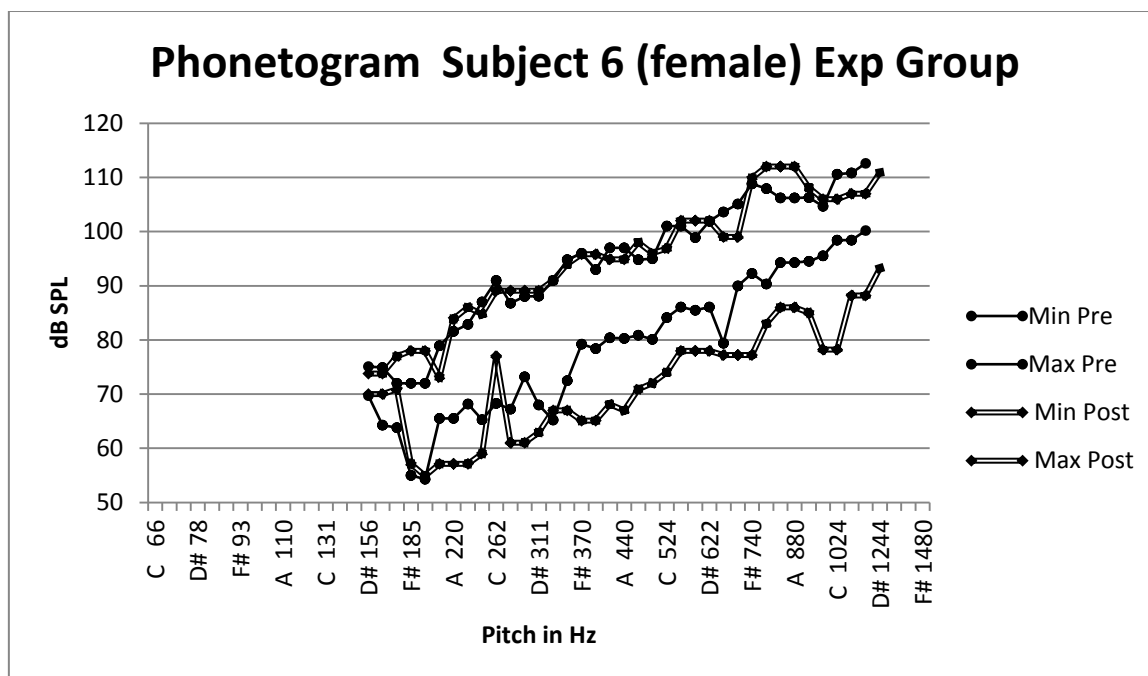


Figure 41  
*Phonetogram of a Female Subject from the Experimental Group showing a Lesser Degree of Change*

Subject 6 showed a lesser degree of change. Her phonetogram (Figure 41) showed a greater facility for soft singing which was reflected in an additional 7 dB in the average dynamic range but she was only able to increase her total semitones sung by one.

## Perceptual Judgments

Perceptual judgments remain one of the most important ways to evaluate voices, this is particularly important when the singing voice is under scrutiny. The opinion of trained judges is considered to be highly valuable in identifying change. Judge preferences were taken into account in this study by assigning a value of 1 to singer's samples from the first, pre-intervention recording and a value of 2 to the samples from the post-intervention. The results are shown below in Table 14.

Table 14 *Judge Preferences for recording of Caro Mio Ben by group*

Group	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	Sig (2-tailed)
Control	1.41	.36	-2.624 *	27	.014
Experimental	1.73	.29			

Note. \* =  $p < .05$

These results (Table 14) indicate that more of the Experimental group's recordings the post-intervention assessment were preferred over their pre-intervention recordings. A greater number of the pre-intervention recordings were preferred for the Control group however. A mean score of 1.5 on this assessment item would mean that there were an equal number of preferences for the pre and post intervention recordings therefore the

Control group's mean of 1.41 would suggest almost equal numbers. The Experimental group's score of 1.73 is well above this confirming that the post-intervention recording was preferred by a greater number of judges for a greater number of singers.

Judges were also asked to provide a strength rating of their preference but statistical analysis did not demonstrate any significant differences in the strength of their preference ( $t = -.695, df = 27, p = .493$ ).

## Chapter Seven Discussion

This study has identified some areas of disjunction between the literature on Accent Method Breathing and the findings discussed below. Significant benefits were noted in the Phonetograms of the Experimental group and there was a preference in the perceptual judgements for the post-intervention samples in the Experimental group. The results of Maximum Phonation Times and Mean Flow Rate assessments however, do not show any significant differences between the two study groups.

### Maximum Phonation Time (MPT)

MPT was recorded in two ways during this study, via a standard microphone and through the facemask of the Aerophone II system. Significantly different values were obtained from the two recording methods so they will be discussed separately.

All of the MPTs obtained via the microphone were within the range considered as normal based on Shewell (2009), i.e. MPT over 15 seconds is normal for adults. There were no differences between the two groups on the MPT of the /a/ vowel at either testing session, though it can be seen that the Control group had a longer but not statistically significant MPT for /a/.

