Performance Fitness: physiological benefits of aerobic exercise for performing singers

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Declaration of originality

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Performance Fitness: physiological benefits of aerobic exercise for performing singers

Abstract

How does physical fitness affect vocal fitness and the production of a healthy vocal technique? Does an increased level of aerobic fitness and muscle strength have a significant impact on improving a singer’s overall performance? These questions have been posed for centuries in relation to breathing and support in classical singing; however it has only been recently that technological developments have allowed for significant physiological research into the area of human performance.

Primary aim
The primary aim of this study was to investigate the benefits (if any) of cardiovascular and aerobic training interventions on a singer’s capability in a performance situation. Does the increased physical endurance, mental alertness and overall improved muscle strength that this type of exercise provides, have significant benefits for a singer while performing?

This project also includes a portfolio of performance recitals and is accompanied by a creative exegesis in which the issues of physical fitness and its effect on breath and muscular support to achieve the desired sound are explored from a personal perspective. During two of the recitals, given at different stages before and during the exercise intervention, I was monitored for heart rate and exertion levels while singing. The exegesis also includes discussion of the artistic preparation and the choice of repertoire.
Chapter 1

Performance Fitness

Introduction

The object of art is expression.

The essence of expression is imagination.

The control of imagination is form.

The ‘medium’ for all three is technique.

(Witherspoon, 1925, cited in Doscher, 1994, p.xii)

While all art forms originate in the desire for expression, it is undoubtedly a solid foundation of technique that makes it possible. However, building this foundation is often the most time consuming and difficult element in the formation of artistic capability.

The possible effects that a high level of aerobic fitness could have in regards to helping singers develop and maintain a healthy vocal technique and the effects that this could have on vocal fitness has not been widely studied. The possible benefits of including regular aerobic exercise in a singer’s weekly regime could include an increase in stamina, breath capacity, energy levels, mental stability, a reduction in stress levels and a stronger immune system to help prevent sickness.

For hundreds of years, singing masters have written treatises on how to sing, giving students advice on vocal technique, performance aesthetics, good taste and even advice on how to conduct themselves morally. However, there are surprisingly few that mention strategies for achieving or maintaining the aerobic or muscular fitness specific to the uses of singing. For an art form that uses the body as the instrument of expression, it is surprising how little is written about maintaining it.

Complete vocal methods books, or ‘tutors’, emerged in the eighteenth century, and became important sources on vocal technique from that point onwards, but these works too often lacked specific instructions on how to use the voice. The language of vocal pedagogy took various twists and turns, often with obscure meanings. (Stark, 1999, p. xix)
These ‘tutors’ sometimes give instructions incorporating physiological explanations for how to employ the singing mechanisms. Many such manuals use creative imagery to convey the physical sensations produced by correct vocal technique.

Another kind of teacher will decry this physiological approach to vocal instruction, believing that it makes the student self-conscious about the muscles used in singing, and ultimately tense. Instead he advocates a psychological approach. The voice is all in the mind, he declares; if one simply conceives a pleasing tone mentally, the proper muscular action will result automatically. In the studio of this type of teacher images and metaphors shower down like petals blowing off a fruit tree that has just given up flowering. (Rushmore, 1971, p. 224)

It is widely accepted that the aspect of singing that requires the most muscular strength is breath control.

Singers need to develop their respiratory system flexibility to Olympic standards. It is, however, vital to always follow the body’s natural instincts for respiration. (Chapman., 2006, p. 268)

While there are many different theories as to which is the best way to breathe, all of them rely on the strength of the abdominal muscles.

Numerous views and countless pages in the pedagogical literature are devoted to the relative merits of diaphragmatic (belly) breathing, clavicular (shoulder) breathing, raised rib (intercostal) breathing, and back (dorsal) breathing. There are descriptions of breathing practices in national ‘schools’ of singing, suggesting that German, Italian and English singers tend to use different breathing techniques. (Stark, 1999, pp. 91-92)

Even today there is considerable controversy as to the most efficient breathing technique and as to whether any single technique could be considered the ‘correct’ breathing technique for all singers. However for the purposes of this study we will be focusing on singers that have been trained in the diaphragmatic (belly) style of breathing. In her book Singing and Teaching Singing, A Holistic Approach to Classical Voice Janice Chapman describes the function of the abdominal muscles when used in breath support.

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

The SPLAT in-breath is an acronym for *Singers Please Lose Abdominal Tension*. It is a technique that requires the complete relaxation of the abdominal muscles in order to facilitate the inhalation process.

Many of the conventional methods for strengthening the abdominal region, such as crunches and sit ups, are considered unsuitable for singers as they may produce rigid inflexible muscles that may not have the required distensibility for the SPLAT in-breath. The flexibility of the abdominal wall is of prime importance to singers because, if the in-breath is tense or inhibited, the vocal tone will be tight and strangled.

The majority of research being done in the exercise field in relation to singers, in current times, is geared towards weight loss. While weight is certainly a problem for some singers, especially in the classical field, it is the fitness aspect that has received the least attention.

There is also the question of the weight of singers. Although I believe that the public go to the opera and the concert hall to hear wonderful singing and many of the great voices come in large packages, I do feel strongly that all singers, including those with large bodies, need to be fit. (Chapman, 2006, p.246)

In her book Chapman makes one of the few references to physical exercise and its effect on singers that can be found in this type of literature.

There is no question about the necessity for performers to be as physically fit as possible. Aerobic fitness and general core stability (strength and endurance) are very important, and most singers I work with pay attention to their general condition. I recommend fast walking, running, swimming, and regular visits to the gym, but do not advocate the use of weights or stomach cruncher exercise, which would be likely to produce six-pack muscles. The holistic approach to singing includes full body fitness. Care should be taken not to overwork the pectoralis major and upper trapezius muscle sets. However the muscles of the back and the lower back (latissimus dorsi, the lower trapezius, and the deep abdominal muscles) can be safely strengthened. General physical fitness strengthens the immune system and helps stave off illness. Without wanting singers to become hypochondriacs, they certainly need to treat themselves as ‘walking musical instruments’. (Chapman, 2006, p. 245)
The practise of ‘Yoga’ and ‘Pilates’ and awareness-based techniques such as ‘The Alexander Technique’ and the ‘Feldenkrais Method’ are advocated by some singing teachers and high profile opera singers such as Renée Fleming and Janice Chapman have been publicised as benefiting from these methods of muscular and awareness work. The benefits of increased core strength, correct body alignment and supple muscles are undisputed. However, there are also those who argue that the different breathing techniques taught by some of these disciplines may be counterproductive for singers, as their continual practice can translate into the subconscious and become the default action of the body making the adoption of correct singing style breathing less natural and free.

Certain of these disciplines teach breathing techniques that seem counter to good voice use in that they restrict movement in the lower ribs and abdomen. (Melton, 2003, 78)

Melton states that the ideal state for vocal expression is one of physical neutrality.

…[W]e are looking for a clean slate, physically and vocally, so that the freedom to do ‘anything’ in terms of character and style, can come out of the physical efficiency of that neutral. (Melton, 26/08/10, 5)

For the purposes of this study the focus will be primarily on the effect that aerobic fitness plays in a singer’s preparation and performance of repertoire.

**Vocal Fitness**

The term ‘fitness’ is generally used to indicate the capacity to perform a certain task. The act of singing in itself will condition the singer and develop their ability to sing. A fully ‘connected up’ singer who sings every day will maintain ‘singer fitness’ just by singing well. (Chapman, 2006, p. 246) A singer with a high level of ‘singer fitness’ or ‘vocal fitness’ denotes a singer who can negotiate long, fast or intricate phrases with control, a pleasant tone and still have enough energy, physical and mental, to deal with the expressive demands of the music. This is developed by regular practice and various technical exercises. However, Vocal fitness does not necessarily correlate with physical or aerobic fitness. This study aims to explore the hypothesis that developing aerobic fitness will significantly contribute to improve singers who already have a high level of ‘Singer fitness’ and a strong vocal technique. While developing vocal technique conditions the singer to use the appropriate muscles, strengthening these same muscles independently may produce an overall stronger, fatigue resistant instrument. It is apparent that conditioning and proper usage
of a muscle can positively affect its performance. Stretching is also seen to produce significant benefits.

Stretching muscles regularly has been shown to maintain ample blood flow and fibre concentration. Like any athlete, the singer must sing regularly to keep the muscles properly toned. (Doscher, 1994, p. xvi)

Singing in itself can feel like a fairly strenuous exercise.

The strenuous physical effort required of singers means that they are athletes, which makes singing teachers athletic coaches as well. (Doscher, 1994, p. xiii)

However, while singing can be both mentally and physical exhausting, it does not contribute significantly to improving a singer’s cardiovascular fitness.

The ‘sung’ exhale differs most substantially from that of tidal breathing (normal breathing dictated by the body’s need for oxygen) in that it needs to be prolonged and the speed and volume of air expelled needs to be controlled to produce the pitch, volume and tone that the singer requires at any given time. The act of singing requires the singer to develop and control one of the body’s most vital survival instincts. Interrupting the regular flow of the breath can require a substantial amount of a singer’s attention.

As an example of the complexity of the singing act, consider the matter of vital breathing capacity. Such a basic factor naturally has an effect upon singing, but it is not necessarily a measure of the quality of tone. Additional factors of pitch, intensity, vowel, register, attack and shape of the vocal tract also influence the amount of air consumed by a given singer, and thus minimize the importance of the vital capacity itself. (Doscher, 1994, p. xviii)

The vital capacity of the breath will always be the body’s first priority, making singing a constant struggle between the mind’s utilisation of the breath to produce a singing tone and the body’s constant need for oxygen. The act of singing also places the body under strain and increases this oxygen requirement.

… [W]e are concerned with singing, a strenuous physical endeavour in which the body’s demands for oxygen are greatly increased. As a result, the inhalation must be deeper and fuller. In addition, an adequate breath supply is needed at a specific time and for a longer duration than is necessary for speech. Indeed both of these conditions apply to very few other athletic tasks. (Doscher B., 1994, p.1)
These strenuous demands made on the body while singing can be extremely fatiguing on the respiratory muscles and even lead to sensations of dizziness due to inadequate oxygen delivery to the brain; however, the higher the level of aerobic fitness that a person develops, the more capable their body becomes at extracting the oxygen supplied by the inhalation. The exhalation of a person with a low level of fitness will contain carbon dioxide but also a significant portion of oxygen. While the exhalation of a person with a high level of aerobic fitness will contain very little oxygen as their body is accustomed to absorbing and utilising greater amounts to fuel their muscles. This means that the fitter individual may find it easier to control their breathing as their body is capable of making maximum use of the oxygen provided and is less likely to suffer adverse effects if the breath is less frequent.

Aerobic exercise is well documented as having a myriad of health benefits for people of all ages. There are many different ways in which to develop cardio-respiratory fitness from running to cycling and everything in between; however, for the purposes of this study the focus is on walking and jogging.

Walking could be said to be the most accessible form of exercise. It requires no specialist equipment, can be done by any able-bodied person regardless of fitness level, can be used as a healthy low cost means of transport without paying for petrol or increasing green house gas emissions, can be engaged in as social activity, has innumerable health benefits, and above all is enjoyable.

Walking on a regular basis is said to help in the prevention of heart disease, stroke, type 2 diabetes, falls, fractures and injuries (through improved strength and co-ordination), colon cancer (Hoffman-Goetz and Husted, 1996, p.180), hypertension, osteoporosis, depression and lower back pain. It has also been found that beginning a program of walking can lower the intraocular pressure of people suffering from glaucoma. A study conducted in 1997 at Freiburg University Medical Centre found that walking can reduce the side effects of high dose chemotherapy. (Dimeo, 1997, p.1)

Walking regularly has also been seen to improve psychological well-being, help to normalise metabolic function, increase muscle strength and flexibility, improve strength and endurance, improve respiratory function and increase concentration and memory function.
Regular walking is also credited with strengthening the immune system, increasing energy levels and managing weight.

Exercising on a regular basis is referred to as chronic exercise. While it is generally agreed that exercise has to be performed regularly in order to experience its benefits, the frequency, duration and intensity for optimal cardio-respiratory fitness can be somewhat obscure.

Regular physical activity is associated with higher levels of physical fitness, particularly aerobic power or cardio-respiratory fitness, favourable chronic-disease risk-factor profiles, reduced risk of clinical events, and greater longevity. However, an incomplete understanding still exists as to the specific dose of physical activity, in terms of frequency, intensity, and duration, and the related volume of energy expenditure that is effective in achieving specific biological or clinical outcomes. (Blair and La Monte, 2005, p.165)

In the 2005 study ‘Prescribing Exercise at varied Levels of Intensity and Frequency’, Glen E. Duncan found that walking can increase aerobic fitness at both moderate and high intensity. Moderate Intensity Walking is defined as walking at 45-55% of subject’s maximum heart rate, an intensity at which they may be breathing a little harder than usual but are able to keep up a full conversation. High Intensity Walking is walking at 65-75% of subject’s maximum heart rate. They are able to speak only in short sentences. Subject’s maximum heart rate varies by age, health and fitness level.

It was found that subjects who walked at moderate intensity more frequently displayed a similar increase in fitness level to those who walked at a higher level of intensity less frequently.

The findings demonstrate that significant improvements in cardio-respiratory fitness can be achieved and maintained over 24 months via exercise counselling with a prescription for walking 30 minutes per day, either at a moderate intensity five to seven days per week, or at a hard intensity three to four days per week. (Duncan, 2005, p.165)

It has been discovered that walking on a steep gradient can be beneficial in both directions. Walking uphill is generally considered to be the most beneficial for increasing the intensity of aerobic conditioning by raising the heart rate. Walking uphill also significantly lowers triglycerides. Triglycerides are a type of fat found in the blood stream which if present
in high quantities can increase the risk of thrombosis (blood clots) and lead to a reduction in HDL “good” Cholesterol.

A 2004 study conducted by Dr. Heinz Drexel found that walking down hill is far superior for lowering blood sugar levels. The study took forty-five healthy yet sedentary people and asked half of them to hike up hill and half down hill on a steep mountain in the Austrian Alps. A cable car was used to transport participants in the direction that they were not required to walk and cable car tickets were used to measure compliance. They were asked to do this three to fives time a week for two months and then the groups swapped direction for another two months. Participants’ blood sugar, cholesterol and triglycerides were checked thirty-six hours after each hiking session. The findings showed that down hill walking was significantly more beneficial for improving glucose tolerance (lowering blood sugar). This information could be useful for the singer who wishes to start an exercise program but is not yet fit enough to take on more strenuous exercise. The knowledge that even non-strenuous activity like walking downhill is still beneficial could help maintain motivation and decrease the risk of giving up through frustration.

A study conducted in 2005 called ‘Effects of Physical Activity on Life Expectancy with Cardiovascular Disease’ and published in the Archives of Internal Medicine, claimed that exercise levels can be directly related to years lived without cardiovascular disease. The study took data from the Framingham Heart study to calculate the effects of high, moderate and low levels of physical activity among populations aged fifty years and above. The Framingham Heart study examined 5209 residents of Framingham Massachusetts, USA. The cohort has been examined biannually for 46 years. Based on the information collected the 2005 study found that a moderate level of physical activity, such as walking 30 minutes a day, lengthened the average total life expectancy of subjects by 1.3 years and added 1.1 more years to those without cardiovascular disease, compared with those with lower activity levels. Those who chose a high physical activity level gained 3.7 years of life and added 3.3 more years without cardiovascular disease. They concluded, "Our study suggests that following an active lifestyle is an effective way to achieve healthy aging." (Franco, 2005, p.165) Healthy aging is particularly important for singers as the singing career is one that does not start until relatively late. The classically trained voice is not considered to be fully mature until at least the mid to late twenties and opera singers usually do not reach the peak of their career until their forties and continue to sing well into their sixties and beyond. The demands of stage
performance can also be quite physically taxing. Sword fighting and dancing are a few of the common requirements of the stage performer.

It has been shown that regular exercise can not only lengthen life span but also significantly improve the quality of life. Even non-fatal disorders such as the common cold and depression have been seen to improve by exercising on a regular basis.