At the initial assessment, via the microphone, the Control group had a longer phonation time than the Experimental group for the vowel /i/. This difference was statistically significant at the  $p > .05$  level and was the only significant difference between the two groups. This difference was also present at the second assessment session when it was again significant at the  $p < .05$  level. This difference being present at both testing sessions cannot be attributed to a measurement phenomenon and suggests that it is a true difference in the abilities of the two groups.

Accent Method instruction did not improve the MPT of the Experimental group significantly. This finding is contrary to that anticipated from the literature. As indicated in chapter 4, MPT has been reported as showing improvement with Accent Method for both disordered and normal voices (Thyme-Frøkjær and Frøkjær-Jensen, 2001, Kotby, 1995 and Bassiouny, 1998), but the subjects in the current study showed no significant improvement in MPT.

It may be that because all the subjects were singers, they had already practised, through other vocal exercises and through regular singing to improve MPT by phonating closer to the end of their breath capacity whilst singing. Sundberg (1987) indicates that singers use more of their lung capacity when singing than speakers do when talking. This may account for the differences seen between this study group of normal voices, who were singers and Thyme-Frøkjær's group of normal voices who were not singers but speech and language therapists.

The MPT was significantly shorter for both groups when it was recorded through the facemask of the Aerophone II system than when recorded via the standard microphone

( $p < .01$ ). This difference between the two recording methods was also present at the second post-intervention assessment session. This phenomenon has not been reported in the literature to date. It appears that Thyme-Frøkjær and Frøkjær-Jensen routinely record MPT via the facemask of the Aerophone II system and the MPTs reported by them in 2001 are very similar to the MPTs obtained in the present study via the microphone (i.e. 20 -21.5 seconds). This difference cannot be explained by equipment malfunction as the Aerophone II system was calibrated as per the manufacturer's instructions prior to each testing session and was found to be operating and recording correctly.

The act of phonating into the Aerophone II facemask is a more unusual task and the perception of one's own voice is altered when so doing. Singers tend to be more aware of the sound of their own voices and this altering of the aural percept of their voice may have accounted for the shorter phonation times seen via the face mask. The singers in this study were all in the first two years of their tertiary level training. The early years of tertiary level training tend to focus on the acquisition of technical skills and that for these less experienced singers their vocal technical proficiency may not be great enough to allow them to overcome the effects of the altered aural perception. Additional research using a group of subjects from both the earlier and later (perhaps post-graduate) years of training and validated by a much larger sample size would be advantageous in order to compare the MPT acquired by the two methods.

The subjects in the Experimental group also showed a significant reduction in MPT measured via the Aerophone II facemask in the second post-intervention session. This reduction was seen on all of the vowels that were tested and was significant at the  $p <$

.05 level. This reduction in MPT was not seen in the Control group so it must be postulated that the Accent Method instruction they received had some effect on this result. Given the way in which Accent Method is taught and the findings from other studies that suggest an increase in MPT is usual with Accent Method instruction this finding raises further questions for the researcher. It is also important to note that there was no reduction in MPT when measured via the microphone.

Additional analysis of the aerodynamic measures taken with the Aerophone II also indicated a significant reduction in the volume of air expired ( $t = 2.48$ ,  $df = 14$ ,  $p = .026$ ,  $p < .05$ ), but no significant difference in the MFR or the dB (overall volume level).

Thyme-Frøkjær (2001) reported a significant reduction in the volume of expired air for her normal subjects post Accent Method training, but this was combined with an increase in MPT which would translate to a reduction in the MFR. The results of the current study suggest that the subjects took in less air, resulting in a reduced MPT and reduced volume of air expired. Because they used the air they had inspired with similar efficiency, there was no change in MFR or dB level. This finding suggests that the Experimental group did not take as large a breath as they did at their first pre-intervention assessment session. The instructions for the assessment items (see Appendix) were the same, but it appears that the Experimental group subjects were influenced by their Accent Method training. This is possibly due to the training's focus on a 'natural' breath and not 'over breathing'. The instruction to take a 'deep' breath may have meant something different to them at the second post-intervention assessment which may have influenced these results. There were no changes in the Control group's results and though they were seen each week by the examiner no instructions about breathing were ever given in their sight singing classes. Therefore they would have had



no reason to change their impression of the instruction take a ‘deep’ breath. It is still worthy to note that this reduction in MPT was only seen via the facemask of the Aerophone II system and not when MPT was taken via the microphone, which showed a slight but not significant improvement. There may be some additional influence caused by the altered perception of one’s own voice when using the Aerophone II facemask which affected the Experimental group to a greater extent.

MPTs were also taken for vowels separated by one octave in pitch. These vowels were all recorded through the facemask of the Aerophone II as part of the MFR assessment. The subjects were asked to phonate at their modal pitch and then one octave higher. The MPTs were significantly shorter at one octave above modal pitch ( $p < .01$ ). This was seen on both the /a/ and /i/ vowels, for both the Experimental and Control groups and at both testing points.

At one octave above modal pitch female singers are most likely to be phonating in Laryngeal Mechanism 2 (head voice) rather than in Laryngeal Mechanism 1 (chest voice). Vocal fold closure tends to be less tight in this laryngeal mechanism and thus more air would be expected to be used (Heinrich 2006). The increase in the number of opening and closing phases of the vocal folds caused by the increase in vocal fold vibration to reach the target pitch will also lead to more air flowing past the glottis. Male singers are probably still phonating in Laryngeal Mechanism 1 though phonating in Mechanism 2 could also be possible one octave above modal pitch. The faster vocal fold vibration rates required to reach the target pitch would also require more air usage. Increases in air flow would lead to the reduced MPTs seen at these higher pitches and this is

confirmed by the significantly greater MFR seen through the vowels phonated one octave above modal pitch.

## **Aerodynamic Studies**

The subjects in this study had a significantly greater MFR through steady state vowels than that reported by Thyme-Frøkjær (2001). She reports a mean of 120 with a standard deviation of 20 ml/sec for an /a/ vowel at modal pitch. As there were no differences between the two groups on MFR measures the whole group of 29 subjects can be evaluated together, in doing so a mean of 152 with a standard deviation of 57 ml/sec was obtained. This result not only suggests a higher mean than Thyme-Frøkjær obtained but also much greater variability as seen by the larger standard deviation. This mean of 152 ml/sec is closer to that reported by Thyme-Frøkjær in one of her study groups of female speech and language therapists prior to Accent Method Instruction, when a mean of 173 ml/sec was reported. In her study however, the mean moved to be within the reported normal range post intervention. The current study showed no significant differences in either group post-intervention so these greater values must be accepted as typical for this group.

The normative data reported, and the recommended acquisition method in the Aerophone II manual uses an /a/ vowel. This is considered an open vowel and as such has less restriction to the airflow through the vocal tract. Singers and singing teachers report that other vowels are 'better' or 'easier' (Chapman 2005) and so a close vowel /i/ was also evaluated. On MPT testing the Control group did have a significantly longer phonation time on an /i/ vowel than the Experimental group, though for both groups

the MPT of the /i/ vowel was longer than that of /a/. MFR rates however were not significantly different between the two vowels at either testing point or for either group. This suggests that the restriction of the airflow through the vocal tract is not significantly different for an open vowel /a/ from a closed vowel /i/.

A difference in the MFR was identified for vowels of different pitches. MFRs were significantly greater for vowels that were one octave higher in pitch. As mentioned in discussion of the MPTs differences in either laryngeal mechanism (register) or simply faster vocal fold vibration rates (giving a greater number of open and closed phases of the vocal folds) - could account for the increase in the MFR. There were no differences in either group post-intervention, which suggests that Accent Method was not able to change the MFR in this group of subjects either at modal pitch or one octave higher.

An evaluation of change, either to or away from the mean, was also carried out.

Although not statistically significant there was a trend for the subjects in the Experimental group to move towards the mean following Accent Method instruction. This would be consistent with the reported findings in the literature; that Accent Method tends to normalise airflow. This change analysis was carried out using the mean and standard deviations obtained from the whole study population of 29 subjects.

Evaluation of the other aerodynamic measures for the two groups indicates a significant reduction in the volume of expired air for the experimental group. This finding is consistent with that reported by Thyme-Frøkjær (2001) where her group of normal female voices showed a reduction in the volume of air expired. The current Experimental group did not show the reduction in MFR that her group demonstrated

because there was a concomitant reduction in MPT. As reported previously there was no reduction in MPT when taken through the microphone and had the MPT via the Aerophone II face mask remained unchanged there would have been a reduction in the MFR. One explanation may be that the subjects in this group were unable to ignore the altered aural percept of their own voices via the Aerophone II facemask which affected their willingness to phonate until the end of the breath cycle.

Qualitative analysis of the morphology of the airflow traces was also carried out and two distinct patterns were identified as shown in Figures 29-32. The typical pattern of steady airflow through the vowel, perhaps lessening slightly as the MPT was reached, to sustain a constant dB level, was seen in most of the subjects from either group. This typical pattern was seen for both vowels and both octaves tested and is consistent with the pattern of airflow traces reported by Thyme-Frøkjær (2001) and outlined in the Aerophone II manual. The atypical traces were seen more frequently when phonation occurred at one octave above modal pitch, irrespective of the vowel used. Some subjects showed these atypical traces, though often to a lesser degree, in the modal pitch examples of either vowel. There were some differences noticed between the groups however in respect to these atypical traces.

The Control group contained five subjects that had these atypical traces at initial assessment pre-intervention, namely subjects numbered: 21, 23, 24, 27 and 29. At the second post-intervention assessment an additional two subjects showed this atypical pattern even though their initial traces were more typical, namely subjects 17 and 26.

The Experimental group had four subjects with atypical traces at the initial pre-intervention assessment, subjects: 1, 3, 12 and 15 but at the second post-intervention

assessment only subject 12 continued to demonstrate this atypical pattern. Subject 12's airflow traces appeared to show less perturbation at the second assessment post-intervention than initially but the perturbation was still evident in all of the traces when vowels one octave above modal pitch were evaluated.

Examination of the subjects who showed the atypical pattern from both groups at initial assessment indicated that five of the subjects were male and four of the subjects were female, so no gender difference was anticipated. Five of the subjects were first year singers and four were second year singers, suggesting no effect based on year level. All the other measures of vocal function taken: MPT, MFR, Av DR and Max Semi did not appear significantly different from the other subjects, making it difficult to determine what had caused this group of singers to show atypical airflow traces.