One of the most troublesome and frequently occurring disruptions to a performer’s schedule is sickness. Ailments as minor as colds and flu can have a devastating affect, not only on an actual performance but also on the vital preparation time prior to the event. This can result in a lowering of performance standards and, in the case of cancellations, income loss. While this affects all performers, it is particularly evident in singers.

Clearly with a severe cold all singing must cease. Singing with a voice made hoarse by swollen mucous membranes has produced many vocal cripples by leading to chronic hoarseness. (Bunch, 1997, p.160)

There are many well known strategies to boost the body’s immunity and help prevent the contraction of colds or upper respiratory tract infections. Preventative measures ranging from increasing the consumption of certain vitamins to sanitary concerns such as regularly washing and disinfecting of hands are widely known and implemented. However the benefits that moderate exercise can provide on strengthening the immune system are not as well known or widely practiced among singers. By studying the principles of exercise immunology, we can gain an invaluable tool in the prevention of upper respiratory tract infections.

It has been proposed that the relationship between aerobic exercise and URTI (upper respiratory tract infections) may be modelled in the form of a J curve. This model suggests that although the risk of URTI may decrease below that of a sedentary individual when one engages in moderate exercise training, risk may rise above the average during periods of excessive amounts of high-intensity exercise. (Hoffman-Goetz/Nieman, 1996, p.144)

Nieman’s research showed that those who walk at 70-75 percent of their $\text{VO}_2\text{max}$ for 40 minutes per day had half as many days of sickness due to upper respiratory tract infections such as colds or sore throats as those who didn’t exercise. (Quinn, 2008, p.1) $\text{VO}_2\text{max}$ is the volume of oxygen consumed by a person exercising at their maximal capacity and is usually
expressed in terms of litres per minute. \( \text{VO}_2^{\text{max}} \) varies from person to person and is influenced by size, gender, age and level of fitness.

People who exercise regularly report fewer upper respiratory tract infections (URTI) than their sedentary peers. Data from three randomized studies support this viewpoint that near-daily physical activity reduces the number of days with sickness. In these studies, women in the exercise groups walked briskly 35-45 min, 5 d·wk, for 12-15 wk during the winter/spring or fall, while the control groups remained physically inactive. Walkers experienced about half the days with URTI symptoms of the sedentary controls. Epidemiologic research also supports a reduction in URTI risk for those engaging in regular versus irregular moderate-to-vigorous physical activity. (Nieman et al, 2005, p.1)

**Immune cells**

When engaged in aerobic activity the heart pumps at an elevated rate causing the blood to cycle more quickly through the body. The blood carries with it many immune cells which when cycling at this increased pace can target bacteria and viruses more efficiently.

A faster heart means that white blood cells and other components of the immune system circulate through your body faster. This may decrease the amount of time it takes for the immune system to react to a potential infection. (Stibich, 2007, p.1)

White blood cells form the body’s communication network notifying it of any potential attacks and organizing an appropriate immune response. If these cells are cycling at a faster pace throughout the body, the time between the exposure to infectious agents and the body’s immune response can be considerably reduced. This increases the chances of successfully ridding the body of the threat before symptoms of infection can materialize.

Exercising at a moderate level has also been linked to a temporary increase in the body’s production of macrophages. Macrophages are the cells that attack bacteria. Their role is to engulf and break down pathogens and other cellular debris. (Hoffman-Goetz/Nieman, 1996, p.144)

Another component of the immune system is Natural Killer Cells. Natural Killer cells play a vital role in the rejection of tumour cells and cells that have become infected by viruses. They destroy cells by releasing small granules of protein to target the infected cell causing it to fragment.
Natural killer (NK) cells are a subpopulation of lymphocytes with azurophilic granules in their cytoplasm, that have spontaneous cytotoxicity against a variety of tumour cells, virus infected cells and some normal cells in the bone marrow and thymus. (Herberman, 1986, abstract)

A 1989 study found “that exercising at a moderate level increased Natural Killer cell cytotoxic activity by 33% compared to the age matched control group.” (Crist et al cited in Hoffman-Goetz, 1996, 205) The study concluded ‘that long term aerobic training enhances NK cell-mediated cytotoxicity.’ (Crist et al cited in Hoffman-Goetz, 1996, p.205)

Cytotoxicity is defined as the ability to be toxic to cells. The higher the level of Cytotoxic activity the more effective the killer cells will be when targeting infected cells.

Cytotoxic: Toxic to cells, cell-toxic, cell-killing. Any agent or process that kills cells. The prefix cyto- denotes a cell. It comes from the Greek kytos meaning hollow, as a cell or container. Toxic is from the Greek toxikon = arrow poison. (Medicine.net.com, 22/03/09)
**Lymphatic system**

Another factor in the body’s ability to fight colds and infections is the function of the lymphatic system.

The lymph system is a crucial part of the immune system. Deepening the breath is the signal that stimulates the lymph system. The second factor that stimulates lymph circulation is movement -- the act of contracting and releasing muscles. (Christian, 2009, p.1)

The lymphatic system has several major functions: it prevents build-up of tissue fluid surrounding cells by transporting it through the lymph vessels. Where it eventually joins the blood stream, it transports fat and fatty acids to the circulatory system and it transports immune cells to and from the lymph nodes.

One of the reasons gentle exercise is so effective is that it efficiently activates the lymph system, delivering immune cells to their sites of activity. The lymph is an important vehicle for the transport of both immune forces, T cells and certain antibodies. (Christian, 2009, p.1)

‘T’ cells are a type of white blood cell that play a key role in providing protection against different pathogens. The immune system is thought to return to its original state within a few hours after exercise. However, Nieman suggests that when moderate exercise is repeated on a near-daily basis it may have a cumulative effect that leads to a longer-term immune response.

Host protection against pathogens is improved through a summation effect of improved immuno-surveillance that occurs acutely with each moderate exercise bout. This link, however, has not yet been established and will require periodic immune testing before and after walking in a large cohort of individuals randomized to moderate exercise and sedentary groups and followed for URTI incidence. (Nieman *et al*, 2005, p.1)
Oxygenation

The increased oxygen consumption that results from vigorous physical activity is thought to have a beneficial effect on the immune system.

Oxygen plays a key role in our immune function. It is the source of the ammunition used by killer and natural killer T cells against viruses and tumours. (Jahnke, 2006, p.1)

Oxygen is vital for Cell metabolism which is the process by which individual cells process nutrient molecules and produce energy that is utilized in immune function.

Studies that evaluated lung volume and oxygen capacity noted a parallel between reduced oxygen and disease. Oxygen plays a major role in the body’s ability to protect itself against infection. (Christian, 2009, p.1)

Sweat

Aerobic exercise helps to flush toxins from the body through the pores of skin. When body temperature is elevated it activates the body’s inbuilt cooling system, the release of fluids from the sweat glands. Exercise that increases the output of sweat will help to release toxins through the skin including heavy metals, pesticides and pollutants which can suppress immune response.

Cortisol

Cortisol is a hormone produced by the adrenal cortex, which is part of the adrenal gland. It is referred to as the ‘stress hormone’ and is involved in the body’s response to stress and anxiety. Performers by nature of their profession generate an adrenalin response each time they perform. This results in the constant release of cortisol into their blood stream. Consistently high levels of cortisol can, impair cognitive performance, suppress thyroid function, increase the chances of blood sugar imbalances such as hyperglycaemia, decrease bone density, decrease muscle tissue and lower immunity and inflammatory responses in the body. Cortisol weakens the immune system by preventing the growth and function of T cells.
Aerobic exercise has been shown to reduce the amount of cortisol in the blood stream at rest and burn up the excess blood sugar caused by the adrenal response. In this way exercise is extremely beneficial to those who experience a high level of stress in their day to day lives.

**Increase in body temperature**

It has been suggested that a session of aerobic exercise can have an immediate effect in fighting off upper respiratory tract infections.

> When you exercise, your body temperature rises. Many infectious agents cannot survive a shift in even a few degrees (which is why your body generates a fever to fight infection). (Stibich, 2007, p.1)

In this way it is possible to kill off infectious agents before they can take hold. If there is a possibility that the immune system has been exposed to infectious agents a brisk walk or jog could possibly eliminate the infection before the symptoms become evident.

> Mild exercise during sickness with a common cold does not appear to be contraindicated, but there is insufficient evidence at present to say one way or the other. (Hoffman-Goetz/Nieman, 1996, p.155-156)

However exercising when unwell can be dangerous if the symptoms indicate the presence of fever.

> … [A]ttempting to ‘sweat it out’ can be dangerous if the individual is febrile because it can lead to permanent damage to the myocardium. (Hoffman-Goetz and Nieman, 1996, p.156)

The myocardium is the middle layer of the heart, which consists of cardiac muscle and is responsible for pumping blood out of the heart. Damaging the myocardium can have serious consequences and possibly result in death.

While exercising at a moderate level has a strengthening effect on the immune system, there is considerable evidence to suggest that too much exercise can have exactly the opposite effect. In general, moderate exercise tends to enhance neutrophil activity while intensive
exercise may suppress it. (Hoffman-Goetz/Nieman, 1996, p.145) Neutrophils are the most common type of white blood cells and are an important part of the innate immune system.

[T]here is also evidence that too much intense exercise can reduce immunity. This research is showing that more than 90 minutes of high-intensity endurance exercise can make athletes susceptible to illness for up to 72 hours after the exercise session. (Quinn, 2008, p.1)

It is important for performers wishing to experience the immune strengthening benefits of regular aerobic exercise to be careful not to exercise too strenuously as it could actually weaken their immune system and put them at greater risk of upper respiratory tract infections.

Knowledge of the principles of exercise immunology can be practically applied by singers and a wide range of other performers to help prevent sickness and associated disruptions to performer’s schedules and day-to-day lives. Exercise can be used not only to provide an immediate boost to the immune system; but also as a regular precaution to keep the immune system strong and healthy. This is particularly important for performers as their profession regularly places them under high levels of stress which in itself jeopardizes their immune system. However, when embarking on a program of exercise it is important to keep the intensity of the chosen exercise to a moderate level; otherwise it can be counterproductive, resulting in a weakening of the immune response.

**Stress and performance anxiety**

The singing voice is an instrument which is activated as much by mental and emotional elements as physical ones. . . . . . . The effects of anxiety and emotional stress on physical function can be devastating. Since a singer’s concept of self cannot be separated from his/her instrument, it is no wonder that emotional stress is instantly transmitted into disturbances in the vocal organs. (Doscher, 1994, p. 256)

As mentioned above, the life of a performer can be a particularly stressful one compared with many other occupations. While there is only scant evidence in the current literature on how physical and psychological well-being can interact for the benefit of the musician (Williamon, 2004, p.163), the effects of both acute and chronic exercise on stress management have been widely studied.
Cross-sectional studies link exercise habits to protection from harmful effects of stress on physical and mental health, but causality is not clear. Nevertheless, the pattern of evidence suggests the theory that exercise training recruits a process which confers enduring resilience to stress. (Salmon, 2000, abstract)

It has been shown that acute exercise can have a significant effect on lowering blood pressure that can last for several hours after aerobic activity such as walking. This could be useful to performers who suffer from performance anxiety and would normally rely on beta-blockers to steady their anxiety response. By turning to acute pre-performance exercise, they may be able to eliminate the need for tranquilisers and other drugs which would be a healthier alternative in the long run extending the possible length of their career. Acute exercise prior to performance has many other benefits such as the reduction of muscle tension which can have a detrimental effect on singers who require complete control of and the ability to relax certain muscle groups in order to breathe in the correct manner.

Another possible side effect of performance anxiety is a feeling of breathlessness that can render singing virtually impossible.

Temporary anxiety, such as stage fright, produces fear, nervousness and inhibitions all of which show up in reduced respiratory efficiency and increased muscular tension. (Doscher, 1994, p. 256)

It has been shown that fitter people will show less cardiovascular response to physical and psychological stressors. (Williamon, 2004, p.166) This means that the fitter singer is less likely to develop a heightened anxiety response resulting in severe breathlessness or elevated heart rate in stressful situations, and can function more efficiently to focus on the intricacies of performing. Handling other kinds of stress will be perceptibly easier if we are in top physical shape. (Doscher, 1994, p. 257) Chronic exercise may have a beneficial effect on the prevention and treatment of performance anxiety through the conditioning of the cardio-respiratory system resulting in an enhanced fatigue resistance and reducing cardiovascular responses to stress.

Chronic exercise may also have a beneficial effect on musical preparation. It is well known that regular exercise increases energy levels and helps with mental alertness and improved
self-esteem; which could be invaluable to the performer in the practice and preparation stage as well as in performance.

Inactivity may lead to negative moods (e.g. restlessness, irritability, fatigue, and depression) and a negative affective state (low activation and high tension or ‘bottled up energy’). (Williamon, 2004, p.164)

**Postural alignment**

Another benefit of exercise that is particularly relevant to singers is postural alignment. Postural alignment is closely related to the correct engagement of muscles and the two concepts complement each other.

When a singer has developed good postural alignment it is easier to use the abdominal muscles for breath management. Likewise when the breath is well-supported it is easier to maintain the posture and core stability. (Chapman., 2006, p. 25)

As we have seen, exercise has many advantages both for general health and benefits that are more specific to being a performing artist. Exercise can give the musician valuable insight and tools for managing the demands of being a performing artist. (Williamon, 2004, p.163) However the possible benefits of aerobic exercise on a singer’s respiratory muscles have not been explored in great detail.

This study will attempt to analyse whether external intervention on the respiratory system in the form of aerobic exercise will benefit singers while singing.

The **primary aim** of this project is to investigate whether an aerobic-exercise conditioning program designed to increase the level of aerobic fitness in singers will improve their perceived comfort level whilst performing and contribute to improved singing performance.

The **secondary aim** is to investigate the ‘ideal/optimal’ patterns of abdominal muscle activation used during singing by an experienced singer and to ascertain if these muscles benefited from a training intervention.
During this period of study I had two roles, one of which involved conducting and evaluating the experimental program; and the second, as a singer within the exercise program. In this second role, I performed two recitals (CD1 and CD2) specifically programmed to illustrate my level of fitness in performance both before and after the exercise training intervention. The first of these recitals was given before embarking on the exercise program, while the second was timed to illustrate my level of fitness after the twelve week exercise program. The final CD comprises performances that were given after the official exercise program had ended by four to six months: during this time I worked on maintaining my fitness to the level that had been reached during the intervention stage. These recordings of performances are included as evidence of the ongoing benefits from an exercise program in the maintenance stage.

The experimental component of the research forms the subject of Chapter 2, while the Creative Exegesis that follows in Chapter 3 presents an account of the recital presentation, the preparation and programs, with emphasis on the aspect of ‘physical fitness’ in addition to ‘vocal fitness’: the ability to produce the level of performance achieved in rehearsal and private practice while under the stress of live concert performance and recording; also the implementation of a physical exercise program designed to increase my Vo2max, energy levels and lung capacity and the effects this has on preparation and performance. The recital programs undertaken were designed to be testing in regards to physical stamina and mental attention, in order to gauge as a preliminary study the effects that improving aerobic capacity could have on singing performance.
Chapter 2
The Experimental Study

Introduction
In order to investigate the possible benefits that an aerobic fitness intervention program could have for singers, a study was designed with which to evaluate the breathing patterns and self perception of a group of singers after undertaking an exercise training regime. These regimes were designed on an individual basis for each participant to ensure that, if followed, the program should result in an increase of their fitness without being ineffective (if too easy) or too challenging (if too hard).

Primary Research Question
Does increasing the level of aerobic fitness contribute to or enhance recital preparation and performance?

Aims
To determine the feasibility of an exercise training program to improve singing performance.
To determine the efficacy of an exercise training program to improve singing performance.
This study was designed as a supporting study to accompany my own personal experiences in the preparation and performance of vocal recitals, and the effects that a program of physical exercise had on this process.

Methods
Study design
Singers were recruited to participate in a two-month non-intervention control period followed by a three-month exercise intervention. A number of assessments were undertaken before (baseline) and after (pre intervention) the control period and following the intervention stage (post intervention).
Assessments

Each participant was required to undertake the following assessments on three occasions:

- A song performance of their choice of 3-5min in length while being monitored by EMG sensors.
- A questionnaire to assess their personal evaluation of their singing performance and the physical effort associated with their performance (completed immediately after each singing assessment)
- A respiratory function test to assess lung function (flows, volumes and maximum voluntary ventilation)
- An aerobic exercise fitness (VO$_2$max) test on a treadmill (predominantly walking, jogging and incline based test)
- Participants were provided with a pedometer and asked to monitor their activity by recording their pedometer steps for one week prior to the intervention stage and every day for the duration of the three-month exercise-training phase
- Participants were asked to record all exercise (home, gym, step counts) in an exercise diary throughout the three-month intervention stage
- Attendance at the gym was assessed by electronic tracking of gym swipe card access.

Participants

Recruitment

For the purposes of this study I required singers that had received a moderate to high level of vocal training. It was decided that students and graduates of the conservatorium were the most likely to fulfill these requirements. Several strategies were employed to inform singers about the possibility of participating in this study. A poster was designed that was used both as an email attachment and posted on various notice boards around the Newcastle Conservatorium of Music. I spoke to the Head of the Vocal Department who agreed to email this recruitment poster to all the staff and students in the Vocal Department. I also contacted the Administrator for the University Chamber Choir who agreed to email it to the members of the choir.
Study development

Transfer from electromyography to a series of sensor belts.

In the initial study proposal, electromyography (EGM) recordings were planned to assess changes in singers’ respiratory muscle activation patterns. EMG measures muscle activation using a series of small electrodes that are stuck to the outside of the body over the muscles of interest. The electronic impulses transmitted from the muscles are each recorded on a separate channel by the computer. Prior to commencing the study, a series of tests were performed to determine the ideal locations for the electrodes to be placed on the body. I found that there was substantial difficulty in getting clear readings from the muscular impulses, as when the electrodes were placed on the torso, any signal that they were receiving was being overshadowed by the regular beat of the heart (electrocardiogram, ECG). It seems that this is not usually such a major problem as this technique is generally used for sports type studies where the electrodes are most frequently placed on the limbs. The ECG gives a weaker signal when taken from the limbs as it is so much further from the heart. Although complex filtering could have been employed during analysis to remove the impact of the ECG, this was beyond my limited physiological experience.

In view of this problem, the decision was taken to use a series of pneumograph (respiratory motion sensor) belts instead of the electromyography. These belts consist of approximately six inches of stretchy textile tubing into which is sewn several sensors. This tubing is fitted tightly to the body using a Velcro strap. Any expansion or contraction of the muscles or the torso is registered by a change in the amount of stretch in the sensor belt and transmitted to the computer via an electronic cable connected to a power lab. By positioning a series of these belts at different locations around the torso it is possible to measure the expansion and contraction of these various locations during respiration, and so determine the exact patterns of muscle activation during the singing process.
Control and intervention stages

Control period

During the control period, participants were asked to change their activity level as little as possible and to simply monitor and record their daily activity with a pedometer and report their step counts after one week.

Intervention stage

Each participant was asked to undertake a three month regime that had been specifically designed to improve their initial individual levels of fitness. The regimes were based on a program of walking or jogging, core strengthening exercises, and non-vocalized singing (unvoiced fricatives) while walking to train the respiratory muscles with two simultaneous workloads. Pedometers were used to help motivate and measure each participant’s compliance with their training plan. Each participant was asked to keep an exercise diary in which to record their pedometer step counts, the length of formal exercise sessions and what type of exercise they performed each day for the three month period. Participants were told that they were expected to devote up to an hour per day to exercising during the twelve-week training period. This included specific exercise sessions as well as monitoring general daily activity using step counts throughout the day. Some of this time was accumulated through the day rather than in a single session.

Fitness Training Plans

The intervention training plans consisted of four elements.
1) Daily activity measured by a pedometer in step counts;
2) Aerobic fitness training at two thirds of VO$_{2\text{Max}}$ for a minimum of thirty minutes per session and a minimum of three times a week;
3) Singer-specific respiratory work while walking three times a week;
4) Core strength work for approximately ten minutes per session and a minimum of three times a week.
Step Counts

Each participant had a twelve week fitness training plan designed for their individual level of aerobic fitness and their daily activity level. To calculate each person’s normal activity level, participants were asked to wear a pedometer for one week without increasing or decreasing their activity from their normal routine. These step counts were recorded every day. These values were then examined and any very high or very low values were excluded. The average of the remaining values was calculated and this established each participant’s normal level of daily activity in the form of steps per day.

Each participant was then asked to increase their daily step count by 1000 per day each week. For example, if the participant’s average daily step count was 6000 before the intervention stage they would be asked to increase this to 7000 per day for the first week, 8000 per day for the second week and so on until they reached 15000 per day. At this point they were asked to maintain this activity level for the remainder of the study. For the few participants whose daily activity level was already in excess of 15000 steps, they were encouraged to set their own goals in regards to daily activity but to concentrate on their higher intensity exercise training session.

Aerobic training

Participants were given a speed and a heart rate at which to walk or jog for 30 minutes a minimum of three times a week. This speed and heart rate were taken from the point in their metabolic fitness test on the treadmill when they had reached two thirds of their maximum aerobic fitness (VO$_{2\text{max}}$). This level of intensity was designed to be challenging but sustainable for a thirty minute period, and to be at a level to achieve a significant improvement in fitness over the twelve week intervention period. Each participant was given twelve weeks complimentary gym membership at either the Forum Sports Centre Harbourside (in the centre of Newcastle and near the Conservatorium of Music) or the Forum Sports Centre on the Callaghan campus of the University of Newcastle. The use of the treadmill at the gym enabled them to more accurately monitor their speed and intensity level in order to gain the most benefit from their training sessions. If participants were unable to make it to the gym or occasionally wished to use a different form of aerobic training equipment, they were instructed to aim for a level of intensity that was challenging but sustainable for the duration of thirty minutes. In addition to this thirty minute training session
participants were instructed to warm up for approximately ten minutes at a lesser intensity to prevent injuries and cool down in the same manner after each exercise session. Participants were also advised to stretch after any physical activity.

**Singer specific respiratory muscles work**

In order to train the respiratory muscles in the precise actions that are required of them while singing, participants were instructed to perform a series of breathing exercises while their respiratory system was already under slight strain. Participants were instructed to walk at a brisk pace while sustaining an exhale to an unvoiced fricative. Examples of this are ‘Sh’ as if telling someone to be quiet or sibilant ‘S’ sounds. They were instructed to complete 10 exhales in this manner at least three times a week.

**Core Strength**

Participants were asked to perform approximately ten minutes of core strengthening exercises three times a week. The muscles of the core are primarily the abdominal muscles; however they also include the muscles of the gluteus complex, the back muscles and the muscles of the upper legs. Participants were not given specific directions as to which exercises to perform as it was judged to be safer for them to ask the staff at their gym to recommend exercises specific to their level of strength. Also the gym staff would be able to supervise these exercises and correct any unsafe technical problems. Stretching was recommended after all periods of exercise.
Assessments

Participants were asked to undergo the following assessments on three occasions over a five month period. Each test session took approximately one hour per participant. These assessment sessions were the main organizational challenge for this project as it required coordinating the available lab time with the schedules of the participants, the staff at the human performance laboratory, the supervising professor and the piano accompanist. This proved to be somewhat problematic at times. Participants were provided with free parking permits at the human performance laboratory, complimentary gym membership with a choice of two locations and a pedometer to monitor their daily physical activity level and which they were permitted to keep after the conclusion of this study.

Muscle activation while singing

Participants were asked to choose a song of three to five minutes in length for the muscles activation test. They were instructed to choose a song that they felt comfortable with and would not feel nervous to perform in front of the lab staff and in the very peculiar circumstances of being strapped into motion sensor belts. The decision to let the participants have a completely free choice in regards to their performance repertoire was also due to the large variety of voice types and styles that were participating in the study and as no two voices are the same: only the individual singer can judge what will be comfortable for their voice. Another aspect of this decision was that participants were being evaluated only in regards to their own previous performances and not against each other, so there was no conflict in regards to the difficulty of repertoire.

In order that each performance of the song was sung at a consistent level each time, it was necessary to provide piano accompaniment for this component of the testing. This gave the singer the level of aural support that they were accustomed to and ensured that the speed and pitch of the song was performed at a comparable level in each test. As there is no piano in the Human performance laboratory I arranged to have a portable electric Keyboard transported to the lab for each batch of test sessions. This also required the engagement of a piano accompanist to play these accompaniments.
Each participant was monitored by movement sensors embedded in approximately six inches of stretchy textile tubing throughout their singing. This tubing was fitted tightly to the body using a Velcro strap. Any movements of the respiratory muscles or the torso were registered by a change in the amount of stretch in the sensor belt and this was transmitted to the computer via an electronic cable connected to a data acquisition system. PowerLab, model 8/30 (ADI Instruments, Sydney, Australia) and Chart 7.1 Pro software package (ADI Instruments). The PowerLab amplifies the signal and converts the analogue signal into a digital voltage recording; this recording is then displayed on a computer using the Chart 7.1 Pro software package. This software allows for post-experiment data analysis and data calculations. By positioning a series of these belts at different locations around the torso it was possible to measure the patterns and extent of this muscle activation during the singing process.

Each participant was monitored in five places: around the lower abdominal area (level with the hip bones), around the true waist, just underneath the chest muscle (bra strap level on females), around the upper thorax (level with the arm pits), and around the neck. The extent of the stretch on the sensor belts was then measured in order to ensure that the same tension could be achieved in future tests regardless of any changes in the participant’s size. If the sensor belts were at a different tension it would affect the sensitivity of the readings, so in order to maintain consistency they must be stretched to the same tension in each test. The movement of each sensor belt was recorded on a separate channel and displayed concurrently on the computer screen much in the same way as sound waves. All five channels had to be adjusted for sensitivity for each participant in order to ensure that none of the data peaked off the scale and could not be recorded. In order to find the appropriate settings, each participant was asked to breathe normally and then sing any particularly high or long notes from their song that would require especially large muscle movement. Once established, the channel settings were recorded for future tests in order to ensure that all data was recorded under consistent conditions. Data were sampled at one thousand times per second. The recording started by asking the participant not to phonate for ten seconds then the participant was asked to sing the song of their choice of approximately three to five minutes in duration.
Respiratory Function tests

Respiratory function was measured using a computer interfaced electronic spirometry system (Sensormedics Vmax, Loma Linda, CA, USA). This device needs to be switched on at least twenty minutes prior to use. After it has warmed up it needs to be calibrated. A large metal syringe with a volume of two point four six liters is attached to the mass flow sensor. A mass flow sensor is a plastic tube with a series of electrode pins, which attach via two cables to the computer. These sensor pins measure the volume and speed of air that passes over them. In order to provide the machine with a reference point, the syringe is used to pump a known volume of air past the mass flow sensor in a series of different speeds to teach it the difference between fast, medium, and slow air flow. The computer displays this on a graph as a series of circles of varying diameters and will notify the technicians when calibration has been successful. This needs to be done prior to testing each participant. The participant’s age, height and weight were then entered into the computer which then calculated the expected lung capacity prior to each test. The participants were then fitted with a snorkel-like mouthpiece attached to the mass flow sensor into which they were instructed to breathe. To prevent air escaping out of the nose, a nose peg was used. The nose peg was much like a clothes peg except with some soft foam to make it more comfortable when on the nose.
Test 1: Dynamic Lung Function Test

The initial respiratory function tests measured Forced Vital Capacity (FVC; how much air can be exhaled after a maximal inspiration), Forced Expiratory Volume in 1 second (FEV1; the volume of air that is exhaled in the first second after a maximal inspiration), and Peak Expiratory Flow (PEF: the maximal rate of air movement during the test). This involved breathing in to maximal capacity and then breathing out as hard and fast as possible and holding this exhale until the computer notified the technician that the test was successful. This test assesses the integrated mechanical function of the lung, chest wall, and respiratory muscles by measuring the total volume of air exhaled from full lungs (total lung capacity) to end residual volume (the air left in the lungs at the end of a maximal expiration; this residual volume prevents the lungs collapsing). This test is a test of the strength or explosive power of the respiratory muscles as well as an indication of any problems in the airways.
Test 2: Maximum Voluntary Ventilation (MVV) test

The maximum voluntary ventilation or MVV test assesses the condition of the respiratory muscles in an endurance capacity. It involved breathing in and out as hard, fast and deep as possible at the same time, much like a dog panting. This measured the greatest volume of air that can be breathed in and out per minute through voluntary effort. It is measured over a twelve second period. This can have the effect of making the participants rather dizzy. It is a substantial challenge to the respiratory muscles to maintain large air movements without fatigue.

Assessment of aerobic fitness on the treadmill

Each participant was given time to familiarize themselves with the treadmill prior to performing the fitness test. Participants walked at 4km per hour until they were comfortable with the sensation and had learned how to adjust their stride length appropriately. Then the gradient was increased progressively to 2% and then to 4% in order to familiarize them with the associated sensations. When they were comfortable they were fitted with a heart rate monitor and the same snorkel-like mouthpiece attached to a mass flow sensor and a nose peg in order to guarantee that all the air breathed out by the test subject could be monitored and recorded. Each participant was fitted with a head brace in order for the participants to have their hands free for balance, and in case they needed to use them as leverage to lift their feet off the moving treadmill.

Each participant started with 0% gradient and the treadmill set at 4km per hour. When they appeared to be comfortable with the speed they were asked if they could cope with it being increased. As they could not talk due to the breathing tube in their mouth they were instructed to give the thumbs up for yes or thumbs down for no. The participant’s heart rate was recorded every thirty seconds throughout the test. When the participant gave the thumbs down for the treadmill speed to be increased, the gradient was raised by 2% at a time, until the participant felt they could not continue any more and ended the test. The head brace and breathing tube were then removed and the participants were instructed to walk slowly on the treadmill for a further few minutes in order to cool down.

During the test all air breathed in and out was monitored for volume and the concentrations of oxygen and carbon dioxide in the expired air. By analyzing the amount of oxygen in the air breathed out it was possible to ascertain VO$_{2\text{max}}$, which is the maximum
amount of oxygen that can be consumed by the body when exercising at maximal capacity. Oxygen consumption increases as the intensity of the exercise being performed increases; however there comes a point where the intensity of the exercise can continue to increase without the corresponding rise in oxygen consumption. When this point is reached it is termed the VO$_{2\text{max}}$. This value increases as the individual becomes more aerobically fit and the body becomes more effective at processing and consuming oxygen. The body uses oxygen to fuel the activity of the muscles.

Figure 3. Head brace and mass flow sensor used for treadmill test
**Figure 4.** Tread mill test in progress. Heart rate is being recorded every thirty seconds by one technician on the right while the other controls the treadmills speed and gradient. The computer screen in front is being used to display data.
Results

Descriptive statistics (mean SD) were used to describe the characteristics of participants and compliance with the exercise training program. Responses to the training program were analysed by paired t-tests. All analyses were performed using PASW Statistics 18 (SPSS Inc, Chicago, IL, USA).

Recruitment and Participants

The majority of the volunteers were university students or people who sang regularly in choirs. A limited response to the initial recruitment strategy was received and several people who initially expressed interest declined the opportunity to be a participant once they had read the information statement. Seven participants started the study; then another wave of emails expressing interest in the project was received. In order that these people might also be included and to take advantage of the possibility of larger numbers, a second group of participants were assessed through the testing process. These newer recruits brought the total number of test subjects up to fourteen. The two groups of participants started their tests one month apart, so a decision was made to reduce the control period of the second group by one month in order to bring them into phase with the first group for the intervention stage. All participants began their exercise regimes at the approximately the same time.

Characteristics of participants

The characteristics of the participants and their compliance with the study are presented in Table 1. The singing characteristics of the participants are presented in Table 2. The participants were predominantly female (79%). They ranged in age from 19-53 years with a mean (SD) age of 31± 10 years. Based on body mass index (BMI), seven were a healthy weight, three were overweight and four were obese. Aerobic fitness levels at baseline ranged widely, particularly in the females. Desirable levels for females and males for good health are 36-45 and 40-49 ml O$_2$/kg/min, respectively. In the female participants, mean VO$_{2\text{max}}$ at baseline was 35.5 ± 9.3 ml O$_2$/kg/min with five participants below the desirable level while the other six were in or above this range. Among the male participants, mean VO$_{2\text{max}}$ at baseline was 45.5 ± 11.7 ml O$_2$/kg/min with one participant below, one in and one above the desirable range. Six of the participants were classical singers whereas eight were contemporary performers. Their recent performance experience varied widely (Table 2).
Retention of participants in the study

Of the fourteen people who originally started this project, four did not complete the final testing stage. Two of these were for health reasons: one contracted glandular fever; the other had a bad case of flu. Of the other two, one was unavailable during the final testing phase, and one cited family reasons for their withdrawal from the study. All those who did not complete the study were female; two of these participants had been actively engaged in the training until withdrawal.