An examination of the subjects' principal voice teacher pointed to a determining characteristic for this group. Four of the subjects, subjects 12, 24, 23 and 29 were currently studying with teachers who ascribe to the 'belly out' system of breath support, while three of the others reported that the 'belly out' system had been used with them in the past. The two subjects from the Control group ( subjects 17 and 26) whose airflow traces moved from the more typical to the atypical over time were both first year singers who were currently studying with one of the teachers who actively taught a 'belly out' approach. It appears that adherence to a 'belly out' approach is a major factor in the development of this atypical airflow trace. Supporting this assumption is the fact that three of the four subjects from the Experimental group who showed the atypical traces at the initial assessment showed much more typical traces at the second post-

intervention assessment. This would be consistent with the Accent Method of Breathing they were taught which is firmly of the ‘belly in’ school of support.

Physiologically the perturbations noted in the airflow traces of these ‘belly out’ subjects could represent difficulties maintaining the airflow at an even pressure during expiration. Once the chest cavity is appropriately pressurised with air, usually from an increase of the intra-abdominal pressure, the diaphragm and the intercostal muscles are able to promote a steady airflow at the correct pressure by acting as a releasing brake (Hixon 2006). , Those subjects using a ‘belly out’ approach would find adjustments of abdominal pressure are more difficult to achieve and this may account for the perturbations in the airflow.

Subjects in the Experimental group who underwent Accent Method Breathing training were actively taught a ‘belly in’ style of support with the intra-abdominal pressure increased by an immediate movement of the abdominal wall inwards. This would serve to effectively pressurise the chest with air, allowing the mechano-pressure receptors of the chest wall to function and send appropriate signals to the respiratory muscles to maintain adequate airflow at the correct pressure. Those subjects in the Experimental group who had atypical traces showed more typical patterns following their training suggesting that appropriate ‘belly in’ support helped achieve a more typical airflow trace.

Although there were no significant differences in either the MPT or MFR of the Control and Experimental groups post-intervention, Accent Method Breathing appears to be effective in changing the atypical airflow traces seen in this study.

## Phonetograms

Evaluation of the whole group of subjects indicated that both measures, Av DR and Max Semi, improved over the course of the study with significant results ( $p < .001$  for Av DR and  $p < .01$  for Max Semi). This improvement is not unexpected, as all of the subjects continued to have their usual programme of singing lessons, song classes and singing experiences during the term in which the study was carried out. Improvements in vocal function over the course of a term would be normal and desirable. Evaluation by group however, indicated that the Experimental group showed a significant improvement of both Av DR ( $p < .001$ ) and Max Semi ( $p < .01$ ) at the second post-intervention assessment whilst the Control group did not. The Experimental group received Accent Method instruction while the Control were also seen weekly (for sight singing practice only), it would appear therefore that improvements noted in the Experimental group can be attributed to the Accent Method intervention they received.

These results are consistent with those reported in the literature with Accent Method being effective in improving the phonetograms post training. This finding has been reported with both normal and disordered voices but as the voices in the current study were all normal, Thyme-Frøkjær's (2001) results are probably more relevant. Thyme-Frøkjær reported on a large number of female speech and language therapists who showed significant improvement in their phonetograms post training, she also had data showing additional improvement over time and with additional 'advanced' courses. The current study also indicated significant changes post training with Accent Method however it is important to note that both male and female subjects were included in this

study with no significant differences noted between the genders. It appears that Accent Method is effective in improving the phonetograms of subjects regardless of gender.

The group phonetograms shown in Figures 35-37 illustrate the changes that occurred over the course of the study. The Experimental and Control groups' average dynamic ranges and maximum numbers of semitones sung were not significantly different at the initial assessment point.

The Control group's comparison phonetogram (Figure 35) shows some improvement in the dynamic range but no discernible difference in the maximum number of semitones sung. The Control group appeared to have a greater facility for soft singing at the post-intervention assessment than they did initially but the  $p$  values for the Av DR ( $p = .088$ ) only approached but did not reach significance.

The Experimental group's comparison phonetogram (Figure 36) clearly shows the significant improvement in the dynamic range and the maximum number of semitones sung. The dynamic range shows an improved ability to sing both more loudly and more softly post intervention. In addition, the number of semitones sung improved at both the upper and lower pitches of the range. These results are again consistent with those of Thyme-Frøkjær (2001) who reported improvements in both soft and loud vocalisations as well as improvements in both high and low pitches.

Figure 37 indicates the differences between the two groups at the second post-intervention assessment (there were no significant differences at the initial assessment).

The Experimental group is showing a significantly greater dynamic range ( $p < .05$ )



however there is no significant difference between the maximum numbers of semitones sung.

There was a large degree of variation amongst the phonetograms produced by the subjects, in both groups. No subject from either group showed deterioration in the phonetogram between the January and March recordings but Figures 38-41 give an indication of the range of phonetograms from the Experimental group. This variation in change is again consistent with the reported literature as Thyme-Frøkjær (2001) also provides some examples of very great change in some of her subjects (all female). It is important to note that the male subjects in this study (Figures 10 and 11) also showed a similar degree of variability to the the female subjects, again confirming no significant differences in the outcomes with male and female subjects.

In conclusion the phonetograms show significant differences post Accent Method training. The Experimental group shows a significant increase in both Average Dynamic Range and Maximum Semitones Sung whilst there are no significant differences in the phonetograms obtained from the Control group at the two testing points. The two groups were equivalent at the pre-intervention assessment but post-intervention the Experimental group had a significantly greater average dynamic range although the maximum number of semitones sung by the two groups was still not significantly different.

## Perceptual Judgments

Improvements in vocal function measures such as greater dynamic ranges on phonetograms, increases in pitch range and the acquisition of more normal air flow traces are unable to identify an improvement in the singing voice itself. The judgment of improvement in singing voices is always difficult and it is not always possible to draw direct links between improvements in vocal function measures and a perception of improved singing. There is a degree of subjective judgment in the evaluation of singing voices which serve to make the identification of improvement difficult. Examiners in vocal departments are faced with these challenges whenever they are called upon to mark student performance examinations. Innate musicality and musicianship must comprise at least part of the examiner's judgment. In the early years of a singing student's training, when the emphasis is usually on the acquisition of technical facility, the examiners also make judgments about the efficiency and production of the singing voice. In this study the five judges were asked to make a preference judgment based on the two samples of unaccompanied singing they were played. Once their preference was established they were also asked to provide a degree of strength of that preference. The two samples, one pre-intervention and one post-intervention were randomised; the subjects from the two groups were also randomised so the judges had 29 pairs of samples to assess.

The judges had a significantly greater preference for the samples recorded from the Experimental group at the post-intervention assessment ( $p < .05$ ) than they did for the samples from the Control group. Given that all students received a term's routine singing lessons and singing experiences, a preference for the later post-intervention

recording over the initial recording would be expected for the whole group. While there were no significant differences in the judges rating strength, during analysis of the data it was apparent that approximately half of the Control group's post-intervention recordings were preferred. However, a significantly greater number of the Experimental group's post intervention recordings (approximately two thirds) were preferred. This would suggest that the intervention with Accent Method had a significant positive impact on the overall voice quality as judged by the expert panel.

## Chapter Eight Conclusion

The evaluation of data from the experimental and control groups appears to answer the principal research question with some degree of clarity. Accent Method Breathing appears to have a beneficial effect on the voices of young classical singers.

Improvements in the phonetograms of the experimental group were noted and a clear preference expressed by the judges for the post intervention recordings of this group. An examination of the more specific research questions gives a more detailed insight into the findings of both the literature review and the experimental study.

Accent Method Breathing is being specifically mentioned as a beneficial technique in some modern vocal pedagogies. Janice Chapman in the two editions of her book (2006 and 2012) refers directly to Accent Method and provides a brief outline of its teaching sequence and carry-over into the singing voice. Accent Method falls firmly within the ‘belly-in’ school of breathing for singing and as such would now represent the majority of teachers’ thoughts on the teaching of breathing for singing. Controversy continues to exist about the notions of breathing and support for singing but as scientific knowledge and principles become more commonplace within the teaching studio there appears to be a gradual shift towards a more ‘belly-in’ predominance. Hixon in his 2006 book even provides a number of singing exercises that are in essence Accent Method exercises, even though he does not appear to know of or quote the method.

Accent Method relates very well to the current scientific and medical knowledge of breathing both for singing and speaking. Accent method is well grounded in scientific fact and its principles closely follow the current knowledge of the structure and function of the respiratory system. The basic principle of Accent Method, that the contraction of the diaphragm for the in-breath alternates with contraction of the abdominal muscles for the out-breath appears to accurately describe the voluntary features of breathing for speaking or singing. There is additional interaction of the inspiratory and expiratory muscles caused by pressure and reflexes, so that the diaphragm and intercostal muscles often continue their inspiratory action well into the expiratory phase (this would seem to be vital to the notion of ‘support’ of the singing voice) which Accent Method does not directly take into consideration but the components of respiration for singing that are directly under the singer’s control are well served by the principles of Accent Method. Accent Method has been studied in both normal and disordered voices and found to be of benefit. This benefit can be seen in the improvement of vocal function in normal voices so that a more dynamic and flexible voice is available for use while in disordered voices an improvement towards more normal vocal function is achieved.

In the current study there were significant changes to the pitch and dynamic ranges of the test subjects. The whole group of 29 subjects showed a significant improvement in both the pitch and dynamic ranges over the 10 week course of intervention. When the two groups were evaluated separately it was clear that the control group who did not receive Accent Method instruction did not show statistically significant improvement whilst the experimental group who underwent Accent Method instruction showed statistically significant improvement on a number of measures. The two groups were tested as equivalent in the pre-intervention stage of the experiment so it would appear

that the Accent Method instruction received by the experimental group was a major contributing factor to their significant changes. The experimental group showed highly statistically significant improvement in their dynamic ranges as measured by the phonetograms. There was a less great but still statistically significant change in the maximum number of semitones sung post intervention.