Compliance with the training program

While the remaining ten participants completed the final testing phase of this experiment, there is substantial doubt as to the compliance with the fitness training programs as only five of these ten returned a fitness diary in which they documented their activity level and training sessions. Further, six participants did not use the gym membership at all in spite of free membership being provided (Table 1); these participants were all female. Only five participants used the gym with any consistency and only two participants used it at a level that could truly be expected to produce a training effect.
Table 1: Participant characteristics and compliance with the program

<table>
<thead>
<tr>
<th></th>
<th>Age (y)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
<th>BMI (kg/m²)</th>
<th>VO2 max (mlO2/kg/min)</th>
<th>Gender</th>
<th>Gym Attendance</th>
<th>Study Completion</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>36</td>
<td>159.9</td>
<td>55.96</td>
<td>22</td>
<td>45.1</td>
<td>Female</td>
<td>16 visits</td>
<td>Completed</td>
<td>Complied</td>
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<tr>
<td>S2</td>
<td>39</td>
<td>162</td>
<td>77.2</td>
<td>23.3</td>
<td>48.3</td>
<td>Male</td>
<td>21 visits</td>
<td>Completed</td>
<td>Inconsistent</td>
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<tr>
<td>S3</td>
<td>25</td>
<td>156.5</td>
<td>60.8</td>
<td>24.8</td>
<td>33.8</td>
<td>Female</td>
<td>29 visits</td>
<td>Completed</td>
<td>Complied</td>
</tr>
<tr>
<td>S4</td>
<td>23</td>
<td>165</td>
<td>101.9</td>
<td>37.4</td>
<td>31.1</td>
<td>Female</td>
<td>0 visits</td>
<td>Completed</td>
<td>Inconsistent</td>
</tr>
<tr>
<td>S5</td>
<td>39</td>
<td>184.2</td>
<td>103.2</td>
<td>30.4</td>
<td>32.7</td>
<td>Male</td>
<td>27 visits</td>
<td>Completed</td>
<td>Complied</td>
</tr>
<tr>
<td>S6</td>
<td>36</td>
<td>164.4</td>
<td>93.6</td>
<td>34.6</td>
<td>24.5</td>
<td>Female</td>
<td>14 visits</td>
<td>Did Not Complete</td>
<td>Inconsistent</td>
</tr>
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<td>19</td>
<td>164.7</td>
<td>52.8</td>
<td>19.5</td>
<td>38</td>
<td>Female</td>
<td>0 visits</td>
<td>Did Not Complete</td>
<td>Inconsistent</td>
</tr>
<tr>
<td>S8</td>
<td>20</td>
<td>177</td>
<td>82.74</td>
<td>26.4</td>
<td>37.5</td>
<td>Female</td>
<td>16 visits</td>
<td>Did Not Complete</td>
<td>Inconsistent</td>
</tr>
<tr>
<td>S9</td>
<td>20</td>
<td>156.2</td>
<td>59.04</td>
<td>24.2</td>
<td>41.3</td>
<td>Female</td>
<td>13 visits</td>
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<td>Complied</td>
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<td>44</td>
<td>168.3</td>
<td>87.12</td>
<td>30.8</td>
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<td>Female</td>
<td>0 visits</td>
<td>Completed</td>
<td>Inconsistent</td>
</tr>
<tr>
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<td>33</td>
<td>177</td>
<td>66.6</td>
<td>21.3</td>
<td>49.4</td>
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<td>24</td>
<td>156.5</td>
<td>53.18</td>
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<td>42.6</td>
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<td>53</td>
<td>166.7</td>
<td>73.77</td>
<td>26.5</td>
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<td>Female</td>
<td>0 visits</td>
<td>Did Not Complete</td>
<td>Inconsistent</td>
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<td>28</td>
<td>197.1</td>
<td>111.86</td>
<td>28.8</td>
<td>55.5</td>
<td>Male</td>
<td>19 visits</td>
<td>Completed</td>
<td>Complied</td>
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</table>

Table 2: Participant’s singing characteristics

<table>
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<th></th>
<th>Age</th>
<th>Gender</th>
<th>Singing Style</th>
<th>Singing Training</th>
<th>Voice Type</th>
<th>Recent performance experience</th>
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<td>S1</td>
<td>36</td>
<td>Female</td>
<td>Classical</td>
<td>Private lessons</td>
<td>Soprano</td>
<td>Chorister</td>
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<tr>
<td>S2</td>
<td>39</td>
<td>Male</td>
<td>Classical</td>
<td>BMus(hons)</td>
<td>Tenor</td>
<td>Operatic roles</td>
</tr>
<tr>
<td>S3</td>
<td>25</td>
<td>Female</td>
<td>Classical</td>
<td>BMus(hons)</td>
<td>Soprano</td>
<td>Soprano with early music chamber ensemble</td>
</tr>
<tr>
<td>S4</td>
<td>23</td>
<td>Female</td>
<td>Classical</td>
<td>BMus(hons)</td>
<td>Soprano</td>
<td>Operatic roles</td>
</tr>
<tr>
<td>S5</td>
<td>39</td>
<td>Male</td>
<td>Contemporary</td>
<td>Private lessons</td>
<td>Tenor</td>
<td>Musical theatre roles</td>
</tr>
<tr>
<td>S6</td>
<td>36</td>
<td>Female</td>
<td>Classical</td>
<td>BMus</td>
<td>Mezzo Soprano</td>
<td>Chorister/soloist</td>
</tr>
<tr>
<td>S7</td>
<td>19</td>
<td>Female</td>
<td>Contemporary</td>
<td>Private lessons</td>
<td>Mezzo Soprano</td>
<td>Pub Gigs</td>
</tr>
<tr>
<td>S8</td>
<td>20</td>
<td>Female</td>
<td>Contemporary</td>
<td>BMus (in progress)</td>
<td>Soprano</td>
<td>University exams</td>
</tr>
<tr>
<td>S9</td>
<td>20</td>
<td>Female</td>
<td>Contemporary</td>
<td>BMus (in progress)</td>
<td>Soprano</td>
<td>University exams</td>
</tr>
<tr>
<td>S10</td>
<td>44</td>
<td>Female</td>
<td>Classical</td>
<td>Private lessons</td>
<td>Soprano</td>
<td>Musical theatre roles</td>
</tr>
<tr>
<td>S11</td>
<td>33</td>
<td>Female</td>
<td>Contemporary</td>
<td>BMus (in progress)</td>
<td>Mezzo Soprano</td>
<td>University exams</td>
</tr>
<tr>
<td>S12</td>
<td>24</td>
<td>Female</td>
<td>Contemporary</td>
<td>Private lessons</td>
<td>Soprano</td>
<td>Band Gigs</td>
</tr>
<tr>
<td>S13</td>
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<td>Private lessons</td>
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<td>None</td>
</tr>
<tr>
<td>S14</td>
<td>28</td>
<td>Male</td>
<td>Contemporary</td>
<td>Private lessons</td>
<td>Bass</td>
<td>Chorister</td>
</tr>
</tbody>
</table>
Singing muscle activation patterns

Several interesting patterns appeared during the muscle activation tests that distinguished different styles of singing. The classical singers formed a very distinct pattern, with the trace measuring activity in the lower abdominal region moving in contrary motion to the other four traces. This pattern showed that on the ‘in breath’ the lower abdominals relaxed sharply while the traces showing other parts of the torso moved at the same time in the opposite direction. The lower abdominals were then engaged and held for the duration of the sustained exhale that formed the sung phrase. This pattern was observed most notably in the ‘classical benchmark singer’ with the majority of muscle activation in the torso in the lower and upper abdominal regions with very little activity in the upper thorax. The ‘classical benchmark’ singer exhibited a very distinctive chart recording with very little movement outside that required for singing breath control except in the neck trace where a frequent and consistent pattern of small excursions could be observed, possibly indicating vibrato and breath pressure in the larynx. Variations of this pattern can be seen in all the classical singers although sometimes with a greater amount of movement that was not associated with breathing control for singing and varying degrees of activation in the upper thorax; however the relaxation of the lower abdominal region was consistent in all the singers of this style.

The contemporary singers did not form such a consistent pattern. The lower abdominal trace moved in both directions, indicating varying degrees of relaxation and the contraction of the muscles with excursion to a similar degree. There was also a greater involvement of the upper torso muscles during singing and movements were not always associated with breathing. Movements in the neck trace were less consistent with both large and small excursions being equally evident. The lower abdominal traces produced a series of smaller excursions reminiscent of the neck trace. The ‘Contemporary benchmark’ singer also demonstrated these tendencies; however they showed a stronger emphasis on breathing with the majority of their larger muscle movements being consistent with inhalation.
Responses to exercise training program

No clear changes in the patterns of muscle activation were discerned that could be confidently attributed to the exercise-training program. This was primarily a consequence of the lack of a clear training effect in most participants.

Technology identified to provide an objective indication of singing muscular technique

This study produced an entirely unexpected outcome in the form of the discovery that the pneumograph sensor belts could be a useful training tool in the vocal studio. This piece of technology gives the singer an immediate visual representation of their breathing pattern and support mechanism showing exactly which parts of the torso are moving to produce the vocal effect. This would be particularly useful for teachers of vocal technique during a student’s early stage of developing breath control and support when the mind-to-muscle connection has not yet been fully mastered. Often teachers struggle to convey concepts due to the fact that the student’s self awareness is not developed enough to understand and reproduce the sensations that the teacher describes. This monitoring and bio-feedback mechanism could help overcome this barrier by giving a visual reinforcement helping to build this awareness.

Respiratory function tests

A surprising observation of this study was the difficulty a number of participants had initially in performing these standard respiratory function tests. It had been anticipated that singers whose singing skill depends on their control of breathing movements would have no problems performing what are normally regarded as simple tests. It was sometimes difficult to convey to the test subjects exactly how to breathe in order to meet the criteria for a satisfactory test during these assessments, and some improvement was observed after the control period as the participants had processed the information and had a better understanding of what was required.

The general tendency for improvement in respiratory function was in the group of people who were the most consistent compliers with the exercise regime. This assessment was based on those who submitted an exercise diary.
### Table 3. Assessments of singers’ respiratory function

<table>
<thead>
<tr>
<th>Code</th>
<th>MVV (L/min)</th>
<th>FVC (L)</th>
<th>PEF (L/min)</th>
</tr>
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<td></td>
<td>Baseline</td>
<td>Pre</td>
<td>Post</td>
</tr>
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<td>102</td>
</tr>
<tr>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>S3</td>
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<tr>
<td>S5</td>
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<td>95</td>
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</tr>
<tr>
<td>S7</td>
<td>76</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>S8</td>
<td>145</td>
<td>163</td>
<td>163</td>
</tr>
<tr>
<td>S9</td>
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<tr>
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<td>S12</td>
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</tr>
<tr>
<td>S14</td>
<td>263</td>
<td>263</td>
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</table>

**Aerobic fitness test**

Overall aerobic fitness levels did not change (P=0.93) as a result of the training program. This is most likely a result of the failure to engage and comply with the training program. Individual improvements in aerobic fitness were observed in only two participants, S3 (22%) and S5 (11%), who were the participants with the best gym attendance and overall compliance with the program. This indicates that the challenge for using exercise training to improve singing performance first requires identifying programs in which singers are willing to engage.
Table 4. Singer’s treadmill test responses: VO$_2$ max, speed and heart rate at which VO$_2$ max was reached.

<table>
<thead>
<tr>
<th>Code</th>
<th>Baseline VO$_2$max (mL/kg/min)</th>
<th>Speed (km/h)</th>
<th>Gradient</th>
<th>HR BPM</th>
<th>Pre VO$_2$max (mL/kg/min)</th>
<th>Speed (km/h)</th>
<th>Gradient</th>
<th>HR BPM</th>
<th>Post VO$_2$max (mL/kg/min)</th>
<th>Speed (km/h)</th>
<th>Gradient</th>
<th>HR BPM</th>
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<td>4%</td>
<td>197</td>
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<td>17</td>
<td>4%</td>
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<td>202</td>
<td>47.9</td>
<td>11</td>
<td>6%</td>
<td>199</td>
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<tr>
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<td>188</td>
<td>28.2</td>
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<td>177</td>
<td>20*</td>
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</tbody>
</table>

* Test terminated early due to respiratory problem. ** Possible equipment malfunction.
Step Counts

All the participants who submitted diaries had increased their step counts above baseline value. However not all had met the recommended targets set out in their intervention training plan.

Table 5. Step counts reported by participants each week.

<table>
<thead>
<tr>
<th>Code</th>
<th>Baseline</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
<th>Week 6</th>
<th>Week 7</th>
<th>Week 8</th>
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</table>

Self-perception questionnaire

Exactly half the test subjects reported clear overall improvement in their self-perception questionnaire. The two participants who showed the clearest improvement in their VO\(_{2\text{max}}\) were also the ones with the clearest improvement in their singing self-perception questionnaire. S3 and S5 showed a considerable drop in their rating of effort level, indicating that they found the post-intervention performance less strenuous than both the baseline and pre-intervention tests.
Performance Evaluation

VO2 Max

Test Phase

Baseline Pre Post

Performance Evaluation

Baseline Pre Intervention Post Intervention
**VO2 Max**

<table>
<thead>
<tr>
<th>Test Phase</th>
<th>VO2 Max</th>
</tr>
</thead>
<tbody>
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<td>Baseline</td>
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</tr>
<tr>
<td>Pre</td>
<td>32</td>
</tr>
<tr>
<td>Post</td>
<td>37</td>
</tr>
</tbody>
</table>

**Performance Evaluation**

- Overall Performance
- Effort Level
- Breath Control
- Abdominal Support
- Intonation
- Phrasing, Articulation, Emotional expression
- Mental alertness
- Enjoyment

- Baseline
- Pre Intervention
- Post Intervention

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**Questionnaire**
Discussion

A feasibility study was conducted to ascertain if an improvement in a singer’s aerobic capacity would result in an improvement in their perceived ease while singing, and to investigate any changes in breath management. Recruitment for this study was a challenge with very few singers volunteering for this project. Participants’ engagement in the program was also a problem with very few volunteers adhering to the training plans constructed for them. This aspect requires greater consideration in the event of a similar study in the future. Adherence to training was generally poor; only those that adhered improved aerobic fitness. Not only was participation in the more intense gym program disappointing, but increases in daily step counts were generally modest at best. This may suggest that singers need a motivational approach to increasing physical activity. There were some extenuating circumstances – some participants were members of a choir that travelled overseas for competition during the study; this travel factor was unknown at the time of enrolment in the study.
Conclusion

This study suggests that while the possibility that aerobic exercise could have considerable advantages to singers is evident, it will take a considerable amount of education before they will seriously commit to an exercise program to explore this hypothesis.

The use of the pneumograph belts as a training tool in the vocal teaching studio is one that requires further investigation but has the potential to be highly useful in giving clear feedback to students at all levels when exploring and understanding the uses of their breath support mechanism. Bunch mentions in her book *The dynamics of the singing voice* that there is a gap in current research in this area.

Current research in singing is over balanced towards acoustics and vocal fold movement, and some respiratory function analysis, with a small portion devoted to the anatomy and physiology. (Bunch, 1997, p.176)

Investigation into the uses of this technology could potentially make a contribution to filling this gap.

While the number of singers who successfully completed and complied with the requirements of this study is too small in number to give any significant statistical indication of the effects that increasing aerobic capacity could have for singers, there were indications in the two singers who did adhere to the intervention program that were positive in regards to changes in their singing performance. However, as this number of successful compliers was so small it is impossible to say whether these positive changes were as a result of the fitness intervention.
Chapter 3

Creative Exegesis

Performance Portfolio

Part 1: Recitals undertaken during the experimental period

Increasing the level of aerobic fitness: does it contribute to and/or enhance recital preparation and performance?