There were no significant changes to the maximum phonation time post intervention for either group. Accent Method did not appear to change the maximum duration of phonation for the experimental group of subjects. This result is at variance with the literature which suggests that there should be an improvement. The fact that the test subjects were singers and not only speakers may have accounted for this finding since singers are more used to utilising a greater amount of their vital capacity for phonation. It is interesting to note that the average maximum phonation time reported by Thyme-Frøkjær for her normal subjects post-intervention is very similar to that obtained from the current test subjects pre-intervention.

There were no significant differences between the pre and post intervention measures of mean airflow rate in this current study. This is again at variance with the literature which suggests that the airflow should become more normal following Accent Method instruction. All of the subjects in this study showed much higher mean airflow rates than reported in the literature. Calibration of the equipment was well within the manufacturer's tolerance levels so it is felt that this is a valid finding. Mean airflow rates were taken at modal pitch as reported in the literature and then again one octave above modal pitch. The results from the modal pitch recordings, as mentioned previously, were much higher than the norms suggested by Thyme-Frøkjær. The results of the

airflow measures at one octave above modal pitch indicated a significantly higher airflow when compared to the results obtained for the modal pitch vowels. Given the large differences between the averages for this study and the average value for mean airflow rates reported in the literature a much larger normative study using young singers should be carried out to identify specific differences in this population.

The quantitative analyses of the aerodynamic studies were not significant but a qualitative evaluation yielded very interesting results based on the airflow and volume (SPL) trace morphologies. An atypical pattern of morphology was identified that showed a marked perturbation of the airflow trace and on occasions the volume trace for some subjects. All but one of those subjects in the experimental group who demonstrated this morphology at the pre-intervention assessment showed normal morphology at the post-intervention assessment. Those subjects in the control group with this atypical morphology did not show any change of morphology between the two testing points. It is interesting to note that at the post-intervention assessment there were two more students in the control group with this atypical morphology than at the pre-intervention assessment. It appears that Accent Method instruction was instrumental in bringing about a change in the airflow trace morphologies towards a more normal pattern.

A panel of expert judges who did not know the test subjects voices expressed a greater preference for the experimental group's recordings post intervention, than for those of the control group. A rating of 1 was given if the pre-intervention recording was preferred whilst a rating of 2 was given if the post-intervention recording was preferred. The experimental group had a significantly higher score confirming that the judges

preferred their post-intervention recording more often. It would appear that Accent Method made some difference to the judges' preference since the post intervention recording was preferred for more of the subjects from the experimental group.

Accent Method, in this current study was effective in bringing about change to the experimental group. The subjects in the experimental group showed a significant improvement in their pitch and dynamic ranges, as measured by their phonetograms, a more typical pattern of airflow and volume tracings on aerodynamic studies and their post-intervention recordings were preferred more often by the panel of experts. Based on these results Accent Method can be said to have value in the training of young classical singers since it was able to bring about significant improvements in a limited space of time. Further research is needed to define Accent Method's place and importance within a complete course of study for the young classical singer. A number of potential avenues for on-going research exist. It would be interesting to evaluate the benefits of Accent Method to different year levels of students. Would it be of similar efficacy for more developed students such as Post Graduate or Opera School level students? It would also be important to evaluate if a longer training period would promote more benefit. Similarly, it would be of value to assess at different periods post intervention, particularly to see if the effects of Accent Method are lasting or if the students from the control groups 'catch up'. Work on normative studies of air flow in young singers would also be beneficial particularly as the data from the current study is at variance with the reported literature. On-going assessment of the method's efficacy with a much greater number of test subjects would also be valuable in confirming the results of the current study.



## Bibliography

- Agostoni, E., & Sant'Amrogio, G. (1970), The Diaphragm. In E.M. J. Campbell, E. Agostoni, & J. Newsom Davis, *The Respiratory Muscles Mechanics and Neural Control* (pp. 145-160). Philadelphia and London: W. B. Saunders Company.
- Blades-Zeller, E. (2002). *A Spectrum of Voices Prominent American Voice Teachers Discuss the Teaching of Singing*. Lanham Maryland U.S.A. Scarecrow Press Inc.
- Bassiouny, S. (1998). Efficacy of the Accent Method of Voice Therapy. *Folia Phoniatrica et Logopaedica*, 50, 146-164.
- Boone, D. R. (1983). *The Voice and Voice Therapy*. Englewood Cliffs New Jersey USA: Prentice-Hall Inc.
- Bouhuys, A., Proctor, D. F., & Mead, J. (1966). Kinetic Aspects of Singing. *Journal of Applied Physiology*, 21, 483-496.
- Brown, W. E. (1957). *Vocal Wisdom (Enlarged Edition) Maxims of Giovanni Battista Lamperti*. New York: Talpinger Publishing Company.
- Bunch, M. A. (1997). *Dynamics of the Singing Voice Fourth Edition*. New York: Springer-Verlag.
- Bunch, M. A. (1998). *A Handbook of the Singing Voice*. London: Meribeth Bunch
- Burgin, J. C. (1973). *Teaching Singing*. Metuchen New Jersey: The Scarecrow Press Inc.