As a central component of my investigation I felt it would be necessary to examine my research question from a personal perspective. In order to do this I arranged to perform a series of recital programs that would span the period of study before and after the intervention stage. Two of these recitals were designated specifically to monitor aspects of my performance fitness. By documenting my observations and examining the recordings of my performances, I aimed to ascertain if there was a significant difference in my performance standard after increasing my level of aerobic fitness. The particular aspects I aimed to monitor were my feelings of physical ease and confidence while performing and my own perception of my performance standard compared with past performances; and to reflect on the possible influence of other additional factors that might account for this. As part of these observations, I also decided to measure my heart rate during the pre- and post-intervention recitals in order to obtain a more concrete proof, in the form of biological feedback, for what would otherwise be conclusions based entirely on my personal perspective.

The decision to use concert recitals as opposed to other forms of vocal performance for this purpose of monitoring my aerobic fitness and heart rate was due to the consistent level of vocal effort required throughout this type of performance. While singing in a staged entertainment is at times undeniably very strenuous, it is mixed with periods of lesser activity when the performer is not required onstage. Staged entertainments such as operas also have certain physical demands made by acting and movement that are extraneous to the activity required for singing. These activities could most certainly be benefited by an increased level of aerobic fitness; however the purpose of the present study was to ascertain whether
improving aerobic fitness would directly help sung phonation. For this reason it was decided that concert recitals in which the singer was not required to move about the stage or undertake acting demands would be the most functional performance type to illustrate this. For each of these recital programs I was on stage and in most cases singing for a high percentage of the total duration of each performance.

Choice of Repertoire

The choice of repertoire for each recital was an important consideration in the planning of both the experimental aspect and the musical side of this project. It was required to be of a level of difficulty challenging to the respiratory muscles but not to pose an unrealistic increase of difficulty beyond my current level of vocal development. If the repertoire was not sufficiently demanding it would be hard to judge any level of improvement in stamina and feeling of being in control of the performance on stage; however, if chosen only on the basis of technical difficulty, it would not necessarily produce a pleasant and rewarding musical presentation. Some of the most challenging repertoire as far as breath and support are concerned is that written for the castrato voice in the baroque and early classical period particularly in Italy. It has often been claimed that due to the larger physical size of these male soprani their lung capacity was much greater than the average female soprano of today. However one of the principal authors on the subject, Barbier, gives a more complex view of their vocal and lung capacity.

…[It] is often assumed, wrongly, that the castrati, because of their nature, enjoyed a greater lung capacity, a totally exceptional ‘reserve of air’. This argument was justified by some of them, such as Farinelli, who exhibited an astounding capacity for inhaling and exhaling and, while singing, could dispense with breathing for nearly an entire minute. (Barbier, 1996, p.17)

Barbier claims this is due to the intensive training that these young boys were required to undertake.

For six years, sometimes ten, the young castrati worked though a heavy program of daily study which concentrated on breathing, in order to provide the maximum development of the muscles controlling inhalation and exhalation, which guaranteed a vocal technique capable of overcoming all problems. Thanks to these exercises the young castrati gradually abandoned the essentially abdominal breathing of childhood and acquired
perfectly the deep costal-abdominal breathing which ensures regularity and flexibility. (Barbier, 1996, p.53)

While Barbier claims that the fact that these men had been castrated did not in itself contribute to an increase in their lung capacity, there is a clear link between the size of an individual’s lung capacity and their height. It can be observed among professional athletes that those sports requiring the largest lung capacities such as Olympic rowing and swimming generally have very tall participants with broad shoulders and large rib cages. Even within the context of this study we find that the three participants with the largest lung capacity, S2, S5 and S14 were all men over six feet tall. There is evidence to suggest that castrati were unusually tall in comparison to their colleagues, both male and female.

Another surprising aspect often observed was the abnormal height of the castrati, a somewhat awkward phenomenon for men who often took women's roles and stood a head taller than their partners….it (abnormal height) was due to the fact that the action of the pituitary gland was not counterbalanced by testosterone and could lead to over activity of the growth hormone. The fact that the men’s voices had not broken meant that the cartilage links did not knit together after puberty, as in other men. These growth cartilages continued to function and the bones could still lengthen. (Barbier, 1996, p.15) In addition, castration led to a major development of the rib-cage which tended to expand slightly into a rounder shape. (Barbier, 1996, p.16)

It is acknowledged that even the largest lung capacity will be of no use to a singer if they do not learn the proper control of their breath: however the focus of this study is on singers who have already undergone a high level of training and it can therefore be assumed that they will have mastered, at least to some extent, the methods of breath control required. Whatever the reason for the extraordinary facility of the castrati in regards to their use of breath it is clear that the repertoire written for them requires a huge attention to breath control that makes it highly suitable for the purposes of this study.

In modern times this repertoire is sung primarily by female sopranis or mezzo sopranis who are required to learn the careful control and conservation of breath in order to successfully navigate this type of music. The music of this period is also highly suitable for my vocal Fach and in particular my current state of vocal development. While much of the operatic repertoire is also very challenging physically, it was considered to be beyond my vocal

¹My voice is generally considered to be a soubrette / lyric coloratura in the Fach system classification. At the beginning of this study I was 24 years old.
capacity at the time of this study. Another factor that contributed to the choice of this repertoire is that due to a staff research project at the University of Newcastle on the Italian baroque cantata, I had access to a wide variety of newly researched music in this genre. This ranged from cantatas by Neapolitan Porpora whose music is still in the very early stages of revival, to secular and sacred works by Alessandro Scarlatti, to works by the more widely know composers such as Handel and Bach. The Italian sacred duet by Isabella Leonarda and the Spanish baroque repertoire were accessible through the recent publications and research of A-R editions in the series ‘Recent Researches in Music of the Baroque Era’.

While Baroque vocal music does not generally require the sheer level of volume and carrying power or intensity of sound that is required of the later repertoire, it does require a high degree of stamina and precision of breath management. Another important aspect of this vocal repertoire is the large amount of passage work which requires a flexible vocal facility. This facility, I feel, is greatly enhanced by having loosened or highly relaxed vocal folds. While the legato passages requiring a smooth line with the minimum of interruptions requires the vocal folds to be much tighter. Learning to adjust the level of tension in the vocal folds can be a very hard process especially if the support from the abdominal muscles is not sufficiently active.

These programs were prepared with a variety of instruments and instrument combinations played by fellow students, mostly from the B.Mus and Honours programs at the Conservatorium. The majority of these associate artists were learning baroque instruments in addition to their study on modern instruments. While there were no fixed ensemble members throughout this series of recitals there was a development of familiarity between several members who frequented a number of the programs. The most notable of these was the partnership between myself and the other soprano who participated in the duet sections of these recitals.

The concerts were presented in a variety of different locations throughout the Newcastle region. In addition to the Concert Hall at the Conservatorium there were also two churches used as venues for these presentations.
Part 1 (Experimental period recitals monitoring HRT)

Recital One, 26/08/2010
(CD1 tracks 1-9)
Duration: 58 min
Max Heart rate: 176 BPM
Average Heart rate: 146 BPM
Energy 462 Kcal

This measure of the energy expenditure recorded here may not be entirely accurate. While it is established that a person’s heart rate correlates with energy expenditure (the higher the level of effort the higher the heart rate) it does not always follow that if the heart rate is high the effort level is also as high. This is common knowledge within the fitness and weight loss community; however it could be a cause for confusion to the general population.

Program: “Storm Tossed Cantatas”
Works for Soprano, Flute, Strings and Continuo by N. Porpora and J.S. Bach

With the above criteria in mind, the cantatas of Nicola Porpora (1686-1768) suggested themselves. Porpora is well known for his collaboration with Farinelli perhaps the most famous castrato of all time who was rumored to have been over six feet tall with a huge ribcage. (Farinelli, real name Carlo Broschi 1705-1782) (Cummings, p, 196) As stated above this physical size seems to have been a characteristic among many castrati. Many of Porpora’s vocal compositions were written specifically for Farinelli’s voice and require not only a high degree of vocal flexibility but also a large amount of air. His reputation as a vocal teacher with strict standards was legendary.

We would like to believe the fine story of Porpora who is said to have made his students sing every day for six years, without flagging, all the way through one single sheet of exercises which included all possible difficulties in the art of vocalizing. (Barbier, 1996, p.54)
There are very few published editions of Porpora’s music; however there has been a recent modern revival and some of his cantatas are available on an internet site called the Porpora project (http://www.porporaproject.com/).

Porpora’s cantata “Or che d’orrido verno” fitted the requirements well and had the added advantage of having a flute obbligato, which added an extra element of concentration and musical coordination to the performance. In order to complement this work musically, it was decided to find another suitable piece to present with similar instrumentation. The music of J.S Bach is notorious for its difficulty in regard to breath control for all wind instruments, and especially in his vocal writing. Its long phrases and unremitting momentum require the maximum in breath control with very little time given to refill the breath reservoir. I wanted to find another cantata with flute obbligato in order to balance the recital program and also make best use of the flute player. I found the little known cantata “Non sa che sia dolore” which matched quite well the level of difficulty required and was similar in emotional content and imagery to the Porpora. Both cantatas were structured in the same way having an introductory instrumental Sinfonia followed by two arias preceded by recitatives. I found a score for this cantata on an internet site called “WIMA: Werner Icking Music Archive” (http://icking-music-archive.org/index.php) This site is dedicated to producing editions of works that are hard to obtain through published means and make them available to performers free of charge. We used this source for the instrumental parts and the recitatives: however as the score was in soprano clef I used versions of both arias found in a compilation by Musica Rara of Bach arias from cantatas and oratorios with obbligato flute.

The first aria of each cantata is about the sorrow of being parted from the beloved while the second aria of both works uses the analogy of a ship battling rough seas but nearing shelter, to express the feelings of hope that the sorrow of being apart would soon be resolved. This conjunction of ideas was the inspiration of the title of this presentation “Storm Tossed Cantatas”. Both arias are set for soprano, flute, two violins, viola and continuo. While these two cantatas were written at a similar time, the Bach was probably written in either 1729 or 1734 and the Porpora is thought to have been written between 1725 and 1730, the style of the Porpora is much more classical in nature.
**Technical Considerations/ Preparation**

After having learnt the notes and general structure of the pieces, I focused on the most technically challenging passages such as long phrases and fast melisma or coloratura passages. I practiced the long phrases to rolled ‘r’, and by breathing the words to the rhythm of the piece.

This exercise (rolled ‘r’) can be used for all singers. It assists in the development of the core skills directly. The rolled ‘r’ providing as it does a secondary valve produces back pressure in the mouth promoting easy phonation at the vocal fold edges. The rolled ‘r’ itself places an instant demand on the airflow and support. (Chapman., 2006, p. 271)

The melismatic passages, I practiced to a variety of dotted rhythmic patterns, as well as rolled R’s, lip trill and twang. I have found that a complete release of the abdominal support and not re engaging the muscles before embarking on a long section of coloratura is quite an effective way of conserving breath through long melismatic passages; however if the passages go too high it can create problems pitch wise. The tendency can be to go flat. Expelling enough fast air to close the chords sufficiently when they are in the shortened position required for high notes is very hard without the control from the lower abdominals which act as the accelerator in expiration. It is also possible to let the voice come off its core of sound producing a squeaky falsetto-like tone which is very hard to control in regards to pitch and has the tendency to become sharp.

Another problem I have when it comes to long coloratura runs is that my upper abdominal muscles can lock making the supply of air to the larynx unreliable and making rapid changes of pitch hard to produce. This locked feeling of the belly is accompanied by feelings of being out of breath even when the lungs are not empty. This could be due primarily to psychological factors. The fear of not being able to make it through the long run of notes could cause tension in the muscles resulting in locking of the abdominal wall. Also day to day tension carried in these muscles is, I feel, also a factor. I have noticed that during periods of stress unrelated to actual musical performance that these muscles can be tighter than normal and produce these same undesirable effects even during practice sessions. It is also possible that there is residual tension being held in the muscles due to physical activities that use these muscle groups. I have found it useful to stretch the abdominal muscles fairly
frequently and also to massage the effected area immediately prior to practice seems to alleviate this to some degree. Several recent works on singing technique mention that it is inadvisable to lift weights for this reason. (Chapman, 2006, p. 245)

Posture can also have an impact on these muscles as standing or sitting with a collapsed chest (low sternum) contracts the upper abdominal muscles and stretches the upper back making it hard to open the ribs when needed for inhalation and creating tension in the diaphragm region. (Melton, 2010, p.4) I have also become aware that during the coloratura passages, particularly in the last aria of the Porpora cantata that I am aspirating in order to make the articulation of each note. This could also be contributing to the feeling of being out of air as I am expelling too much breath when it is not necessary.

Text and Music

The text provided the main impetus for all elements of musical expression throughout both cantatas. While the text of the cantata by Porpora makes no specific reference to a particular occasion, the Bach has a number of references that suggest it was composed in response to the departure of a friend known to the Bach family. It has been proposed that the piece is a farewell cantata addressed to a young man who is leaving his home town. The first recitative refers to Minerva who was the Roman Goddess of arts, medicine and commerce. This reference has been taken to imply that the person departing is a scholar.

From the text we learn that the traveler is a scholar returning to his homeland in order to serve it. (Dürr, 2005, p.924)

The nature of the text has led to some debate as to the authorship of this cantata.

The unresolved questions being with the text, which is written in Italian at times poor enough to be incomprehensible. (Dürr, 2005, p.923)

Dürr suggests that the text was compiled from several different sources by a ‘text editor’ who was largely unfamiliar with the Italian language and who molded it to fit the occasion. (Dürr, 2005, p.923)
Two possible identities for the traveler have been suggested by Dürr: he proposes that this cantata could have been dedicated to, either Johann Mathias Gesner (1691-1761) who left Weimar in 1729 to return to his native Ansbach, or to Lorenz Christoph Mizler (1711-78) who left Weimar in 1734. Dürr feels that the latter is far more likely as the text suggests a young man and Gesner would have been thirty eight at the time of his departure. (Dürr, 2005, p. 924)

The first aria describes the sorrow of the people being left behind with doleful hearts. It is not the usual Italian situation about the parting of lovers it may even be a parody of the Italian ‘Cantata di Partenza’. The long legato lines and falling phrases of Aria 1 (CD1 track 3) work perfectly to illustrate this forlorn sentiment. To enhance this I aimed to produce a fairly dark tone and make the lines as smooth as possible with gradual dynamic variations between the phrases that built on each other. The references to patriotism in the B section of this aria are in accord with both the theories proposed above – i.e. that it may be addressed to either a scholar or a soldier. The second section of this aria is less mournful, assuring the departing person of the justness of his patriotism and wishing him favorable seas for his journey. In order to portray this optimistic change we took the B section at a slightly brighter tempo with a strong attack at the start with rhythmic emphasis to highlight the themes of patriotism. The friendly winds and waves were portrayed by a generally lighter sound and texture throughout the end of the B section. This is helped by the tripping triplet passages of Bach’s setting that are reminiscent of small placid wave-type patterns.

The second recitative assures the traveler of his worth and commends him for his wisdom which is in contrast to his age, leading to the assumption that the subject is quite a young man. The final aria in lilting three eight time is the embodiment of optimism. The dance-like nature of this piece requires a bright tonal color and buoyancy to the sound and articulation. I tried to envisage a feeling of light waves and sea foam throughout this piece. However I felt despite my efforts some of the longer coloratura passages became a bit bogged down due to breathing constraints in the recital performance. The highly contrapuntal writing during this cantata also contributes to this. The voice never gets to travel freely on top of a light instrumental accompaniment, but is always engaged in linear dialogue with the flute and violins.
The second Cantata of this program, by Nicola Porpora, has similar nautical allusions. The first recitative deals with the bleak prospect of winter and its devastating effect on the European landscape, making a direct correlation between this and the heart of a lover separated from its beloved. The first aria expands on this theme of being separated from the beloved in a very sweet lilting gallant style. The ‘A’ section with its frequent trills and dotted rhythms, feels somewhat tongue-in-cheek about its sentiment. The light elegant nature of the musical phrases seems to be in contrast to the melodrama of the text. In order to bring out more of the emotional expression of the text we concentrated on bringing the sigh-like nature of the piece to forefront. Phrases such as the repeated ‘Oh Dio!’ which occurs throughout the A section I emphasized by making the last one far louder and more passionate than the first. The B section is a little more genuine and passionate in its misery: I aimed to highlight this with a more agitated tonal color and by smoothing out the dotted rhythms to achieve a more legato effect.