- Caldwell, R., & Wall, J. (2001). *Excellence in Singing: Multilevel Learning and Multilevel Teaching*. Redmond Washington: Caldwell Publishing Company.
- Campbell, E. J. M. (1970), Accessory Muscles. . In E.M. J. Campbell, E. Agostoni, & J. Newsom Davis, *The Respiratory Muscles Mechanics and Neural Control* (pp. 181-193). Philadelphia and London: W. B. Saunders Company
- Campbell, E. J. M., & Newsom Davis, J. (1970), The Intercostal Muscles and other Muscles of the Rib Cage. In E.M. J. Campbell, E. Agostoni, & J. Newsom Davis, *The Respiratory Muscles Mechanics and Neural Control* (pp. 161-174). Philadelphia and London: W. B. Saunders Company
- Chapman, J.C (2006), *Singing and Teaching Singing – A Holistic Approach to Classical Voice*. San Diego, Oxford and Brisbane: Plural Publications
- Chapman, J.C (2012), *Singing and Teaching Singing – A Holistic Approach to Classical Voice Second Edition*. San Diego, Oxford and Brisbane: Plural Publications
- Colton, R.H. and Estill J. (1981). Elements of Voice Quality: Perceptual, Acoustic and Physiologic Aspects. In N. J. Lass (Ed), *Speech and Language: Advances in Basic Research and Practice, Vol. V.*. New York: Academic Press.
- Coffin, B. (1989). *Historical Vocal Pedagogical Classics*. London: The Scarecrow Press Inc.
- De Alcantara, P. (1997). *Indirect Procedures A Musician's Guide to the Alexander Technique*. Oxford United Kingdom. Oxford University Press.
- Emmons, S. (1988) Breathing for Singing. *Journal of Voice*, 2(1), 30-35.
- Fex, B., Fex, S., Shiromoto, O. & Hirano, M. (1994). Acoustic Analysis of Functional

Dysphonia: Before and After Voice Therapy (Accent Method). *Journal of Voice*, 8(2), 163-167.

Foulds-Elliott, S.D., Thorpe, C.W., Cala, S.J., & Davis, P.J. (2000). Respiratory Function in Operatic Singing: Effects of Emotional Connection. *Journal of Logopedics, Phoniatrics and Vocology*, 25, 151-168.

Fromkin, v., Rodman, R. & Hyams, N. (1998). *An Introduction to Language*. Orlando Florida USA: Harcourt Brace College Publishers.

Garcia, M. (1984). *A Complete Treatise on the Art of Singing: Part One*. New York. Da Capo Press.

Harris, S. (1998). Speech Therapy for Dysphonia. In Harris, T., Harris, S., Rubin, J. S. and Howard, D. M., *The Voice Clinic Handbook*. (pp. 139-206). London: Whurr Publishers Inc.

Heinrich, N. (2006). Mirroring the Voice from Garcia to the Present Day: Some Insights into Singing Voice Registers. *Logopedics Phoniatrics Vocology*, 31(1), 3-14.

Hixon, T.J. (2006), *Respiratory Function in Singing. A Primer for Singers and Singing Teachers*. Tucson Arizona: Redington Brown

Hixon T.J. and Holt, J.D. (2005), *Evaluation and Management of Speech Breathing Disorders Principles and Methods*. Tucson Arizona: Redington Brown.

Hixon, T. J., Watson, P. J., Harris, F. P., & Pearl, N. B. (1988). Relative Volume Changes of the Rib Cage and Abdomen During Prephonatory Chest Wall Posturing. *Journal of Voice*, 2(1), 13-19.

- Hixon, T. J. & Collaborators. (1987). *Respiratory Function in Speech and Song*. Boston: College-Hill Press.
- Husler, F., & Rodd-Marling, Y. (1960). *Singing: The Physical Nature of the Vocal Organ*. London: Faber and Faber
- Iwarsson, J. (2001). Effects of Abdominal Wall Movement on Vertical Laryngeal Position During Phonation. *Journal of Voice*, 15(3), 384-394. Retrieved from Science Direct, [www.sciencedirect.com](http://www.sciencedirect.com) 26/4/05.
- Kotby, M., N. (1995). *The Accent Method of Voice Therapy*. San Diego California, Singular Publishing Group Inc.
- Kotby, M., N., Shiromoto, O., & Hirano, M. (1993). The Accent Method of Voice Therapy: Effect of Accentuations on FO, SPL, and Airflow. *Journal of Voice*, 7(4), 319-325.
- Lehman, L. (1993). *How to Sing*. New York. Dover Publications Inc.
- Leonard, C. H. (1983). *The Concise Gray's Anatomy*. Ware United Kingdom: Omega Books Ltd.
- Leanderson, R. & Sundberg, J. (1988) Breathing for Singing. *Journal of Voice*, 2(1), 2-12 .
- Miller, R. (1986). *The Structure of Singing System and Art in Vocal Technique*. New York: Schirmer Books.
- Miller, R. (2000). *Training Soprano Voices*. New York: Oxford University Press.
- Mc Kinney, J. C. (1994). *The Diagnosis and Correction of Vocal Faults: A Manual for Teachers*

*of Singing and Choir Directors*. Nashville Tennessee: Genevox Music Group.

Pannbacker, M. (1998). Voice Treatment Techniques: A Review and Recommendations for Outcome Studies. *American Journal of Speech-Language Pathology*, 7(3), 49-64.

Pettersen, V., Bjørkøy, K., Torp, H., & Westgaard, R.H. Neck and Shoulder Muscle Activity and Thorax Movement in Singing and Speaking Tasks with Variation in Vocal Loudness and Pitch. *Journal of Voice*, 2005 in press.

Pettersen, V. & Westgaard, R. H. (2004). Muscle Activity in Professional Classical Singing: A Study on Muscles in the Shoulder, Neck and Trunk. *Logopedics, Phoniatrics and Vocology*, 29, 56-65.

Proctor, D. F. (1980). *Breathing, Speech and Song*. New York: Springer-Verlag Wein New York.

Reynolds, S. *A Virtual Sax Lesson – Breathing*. Retrieved July 17, 2005, from <http://home.jps.net/~bflat7/breath.html>.

Rubin, J. S. (1998). Mechanism of Respiration (The Bellows). In Harris, T., Harris, S., Rubin, J. S. and Howard, D. M., *The Voice Clinic Handbook*. (pp. 49-63). London: Whurr Publishers Inc.

Sataloff, R. (1998). *Vocal Health and Pedagogy*. San Diego USA: Singular Publishing Group.

Schutte, H.K., & Miller, R. (1984). Breath Management in Repeated Vocal Onset. *Folia Phoniatrica*, 36, 225-232.

Shewell, C (2009), *Voice Work Art and Science in Changing Voices*. Chichester Sussex:

Wiley-Blackwell.

Smith, S. & Thyme, K. (1976). Statistic Research on Changes in Speech due to Pedagogic Treatment (the Accent Method). *Folia Phoniatrica*, 28, 19-103.

Sonninen, A., Laukkanen, A-M., Karma, K., & Hurme, P. Evaluation of Support in Singing. *Journal of Voice*, 2005 in press.

Sundberg, J. (1987). *The Science of the Singing Voice*. Dekalb Illinois U.S.A.: Northern Illinois University Press.

Sundberg, J., Leanderson, R., von Euler, C. & Knutsson, E. (1991). Influence of Body Posture and Lung Volume on Subglottal Pressure Control During Singing. *Journal of Voice*, 5(4), 283-291.

Sutherland, Dame Joan, *Microsoft® Encarta® Online Encyclopedia 2005*, Retrieved July, 17, 2005, from <http://encarta.msn.com> © 1997-2005 Microsoft Corporation.

Thomasson, M. & Sundberg, J. (1999). Consistency of Phonatory Breathing Patterns in Professional Operatic Singers. *Journal of Voice*, 13(4), 529-541.

Thomasson, M. & Sundberg, J. (2001). Consistency of Inhalatory Breathing Patterns in Professional Operatic Singers. *Journal of Voice*, 15(3), 373-383.

Thorpe, C. W., Cala, S. J., Chapman, J. & Davis, P. J. (2001). Patterns of Breath Support in Projection of the Singing Voice. *Journal of Voice*, 15(1), 86-104.

Thurman, L. (2004). Myth-Conceptions? About Breathing for Singing and Speaking. *Australian Voice*, 10, 28-37.

- Thurman, L. & Welch, G (Eds), (1999). *Bodymind and Voice Foundations of Voice Education*. Fairview USA: The Voice Care Network.
- Thyme-Frøkjær, K. & Frøkjær-Jenson, B. (2001). *The Accent Method: A Rational Voice Therapy in Theory and Practice*. Bicester United Kingdom: Speechmark Publishing Ltd.
- Tommasini, A.. (1997, September 15). Maria Callas: A Voice and a Legend That Still Fascinate. *New York Times*, Retrieved July 17, 2005, from <http://www.serendipity.li/callas/tomm.html>.
- Vennard, W. (1967). *Singing, the Mechanism and the Technic*. New York: Carl Fisher Inc.
- Ward, J.P.T., Ward, J., Weiner, C.M. & Leach, R.M. (2002). *The Respiratory System at a Glance*. Malden Massachusetts: Blackwell Science Inc.
- Watson, P. J. & Hixon, T. J. (1985). Respiratory Kinematics in Classical (Opera) Singers. *Journal of Speech and Hearing Research*, 28, 104-122.
- Watson, P. J. & Hixon, T. J. (1987). Respiratory Kinematics in Classical (Opera) Singers. In Hixon, T. J. & Collaborators. (1987). *Respiratory Function in Speech and Song*. Boston: College-Hill Press.
- Watson, P. J., Hixon, T. J., Strathopoulos, E. T. & Sullivan, D. R. (1990). Respiratory Kinematics in Female Classical Singers. *Journal of Voice*, 4(2), 120-128.
- Watson, P.J., Hoit, J.D., Lansing, R.W., & Hixon, T.J. (1989). Abdominal Muscle Activity During Classical Singing. *Journal of Voice*, 3(1), 24-31.
- White, R. C. (1988). On the Teaching of Breathing for the Singing Voice. *Journal of Voice*, 2(1), 26-29.