It was decided to perform to these pieces with a small ensemble of one instrument per part. For tuning reasons it was decided not to have two violins per part, and while three per part is considered ideal for tuning purposes, it was thought to be too large for our purpose, or indeed for the purposes of the music itself.

There was some difficulty finding a suitable place to rehearse during the preparation for this recital. Due to unforeseen limitations on arranging regular rehearsal space with access to a harpsichord, we were forced to rehearse in one of the teaching studios which was very cramped and acoustically very difficult for rehearsal purposes. We managed only one full rehearsal with all members of the ensemble present on the day of the actual recital during our warm up in the concert hall. We had previously rehearsed with the viola only once and had never managed to have both the viola and the second violin at the same time. This led to some confusion as far as entries were concerned during the recital, as some of the violin cue phrases were stated in the viola part a bar in advance which the ensemble were not used to hearing. The fugato section in the first aria of the Bach was particularly difficult as the parts are so interwoven with many of the themes being repeated and passed between the various instruments. This compromised rehearsal situation caused an added amount of stress to the normal pressures of performing. While it is impossible to determine exactly where the peak in heart rate occurred I certainly felt far more tension and stress during this first aria of the Bach cantata.
Vowels

During the preparation of this program I struggled with my vowel placement and I felt that they were consistently somewhat too dark especially for this early repertoire. They also influenced my breath control and made coloratura much harder. I endeavored to correct this by doing exercises to twang and practicing my pieces to bright vowels such as the “ee” vowel. I find that the effectiveness of this varies from day to day. This is particularly evident in my middle range however when I get higher than “f5” this problem seems to resolve itself.

Setback

Unfortunately this recital was held up by a potentially serious accident in which the flute player, Lecturer in Flute at the Conservatorium, tripped and fell down some stairs. She injured herself quite seriously dislocating her shoulder and breaking a bone in her foot. She was unable to play for several months and it was necessary to find another flute player for this program. Due to this hold up in preparation time I felt that the rehearsals for this recital lost some of their momentum and the impetus of working with a highly experienced professional obbligato player.

The Issue of Performing from Memory

I decided not to do the program from memory: with an ensemble playing without a conductor performing unfamiliar repertoire for the first time, I felt there was much more potential for things to go wrong. I have found in the past that a slight feeling of insecurity can be a recipe for confusion and lead to making panic-induced mistakes. The extra stress performing these two works from memory could also have had an adverse effect from a scientific point of view. The heart rate that was taken for the duration of this recital could have been significantly affected by extra stress and thus not have been representative of normal performance conditions. Bach cantatas are not usually performed from memory due to the contrapuntal complexity and intertwining of vocal with instrumental parts, as well as the comparative rarity of performances: it is not immediately familiar repertoire ingrained in the minds of performers and audience (compared with Handel’s *The Messiah*). Singing from memory has many benefits in a performance situation as it enables the performer to communicate more directly with the audience without the barrier of the written music coming
between them. It also enables greater freedom of expression through body language and greater credibility that the performer is genuinely feeling the spontaneous emotions that they are expressing.

Adjusting to different pitches: Baroque or Modern Pitch?

We were faced with the somewhat difficult decision of whether or not to use the baroque flute and perform the pieces at baroque pitch or whether to utilize the modern instrument. The baroque instrument would provide a more ‘authentic’ performance and has a very pleasing tone; however it can be very soft and get lost among the other instruments especially when working with modern string instruments strung with metal strings. The tuning of the strings was another consideration as the string players had their own exams to prepare for and we did not wish to jeopardize their own recitals by having them practice in two different tunings. In the end the decision was made to use the modern instrument. I felt that this was a good choice as my voice tends to prefer a somewhat high tessitura. Singing the part down a semitone can make the performance a little more laborious and feel a little flat not just pitch wise but emotionally. This was more so in the case of J.S. Bach cantata as the overall tessitura of the vocal part is lower than that of the Porpora work.

Recital Self-Review

Non sa che sia dolore (Bach)

The first recitative (CD1 track 1) progressed fairly well with my only regret being that my tone was a little shrill at times and I did not feel like I was properly connected to my support muscles.

Parti pur. (CD1 Track 3)

The leap of a sixth that opens this aria was not as well prepared as I had hoped with the transition to the higher note not being as smooth as I would have wished it to be. I believe
that this was caused by not preparing the internal space around the soft pallet area on the lower note. This phrase improved in the Da Capo section of this aria.

There was a small musical mistake with one of my entries during this first aria of the (CD1 track 2, 2:16min) this occurred at bar 33 where I was a little late with my entry. The flute player who took my entry as a cue followed me however we managed to straighten ourselves out in the next few bars. This same mistake occurred in the Da Capo of the “A” section which I feel was caused by panic as I was scared I was going to make the same mistake again and so my concentration was broken. This lead to me feeling somewhat flustered and my tone became shrill and I needed to take an extra breath in bar 36 (CD1, Track 2, 7:24min). During this Da Capo section I decided to leave out a few of the ornaments that I had planned to do due to feeling a little low on energy.

The second recitative (CD1 Track 3) progressed without incident and had some variations in tonal color that were appropriate to the portrayal of the words.

In the second aria of this cantata (CD1 track 4) I found that my breathing went a little ‘haywire’ and I was forced to take a number of unplanned breaths. The phrase starting on the third beat of bar 83 (CD1, track 4, 1:30min) was a mess in regards to breath. I had originally planned to breathe only after the second beat in bar 88 however after coming out of the coloratura phrase preceding this, my abdominal muscles had become tight and I found I could not release them sufficiently to take in enough air to make it through the whole phrase. I took extra breaths before the third beat in bar 85 and in bar 87. A similar problem occurred during the Da Capo of this phrase.

Or che d’orrido verno

The first aria of the cantata (CD 1 track 7) started on a solid footing with only one unplanned breath just prior to the coloratura run in bar 21 (1:25min), and a slight hesitation at the cadence at the end of the ‘A’ section (2:49min)

By the time we reached the second aria of this cantata (CD1 track 9) I was starting to feel somewhat vocally tired, however I feel that it presented quite well with no unplanned breaths or timing problems.
**Breath Control**

At the time of this performance, and in retrospect I felt my breath control was not very good. I think this was partially due to nerves; however I was also struggling with my vowel placement especially during the first aria of the Bach (CD 1 track 2). During the ‘B’ section I took a few unplanned breaths to help keep the phrases alive one of these occurred during the first beat of bar 56 (3:50min). I felt that the tone color was very dark and while this suited the melancholy nature of this movement I felt that it went too far and adversely affected both the pitch and phrasing of this piece. There were several places where I ran prematurely out of breath and was obliged to take fast snatch breaths to get me through the passage. These problems were primarily noticeable in the Bach cantata especially during the first aria (CD1 track 2). I felt that I was far less nervous and able to perform better once we got to the Porpora (CD1 tracks 5-9). This was in part also due to the fact that we had performed the second aria from the Porpora cantata in April 2010 with the first flute player. I have included this performance for comparison purposes (CD1 Track 10). The performance had been quite a successful one with lots of energy in spite of the fact that I had a cold at the time, so I had some confidence from having survived a public performance of this aria before. Another factor that contributed to the energy of this earlier performance was that I was not performing the whole cantata or the whole recital so it felt easier to sing as I did not have the stress of the rest of the music weighing on my mind. I also feel that only after performing any piece of music do I really know it well. No matter how many rehearsals I have or how much individual preparation and practice, the music does not really sink in to my subconscious memory until I have performed it at least once for an audience.

**Emotional and Musical Expression**

At the start of this recital (CD1, track 2) the ensemble was a little shaky and hesitant; however it found a firmer footing part way into the first aria (CD1 track 2). Interaction between the musicians developed and I found that I was able to communicate with the obbligato flute player more and more as the recital progressed; however I felt that this came nowhere near the level of musical interaction that we had achieved in rehearsal. It is probable that another complete performance would be necessary of this unfamiliar challenging repertoire to make it feel a less strenuous experience.
**Interaction with Ensemble**

The nature of having a specific obbligato instrument makes the interaction between the ensemble members slightly more complex, as having two soloists we need to be more aware of which part is the leading part at any given time. The interaction between these soloists needs to be very highly developed for a successful musical performance.
Recital 2 ‘Natività’: 22 December 2010

(CD 2 Tracks 1-8)
Duration 1.06 h
Max HRT 172
Average HRT 136
470kcal

This concert involved a wide variety of performances and vocal/instrumental combinations. As I was not involved in all the pieces it was necessary to ensure that the data recorded from the heart rate monitor was accurate and relevant to the time that I was singing and not waiting back stage. In order to achieve this I utilized the pause function on the heart rate monitor so that all data recorded was from the time that I was actually performing.

Christmas Concert Occasion: Venue and Pitch Factors

Due to the time that this concert fell in the course of the experiment, we came very close to Christmas with the date. This led to programming a recital with a Christmas theme and it was decided to call the program ‘Natività’.

It was decided that it would be appropriate to hold this concert in a church and we found a very nice local stone church with an organ which offered the possibility of having the liturgical pieces accompanied by organ. We were able to transport a small harpsichord to play with baroque oboe and violin at the lower pitch of A415. The organ was not only tuned to modern pitch, but was found to be currently tuned at the comparatively high pitch of A 456. This meant that the two solo singers performed at two pitches during the program. While the organ was tuned to equal temperament, the harpsichord was tuned to an unequal temperament (Vallotti), introducing an additional factor of tuning awareness into the concert.
Repertoire

The choice of repertoire for this concert was influenced by a number of factors. Most importantly it had to be of a similar degree of technical and performance difficulty as the first recital in order to generate a valid comparison in the readings of effort recorded via the heart rate data. I decided that in order to match the previous recital in terms of difficulty we also needed to include pieces with obbligato instruments, as this provides an extra mental challenge that could possibly be affected by a change in fitness level. Another way in which the two programs were similar is that they contain works that are rarely performed and that were new to me prior to the preparation of the performance. The choice of the Handel German Arias presented itself as a good choice as it offered several options when it came to available instruments to play the obbligato parts of the different arias. As there were two fellow students involved in this program who were specializing in baroque instrument studies, one on the oboe and one the violin, we chose works that would be appropriate in terms of keys and technique for these two instruments. There are several recent commercial recordings of these nine arias. Two notable ones in terms of obbligato instruments are the 2007 recording sung by Carolyn Sampson with the King’s Consort, in which violin is used as the obbligato for all the arias; Dorothea Roschmann with Akademie fur Alte Musik Berlin, 2000, in which “Künft’ger Zeiten eitler Kummer” is with violin, “Meine Seele hört im Sehen” and “Das zitternde Glänzen der spielenden Wellen” are with oboe obbligato and there are several arias on this recording that utilize flute as the obbligato instrument.

We came to the decision to use three arias that we felt were particularly beautiful and contrasting in nature. We felt that “Meine Seele hört im Sehen” (in B flat major) and “Das zitternde Glänzen der spielenden Wellen” (in E flat major) were particularly suitable for the oboe while “Künft’ger Zeiten eitler Kummer” with its descending triplet phrases and peaceful mood seemed particularly suitable for the violin. The Scarlatti cantata “Jam Sole Clarior” (A. Scarlatti, Concerti Sacri, op. 2) was thought a suitable piece for this concert as not only does it have a Christmas theme, but is from a similar period to works chosen for the pervious recital. Like the Porpora cantata in the first recital, I had a chance to perform this piece prior to the official recital which I found very helpful especially in view that at the time of this concert there was no recording of this piece that I could draw on for interpretive influences. The duet “Ad arma, o spiritus” by Isabella Leonarda (1620-1704), while being from a somewhat earlier style to the majority of the music in the program, presented certain
technical difficulties in regard to energy and stamina. I felt this would be beneficial to highlight any advance that I had made due to the fitness training.

This program also contained an aria with obbligato oboe from “Cantata per la notte di Natale” (Cantata for Christmas Eve) by Alessandro Scarlatti called “Pargoletto in rozze fasce” (My lord has become a little child). The cantata was composed for performance on Christmas Eve in the Apostolic Place, Rome in 1705. Learning this delightful little Christmas piece was somewhat of a challenge as there is no modern edition and we had to work from a blurry facsimile of the original manuscript. This also presented a particular mental challenge for me as it was notated in soprano clef of which I had had no previous experience. Another factor when working with the obbligato oboe part was that there was no score of both parts written together, so I had no written indication of how the two solo instruments interacted. This performance was thus rehearsed on similar lines to those which the original performers would experience: their own part together with the bass part. The availability of a recording helped to form an impression of the piece Alessandro Scarlatti, Cantata per la Notte di Natale (1705), Concerto Italiano, director Rinaldo Alessandrini, Opus 111, 1996.

Effects of Fitness Program on Practice and Preparation, October to the end of December 2010

For the first four to five weeks of the fitness program I felt very tired. It was not necessarily the case that my practice suffered during this time; however I found that by late afternoon I could no longer concentrate as well as I had previously been able to. This was partially due to the fact that I was waking up much earlier in the morning in order to have enough time to complete the exercise requirements, and partly due to the effects of the exercise itself. My fitness training plan required me to run for a minimum of thirty minutes three times a week and to meet my required number of steps by extra activity throughout the day during the rest of the week. In order to ensure that I was running at the required intensity level, I chose to run at the gym on the treadmill where I could control my exact speed and gradient. In order to meet my pedometer step targets I found that I required at least an hour of walking or the thirty minutes running in addition to my normal daily activity. In general my practice regime consisted of two forty-five minute sessions of actual singing per day except on the two days a week that I had teaching commitments. I found on these days extra singing
on top of demonstrating and the talking that is required for giving individual lessons, placed a strain on my voice and resulted in my being vocally tired for the rest of the week.

I found that after a few weeks that the physical tiredness started to disappear and I had more and more energy during the day, especially on the days that I had been to the gym to run on the treadmill. This made practice much easier as I approached it with more enthusiasm and a fresher outlook. I noticed that on days that I had started with a vigorous aerobic activity my vocal production had a greater sense of ease than that on the days that I had only walked. When the body is completely warmed up with an increased blood flow to all the organs this can help in warming up the vocal instrument as well, resulting in a more flexible and effortless vocal production.

Stretching muscles regularly has been shown to maintain ample blood flow and fibre concentration. Like any athlete, the singer must sing regularly to keep the muscles properly toned. (Doscher B., 1994, xvi)

Another factor that contributes to this could be that having mentally connected to the muscles throughout the body by exercising them it was easier to reconnect during practice sessions resulting in a greater awareness of the larynx and a stronger connection to the abdominal support muscles.

Vocally, after a few weeks of fitness training I felt that my voice was sounding a bit harsh and not ringing as easily and my vibrato seemed to be a lot faster. After experimentation I felt that this could be due to over supporting. The increased core strength that I had developed in the gym was making it much easier to support and yet I was judging my support by the same effort level as I had been used to feeling. This led to too much air pressure being pushed into the larynx causing my vocal folds to shut tightly and not let enough air through to make a pleasant sound. This technical problem is discussed by Meribeth Bunch in her book *Dynamics of the singing voice*.

A rate of much more than eight pulsations per second is normally too fast and produces either an unpleasant sound like a bleat or tremolo, and is often caused by too much pressure on the vocal folds. (Bunch, 1997, p.108)

On realizing this was the problem, it was fairly easy to remedy by being conscious of always letting the air rise, and by practicing problematic passages to lip trill type exercises. I found
that an extra focus on always releasing the support muscles completely in between phrases was also a key element to helping to reduce this problem. Another vocal problem that occurred particularly on the days where I had been working on my core strength was that during coloratura passages my upper abdominal muscles would sometimes lock even when I wasn’t running out of breath and it made it very hard to control the flow of air into the larynx and gave me the feeling of being out of breath. While this had occurred on occasion prior to the fitness intervention I found a strong correlation between working my core muscles and the presence of this technical problem. I discovered that to remedy this it was possible to dig my fingers into my stomach muscles between the front of the false ribs and massage the muscles reducing some of the muscle tone and freeing up this area. The increased awareness of these muscles that I had developed by isolating them through targeted exercises also made it easier for me to locate the problem and work on mentally relaxing tension in this area as I became aware of it. By focusing on abdominal exercises that primarily targeted the lower abdominal region, such as leg raises, I was able to prevent this problem from recurring and yet keep the ease of engaging the support muscles when required.

**Pitch and Ensemble Factors**

There were some difficulties in this recital when it came to tuning. We had chosen to use the church organ for the Isabella Leonarda duet and the ‘Concerto Sacro’ by Alessandro Scarlatti “Jam Sole Clarior”. However when we had our first rehearsal in the church we discovered that the organ was almost a quarter of a tone sharp. In order to perform the Handel German arias with baroque oboe we needed to bring in a harpsichord that was tuned to baroque pitch at A415. We also had to consider our string players performing a Debussy piano trio at A440. In order that the strings did not have to change their tuning three times in the space of one concert, the program order was arranged so that all works containing strings and voices only were performed with the organ (The Debussy Piano Trio was performed after the interval to allow plenty of time to make the change from the sharp organ pitch to piano at concert pitch.) For the singers the change in pitch was somewhat easier; however the mental adjustment required was sometimes a little taxing and resulted in some small pitch errors. Another contributing factor when it came to adjusting the ear to several pitches in one concert was that the organ was some distance away from where the ensemble was set up. This made simultaneous entries hard as well as the difficulties of hearing the organ over the other ensemble members. We had a limited number of rehearsals for this recital as the cellist came
from Melbourne and the violinist from Sydney. This led to rehearsals being exclusively during the day before the recital was held. For experimental purposes this was not a bad situation as the periods of rehearsal for both recitals were very similar: however for musical purposes it was not ideal.

Recital Review

In general I felt that this concert was far more comfortable than the first. On listening to the recordings I believe that my vocal tone and color has considerably improved. My vowels are not consistently placed in the most desirable place, however they have improved and I feel that my sound has become more focused.

During this recital I felt much more secure in my breath control than I had in the previous recital. I do however feel that my “Oh” vowel during this concert was causing some difficulties both in terms of pitch and breath control. During the concert the “Oh” vowel was being placed a bit too low and making my tone darker and giving me more of a mezzo soprano color. This problem occurred most notably on the word ‘Flores’ in the melisma spanning bar 130 to 133 (CD2 track 1, 5:46min). This color while not unpleasant in itself is not I feel suitable for my voice, as it makes it very hard to control the tuning, coloratura and large interval leaps become less accurate. However, in spite of having similar vowel placement problems as the last recital I felt that my breathing and articulation was much easier that the first recital. This could possibly indicate that the improvement in my Vo2max and lung capacity through aerobic exercise has made a positive impact on my use of air for singing purposes.

During the Duet “Ad arma, o spiritus” (Leonarda) which opened the concert there were a few glitches in pitch and slightly hesitant entries, (CD2 Track 1) the most notable of these was at bar 47 at the beginning of the first ‘Largo’ section (1:48min). There were also some breaths taken in places that I had not intended to take them such as at the end of bar 88 (CD2 track 1, 3:20) and during the section between bars 93 and 99 (3:30min), I took two breaths that were not planned and failed to take a breath in the planned place which was bar 96. The hesitant entries I feel were due to the lack of physical communication with the organist who due to the placement of the organ was a considerable distance from the singers and was also
facing away from the stage. Taking this into consideration I felt that the complicated rhythmic and harmonic devices came across quite well and the differences in tempo and mood of each movement were well contrasted and articulated.

In the first of the German Arias “Künft’ger Zeiten eitler Kummer” (Handel) I had some problems with breath control and pitch; this was partially due to an insecure feeling about tempo. While being aware of the danger of making this piece too slow, during the performance, I felt that at times I rushed and this led to being flustered in regards to taking time to breathe. There were not many unplanned breaths in this piece with bar 65 being the most obvious (CD2 Track 2, 3:10min). The breathless feeling was more a product of a perception that I did not have enough time to take a breath properly which made the phrasing sound somewhat graceless. This improved to some extent during the Da Capo section although I still left out some of the ornaments that I had planned to perform, most particularly the upward leap in bar 18, due to feeling insufficiently physically prepared. However in spite of this when listening to the recording I feel that it is not very obvious from the perspective of the audience.

The two Handel arias with baroque oboe (CD 2 Track 3 and 4) had a strong energetic feel in spite of some difficulties in the tuning and sounding of the oboe which were due to the high level of humidity that day. The coloratura passages felt fluid and there was no strain in regards to breath control or problems caused by my abdominal muscles locking. I felt that there was a strong level of communication between all ensemble members in these two pieces and the interaction between the voice and the oboe was successfully maintained throughout. I noticed that my high notes in particular had a lot more warmth and ring than in the previous recital. This could be due to the extra strength in my support muscles which made it easier to produce a fast stream of air which assisted in maintaining the necessary closure of the vocal folds. I felt that this newfound ease made my portrayal of the joyous nature of these pieces far more convincing. Certain parts of the text such as “Alles lacht” (everything laughs) which often occurs at the end of a phrase, throughout the piece, were far easier to bring out in a suitable laughing tone as I was not worried about running out of air before I could articulate it.

The Concerto Sacro “Jam Sole Clarior” presented a challenge as far as communication within the ensemble was concerned which was once again due to the position of the organ
from the rest of the performing ensemble. Nevertheless I felt that it had a strong rhythmic
drive and expressed the themes of glory and the image of the victorious St Nicholas bathed in
sunlight. I feel that in my first entry in bar 5 (CD2 track 5, 0:13min) that the first quaver
required more weight and a little more length to be a truly convincing, strong entry. This may
have been due to my taking too much time on the consonant and not letting the vowel ring for
long enough. I feel on listening to the recording that I should have started the consonant
before the beat to enable the vowel to have enough time to sound.

I felt my sound was too thick and unfocused for the fast coloratura dialogue with the
violin in the last aria and caused some pitch inaccuracies. (CD2 track 7) However despite this
I felt that these coloratura passages sounded fluid and flexible (Bars 26-32, 0:21). There were
some rhythmic inaccuracies during the dialogue with the violin at the very end of this piece
(bars 108-115, 1:57min) where I got a bit carried away and began to rush, increasing the
tempo when I should have held it steady.

Through trying to make “Pargoletto in rozze fasce” (CD2 Track 8) as sweet and peaceful
as possible I felt that I lost some of the focus in my tone and I had a tendency to be a little
underneath the note throughout. This could also be due to being a little vocally tired at the
end of the concert. However I felt that the mood was well captured and the focus improved
somewhat in the more dramatic passages.

**Conclusions**

While there were still technical problems in the post-intervention recital, I felt that as an
overall performance it was far better than recital number one. The biofeedback shows a ten
point decrease from 146 to 136 beats per minute in the average heart rate reading which
shows that I was far less nervous and placing less strain on my cardio respiratory system
throughout the second performance. This could account for the improvement in my breath
control which left me with more mental space and energy to concentrate on the portrayal of
the emotional content of the music, and be less concerned with the technical considerations.
The maximum heart rate in the second recital was also lower showing that even at the peak
moment of exertion or stress I was not exerting myself as much as in the first recital.
On a somewhat superficial note, that is nevertheless a consideration for performers, I have noticed some positive changes in my physical appearance post exercise intervention. Benefits include moving with more certainty and coordination, and clearer skin with a fresher appearance.
Part 2: Recitals given Post-Intervention Period

Included in the audio submission are live recordings of several whole works, which were performed in two concerts, given after the twelve week fitness training program had ceased. (CD 3) While I was no longer training according to the schedule or monitoring my activity with a pedometer, I was still running up to three times a week and walking a few times a week during this rehearsal period. I had changed my training style from thirty minutes steady state cardiovascular exercise to high intensity one minute sprint intervals followed by periods of walking for recovery. I found that this style of exercise challenged my cardio respiratory system without placing as much strain on my muscles and joints as the periods of running impact were shorter and less repetitive. While I do not believe that my level of fitness had increased since the end of the training schedule, I felt that my fitness had not decreased by a significant amount, and that I retained a similar level of fitness to that achieved when I was at the end of the intervention program. However a personal evaluation of one’s fitness level can be unreliable and there were no fitness tests undertaken during this period to give accurate feedback as to my condition. What can be said with reasonable certainty is that my level of fitness for these two concerts was higher than it was prior to commencing training.

These performances show the level of fitness that would come from regular vigorous physical activity such as an individual might undertake as part of their lifestyle, while not being on a specific program designed by a fitness professional. These items are included to show post-intervention performances, done without the constraints of monitoring equipment or a specially staged recital. They are included to show any progress in breath control and general vocal facility that may have been achieved through the increase in my level of fitness without the stress and artificial focus of an experimental recital. The main focus during these performances was to produce a musically and emotionally expressive performance with the primary aim of entertaining the audience. Rehearsal periods for both concerts were very short with only one or two full rehearsals before the performance and new music being learned within a month or two. This was due to the busy schedule of most members of the ensemble and various other musical commitments that required attention around the actual concert date. It also represents the time scale of rehearsal to performance frequently encountered in professional ‘early music’ performances, which may include infrequently performed music, or repertoire being revived for the first time in modern times.
Recital 3 ‘Madrid meets Naples’

The first two pieces and a duet were taken from a concert of Spanish and Italian baroque music entitled Madrid meets Naples held on the 19th of March 2011. This concert was given in a small local church as part of a regular concert series of baroque music. This concert presented a new challenge for me as I had never before sung or studied the Spanish language. The pitch chosen for this concert was a=440 Hz, i.e. standard modern pitch, with a combination of professional and student performers experienced in performing baroque music.

The first piece (CD 3 track 1) “Tornada a San Francisco, La mas pur azucena” by Juan del Vado (1625-1691) is a deceptively simple sounding piece with a very high tessitura (a-b flat in largely syllabic setting). We decided to transpose this down a perfect fourth as while all the notes were within my range the tone that I produce at that pitch was not in keeping with the tranquil nature of the emotional content. This transposition was also due to the fact that the piece is highly syllabic and enunciating consonants in this register of my voice is very difficult and the words would not have been understood. Due to the references in the text to purity and the image of the white Lily I aimed to make my tone as pure and sweet as possible. I felt for this piece that it would enhance the themes of purity to take as much of the audible vibrato out of my voice as possible; however I found during practice that this was causing strain and making me vocally tired very fast so I took the decision to let the vibrato occur wherever it felt natural to do so however I tried to minimize it where possible. This effect has been documented by several authors:

This kind of singing (straight tone) tends to iron out the vibrato and puts an enormous strain on the vocal apparatus. The strain is obvious when one sees the sheer physical effort needed to produce the sound (evidenced by the large number of neck muscles that are visible when these people sing). (Bunch, 1997, p.109)

In the singing voice, ‘straight’ tone is often produced by excessive tension of the throat and facial muscles, which may ultimately diminish the efficiency and health of the voice. Sometimes straight tone is chosen by the singer for artistic reason and in some schools of early music singing, a straight tone is preferred. If breathing and support are well trained, the use of a straight tone for artistic effect is not necessarily vocally unhealthy. (Chapman, 2006, p. 63)
While this did not produce the tone color that I had originally envisaged, due to the reasons mentioned above, I felt that the tone color was still appropriate for the sentiment of the work. In this concert we had the good fortune to be joined by a visiting lute and baroque guitar player from Germany, who along with our usual harpsichord and cello formed our continuo. This was particularly interesting for me as I had never sung with a lute, baroque guitar, or theorbo before. The contribution that these quieter plucked stringed instruments produce in the formation of the texture is significant. I was not aware of this difference in texture influencing my vocal tone in any way but it may have had a subconscious effect on my vocal production.

The ‘Cantata al Santisimo con violines’ by Sebastian Duron (CD3 Track 2) is remarkable in its wide contrast of emotional content between musical movements. These sudden changes require a high level of mental concentration and to ensure that there is a distinct difference between tonal colors from one movement to the next, attention needed to be paid to control of the vocal technique. The transition between the first aria which expresses themes of religious ‘fire and sweet violence’ to the second aria which is mournful and pleading in nature requires a sudden change of color that can be hard if the singer is not completely mentally present. I have found that fitness training has helped considerably with concentration as it teaches the mental discipline to concentrate and be aware of what the body is doing at all times. This newfound awareness has helped me in situations such as this one that required my full attention. This piece has several changes not only of tempo but also of meter which provided another mental challenge. There was a little confusion in the last three bars of this piece (Da Capo of Aria 1) where I did not slow down at the same rate as the rest of the ensemble (8:30min).

The third work from this concert that is included in this submission is a duet cantata by Alessandro Scarlatti (1660-1725) (CD 3 track 3). It tells the familiar story of Clori and Tirsi, characters who epitomize the concept of young love and who appear very frequently in the pastoral style cantatas of this period. In this cantata they come across each other by a brook. They find the image of someone lovely reflected in the brook and fall in love with the appealing person opposite. They find satisfaction in the thought that their love is ‘as pure as the water in the brook’. I sang the part of ‘Clori’ the female role. This duet felt quite comfortable to sing with no unplanned breaths or rhythmic insecurities. The relatively high tessitura of Clori’s part in this duet was much easier to deal with than it would have been.
before the increase in my fitness level. This was particularly evident between bar 18 and 32 of the ‘Andante’ section where the tessitura sits between ‘B’ and ‘G’ at the top of the treble stave (CD 3 track 3, 7:27min). The higher the pitch is within the voice, the more energy and stamina is required to maintain breath control and to produce a pleasant tone. During this solo section of the work Clori replies to Tirsi’s monologue with the same musical phrases transposed up a fourth. In this section there were, in addition to the high tessitura, several quite high anacrusis notes which require a large amount of support. I felt that my higher notes had ‘space’ and room to sound freely and were much better supported than in previous recitals. The final duet section is not as high over all as the rest of the work however it requires both singers to blend at a slow tempo. Overall the piece requires many changes of mood, color and tempo that once again requires a high level of mental alertness.

Recital 4 ‘German and Italian Masters’

The next two cantatas are taken from a concert on the 28th of May 2011 called *German and Italian Masters*. The first cantata by the Neapolitan composer Francesco Mancini (1672-1737) called ‘Quanto dolce è quell’ardore’ is scored for soprano and baroque oboe. It is comprised of two da capo arias in ‘G’ major separated by a short but chromatic recitative. This is a very sweet piece with a tender text and overall positive mood. The only pain that is mentioned is the pain of love which is inferred as a positive pain as the love is not unrequited. The intricate nature of the interwoven melodic lines between the oboe and the voice make this piece challenging both in terms of breath control and rhythmic concentration. I was quite pleased with the first vocal entry which needs to grow out of the oboe line and smoothly take over the melodic line. This required the singer to match their tone as nearly as possible to that of the oboe and to make sure that their onset is as soft as possible. From this point they are required to make their crescendo at the same rate as the oboist diminuendos so that for a moment the listeners are not sure which instrument they are listening to. I felt, on listening to the recording, that we achieved this effect quite successfully in this performance. The slow tempo and added length of the da capo in this aria requires stamina particularly in relation to sustained breaths. The pitch in this piece is somewhat unstable - perhaps due to note insecurities due to lack of rehearsal time, but also bearing in mind the technical difficulties of controlling the pitch of the baroque oboe in the first year of playing the instrument. Aria two (CD3 track 6) is much more lively and needs some attention to precise timing between the dialoguing oboe and singer (bar 48-58, 0:47min). However due to the bouncy nature and the
lively tempo this second aria feels very much as if it ‘sings itself’ without too much manipulation from the performers.

The Porpora cantata ‘Non ho vita, ho viva morte’ (1711, for soprano and basso continuo) was one of the most dramatic and exciting pieces in this program. Like some of the other works performed during these programs, this was possibly a premiere performance in Australia. The text of the first aria (Adagio) (CD 3 track 7) translates ‘I don’t live, I have living death if I have lost my love. The memory of my love is crueler than separation.’ Porpora’s setting of this requires a strong, smooth and very passionate legato line. On listening to the recording I felt that this needed more work to bring out all its potential. I formed the impression from both my feeling at the time and analyzing the recording that I was driving too much air through my instrument in order to try and achieve the desired legato effect. This led at times to a somewhat thicker tone quality than I felt would be ideal. It also resulted in me prematurely running out of air, causing further interruptions to the line through the necessity of taking extra breaths. One such breath occurred in the first phrase after the first beat in bar 7 (0:20). This could possibly have been improved by a slightly faster tempo however the slower speed suited themes of the text and apart from the breath problems felt musically suitable. The pitch was much better during this whole cantata. This I felt was due to having a greater amount of time in which to learn the music. I had learnt this cantata the previous year but this was the first public performance. This gave me plenty of time to “sing it in” so that I was not relying on merely my mental knowledge of the notes but it was also ‘in my voice’ or muscle memory. The emotional intensity that this aria requires is also worth mentioning. When focusing on the emotionally expressive side of the music it can be easy to compromise vocal technique. The melodramatic themes of loss and suffering ‘living death’ in this aria needed a strong level of expressive performance to be successfully conveyed to the audience. The more expressive one needs to be especially in very passionate settings, the more secure and automatic the vocal technique is required to be.

The second ‘Allegro’ aria of this cantata (CD 3 track 9) requires a lot of vocal flexibility and the semiquaver passages need to go quite fast. This final aria portrays the soul ‘like a little boat without a pilot, buffeted by the waves of love.’ During the performance I felt that some of the coloratura (buffeting waves) was a bit blurred and that each note was not clearly articulated. However on listening back to the recording it sounds much clearer than I anticipated. I have noticed from analyzing the recording that I am aspirating some of the
faster passages, which I personally feel is not necessary or desirable. This effect can be used sometimes to give a breathless excited color but I do not feel it is suitable consistently throughout these coloratura passages: I should be using my larynx to articulate each note in a smoother manner instead of relying on the small spurts of air. However the fact that I managed to sustain the phrases in spite of wasting a goodly portion of my breath by using aspirated “H” sounds to articulate individual notes, seems to indicate that my breath capacity has improved. I did find that at the end of some of the coloratura runs my stomach had locked again and I was not able to release it in time to take a proper breath to prepare for the next phrase. This caused some pitch inaccuracies especially in the section of large interval during the A section (bars 17-18, 0:49min).

**Reflections**

While there is no biofeedback to show definitively my VO2max or what my heart rate was during the two non monitored post-intervention performances, my overall impression is that I certainly feel far more fit and capable when it comes to performing than I did pre-intervention stage. During this period I have also become more confident in regard to singing with a wide range of instruments often tuned to pitches other than modern pitch and equal temperament, and the challenges of singing in several tuning systems in one performance. I have also performed works that have not previously been recorded and so had no reference or guidance in regard to interpretation from more experienced singers and musicians, as was the case with the works performed by J.S. Bach and Handel (see Discography). All these performances have been prepared with limited rehearsal times and often limiting circumstances with regard to rehearsal venues. All of this has served to strengthen my adaptability as a concert performer and has required a strong foundation of health and strength both physically and mentally to survive. I feel that regular aerobic exercise has strengthened all aspects of my performance and personal preparation. While there are certain factors in regards to problematic overdevelopment of residual tension in the abdominal muscles, I personally feel that increasing my level of aerobic fitness has contributed significantly to my abilities as a concert performer.

Exercise has also improved my ability to withstand stress in terms of pre-performance nerves but also the high level of stress that I was experiencing in the organization and
execution of the experimental stage of this project. The writing of the thesis is also a huge contributor to the levels of stress that I have been experiencing which has a detrimental effect on my ability to sing. I have been using bouts of acute exercise to treat feelings of anxiety and the feeling of being overwhelmed by everything that I have been required to do. This is also highly beneficial to work out feelings of frustration and ineffectiveness that can be a factor when working in the performing arts, as one is required to strive for perfection which is never attainable.

Sometimes singers report a “finding of the zone” state where they do not need to worry about their voice production at all during an entire recital, concert, or opera. This is the whole purpose of having a good vocal technique, where the voice obeys the imagination for artistic and dramatic purposes and vocal technique itself is only a means to an end (Chapman, 2006, p.285).

In this way physical fitness is very important as it gives one a stronger base both physically and psychologically to withstand the emotional and technical demands placed upon the performer.
Track List of Live Recital Performances

CD 1 (26/08/10)

“Storm Tossed Cantatas”
‘Non Sa che sia dolore’ J.S. Bach. 1685-1750 (16:08min)
Soprano, Flute, Two Violins, Viola, Cello, Harpsichord
1. Recitative. Non sa che sia dolore
3. Recitative. Tuo saver
4. Aria. Ricetti gramezza

‘Or che d’orrido verno’ Nicola Porpora. 1686-1768 (15:20min)
Soprano, Flute, Two Violins, Cello, Harpsichord
5. Sinfonia
6. Recitative. Or che d’orrido verno
7. Aria. Lungi dal ben che s’ama
8. Recitative. Pur fra tanta mia pena
10. Comparison track. Aria. Nocchier ce mira vicino al lido (5:40min)
(Recorded 09:05:2009)

CD 2 (22/12/10)

“Natività”
1. ‘Ad Arma, O Spiritus Rebelles’ Isabella Leonarda. 1620-1704 (9:42min)
(Duet for two sopranos and organ)

Three Arias from ‘Nine German Arias’ Georg Frederic Handel. 1685-1759 (18:09min)
2. Kunft’ger Zeiten eitler Kummer (soprano, baroque oboe and harpsichord)
3. Meine Seele hört im Sehen (soprano, baroque oboe and harpsichord)
4. Das Zitternde Glänzen der spielenden Wellen (soprano, violin, cello and organ)

‘Jam Sole Clarior’ Alessandro Scarlatti. 1660-1725. (5:53 min)
Soprano, Two Violins, Cello and Organ

5. Aria Iam Sole clarior
6. Recitativo. Novus iste defensor veritatis
7. Aria. Et forti animo

8. ‘Pargoletto in Rozze fasce’ from Cantata per la Notte di Natale, 1705, Alessandro Scarlatti. 1660-1725 (5:30 min)
(soprano, baroque oboe and harpsichord)

CD 3 (live performances, 19/03/11 and 28/05/11)
“Madrid meets Naples”

Track 1.
‘Tornada a San Francisco’ Juan del Vado. 1625-1691 (2:46 min) 19.3.11
Soprano, cello, baroque guitar, harpsichord
La mas pura azucena (2 stanzas sung)

Track 2.
‘Cantata al Santisimo con violins’ Sebastian Duron. 1660-1716 (9:03 min) 19.3.11.
Soprano, 2 violins, basso continuo (cello, baroque guitar, harpsichord)
  Ay que me abraso
  O Guerra Misteriosa
  Non deje de arder
  Coplas x 3
  Y en tan celestials
  Ay que me abraso

Track 3.
Duet. ‘O come bello’ Alessandro Scarlatti. 1660-1725 (10:18 min) 19.3.11
Two sopranos and basso continuo (cello, theorbo, harpsichord)
Aria 1. O come bello (Stanza 1, Tirsi; Stanza 2, Clori)
Recitative. Clori del vicin fiume
Aria. Or tu piu non dirai (Stanza 1, Tirsi, Stanza 2, Clori)
Recitative. Non do fede al ruscello
Duet. Cosi puro

“German and Italian Masters”

Cantata ‘Quanto dolce e quell’ardore’ Francesco Mancini. 1672-1737 (11:58min)
28.5.11
Soprano, Oboe and Basso
Track 4. Aria. Quanto dolce e quell’ardore
Track 5. Recitative. Purche a te sia vivinia
Track 6. Aria. Aprimi il petto

Cantata ‘Non ho vita, ho viva morte’ Nicola Porpora (1711). 1686-1768. (07:13min)
28.5.11
Soprano, cello, and harpsichord
Track 8. Recitative. Aure, deh voi portate
Track 9. Aria. Senza governo
Chapter 4
Conclusion

Does increasing the level of aerobic fitness contribute to or enhance recital preparation and performance in singers? This primary research question produced an inconclusive answer from this small exploratory study. Compliance with the exercise training program has proved to be a most troublesome problem in regards to the outcome of the study: only five participants could be described as complying reasonably with the intervention and only two adhered well to their exercise training regimes. As a consequence of this, the major conclusion that can be drawn from this project is that much greater effort needs to placed on engaging singers in exercise training. The singers that complied with the exercise intervention tended to be people who already did some form of exercise training; this study provided them with a structured program to enhance their training rather than initiate training from a low activity and fitness level. In order to achieve a higher level of compliance in a study of this nature, more thought needs to be given to making an exercise regime more appealing to singers. A higher number of participants would also be an advantage; however in a small singing community such as Newcastle it has proved hard to obtain a suitable number of volunteers for such a project. It is possible that in a larger community or in a community of professional singers, motivation to explore this research question might be higher and result in a better level of compliance with the exercise training.

While the results of this study are statistically inconclusive, there is significant evidence that aerobic exercise has a large impact on health and well being in the general population and these benefits must be helpful to singers on a general level as human beings.

If those who love singing are to serve the profession, it is necessary to look at the whole singer and recognize that the importance of the health of the singer and the voice are one and the same. (Bunch, 1997, p.177)

However, singing is a whole body/mind and energy field endeavor and we must begin to look to many more diverse areas of research that will aid in the quest for vocal excellence and performing in the public arena. (Bunch, 1997, p.173)
As Bunch states, further research is required in the field of exercise and sports science to
determine whether there are any significant singer specific benefits from increasing aerobic
capacity.

It is time for singers and voice scientists to look to sports research for what they can borrow
in the way of techniques; much can be gained in that area. (Bunch, 1997, p.174)

In Chapter Three, the creative exegesis, I discussed the personal benefits that I believe
were produced by my adherence to the exercise regime. I observed an increase in my energy
levels and stamina both in regards to singing and day-to-day activities. These changes, I felt,
had a positive effect on my practice and singing performance during and after the increase in
my aerobic capacity. I also observed a drop in my heart rate from the pre-intervention recital
to the post-intervention performance; this change indicates that I was less affected by the
stress of performance both physically and psychologically after improving my physical
fitness. While there may be other factors that could have accounted for this, every endeavor
was made to ensure that both recitals were prepared for and performed in similar
circumstances with equivalent repertoire and comparable rehearsal time.

An unanticipated outcome of this study was the discovery of an aspect of technology that
could be highly useful to singing teachers in their endeavor to convey the physical awareness
and control of the respiratory muscles particular to the uses of singing. The method devised
for assessing changes in respiratory patterns during singing using a series of pneumagraph
belts wrapping the torso and neck in five locations interfaced to a PowerLab Data Acquisition
System has been shown to provide very sensitive indications of appropriate breath control or
areas for improvement that could be used to provide feedback to singers. This could be of
particular value to novice singers, who are still learning breath control and what is required to
sing in particular styles. Strikingly different respirometry patterns were observed between the
classical and contemporary singers, and substantial differences were observed between
benchmark singers and those singers who were less accomplished. This relatively
inexpensive technology could accelerate the learning process in some singers whose
kinesthetic sensitivity is not yet well developed, and who find it hard to follow imagery-based
instructions to achieve the correct sensations for breath control purposes.
“Finally, we admit that the science is far behind the art ... our knowledge of the vocal mechanism in singing is quite limited. There are two major bottlenecks: limitation in subjects and limitation in techniques ... Close co-operation among different disciplines is clearly essential if we are ever to solve the mysteries of the singing voice”. Twenty years later, this quote remains true. It is not easy to study an instrument that lives inside a human body. (Hirano 1988, cited in Bunch 1997, p 173)

As Bunch states, it is not easy to study the singing mechanism as it is an integral part of our being. While developments in science and technology have enabled us to progress in this field of study there is much of the human voice that is still a mystery. This project produced no statistically significant finding, however my personal experience as a compliant participant in this study, and the use of the motion sensor technology in the teaching field, are positive steps in the exploration of this area of study.
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Appendices

Performance Fitness: physiological benefits of aerobic exercise for performing singers

Joelene Sara Griffith
B.Mus. (Hons.) University of Newcastle

Submitted for the degree of

Master of Philosophy (Music)

September 2011
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Information Statement for Research Project

Does exercise training improve singing performance?

Version 1 (1/8/09)

Chief Investigators: A/Prof Robin Callister (Project Supervisor); Dr Rosalind Halton

Student Researcher: Ms Joelene Griffith

You are invited to take part in the research project identified above which is being conducted by researchers from the University of Newcastle. This project is part of the research studies of Ms Griffith who is supervised by A/Prof Callister from the Faculty of Health and Dr Halton from the Conservatorium.

Why is this research being done?
The purpose of this research is to determine whether regular aerobic exercise training and specific strengthening exercises for muscles used in singing reduce the effort associated with singing and consequently results in improvements in singing performance.

Who can participate in the research?
We are seeking singers of a semi professional (high level student singer) to professional level to participate in this study. Also you need to be between the ages of 19 and 60 and be willing and able to undertake 3 months of regular exercise training.

What choice do you have?
Your decision to participate is entirely voluntary and only those who give their informed consent will participate in this project. If you decide to participate you may withdraw from the project at any time and have the option of withdrawing any data that identifies you. No reason for your decision is required. Non-participation or withdrawal from this study will not change any relationship you have with the university and will not disadvantage you in the future.

What will you be asked to do?
If you agree to participate in this project you will be asked to undergo a number of tests (described below) and complete questionnaires on three occasions. Between the first two testing sessions (8 weeks) you will be asked to do your usual level of physical activity (ie don’t increase or decrease your activity). Between the second and third testing sessions you will participate in a 12-week exercise training session that will be developed especially for your initial level of physical fitness. This will involve walking and possibly jogging (on the flat and uphill), as well as strengthening exercises for the muscles used in singing.

Assessments
You will be asked to undergo the following assessments on three occasions over 5 months.

- **Respiratory function tests** – you will undergo a range of respiratory function tests to measure the volume of air in your lungs following inspiration and the capacity to move air quickly in and out of your lungs.
- **Aerobic fitness test on a treadmill** – you will be asked to walk/jog on a treadmill where the speed starts at an easy walking pace and gradually increases in speed and/or grade (incline) until you voluntary exhaustion. During this test you will breathe through a valve so that your expired air can be collected and analysed. The air you
breathe is normal room air. Please bring loose comfortable clothing that is not too warm (shorts, T-shirt are ideal) to wear and appropriate shoes (Joggers, etc) for the fitness test. Change rooms and showers are available downstairs after the test if you wish to shower and change. Following this test you will be interviewed informally to determine your exercise preferences for the training program.

- **Sing your choice of repertoire** – you will be asked to sing one song (3-5 min long) of your choice while wearing EMG sensors to monitor the pattern of activation of the muscles you are using during singing. EMG sensors are small sensors that are stuck to your muscles for a few minutes and they can pick up the electrical activity associated with your muscles contracting so that the pattern of muscle activity can be determined. You will perform the same song on each test occasion. A piano and piano accompanist will be provided in the laboratory for all participants for each test session.

- **Questionnaires**
  - You will be asked to complete a Pre-Exercise Health Screening Questionnaire once prior to enrolment in the study to determine the level of risk associated with exercise training and testing you would be exposed to during the study.
  - Following each of your singing performances you will be asked to evaluate your performance using a Performance Evaluation Questionnaire.

- **Pedometer step counts** – you will be provided with a pedometer (a small device that you attached to a belt at your waist and which you use to count the number of steps you take each day). You are asked to wear the pedometer each day for 7 days and to record your step counts for each of these days for a week at the beginning of the study, the beginning of the exercise program and the last week of the exercise program. You may use the pedometer to set goals and monitor your success during the weeks of the exercise program.

**How much time will it take?**

Each visit to the Human Performance Laboratory will take approximately one hour. There will be a total of 3 visits throughout the 5-month period of this study. You will be expected to devote up to an hour per day during the 12-week training period. This will include specific time for exercise sessions on some days as well as monitoring the extent of your walking with step counts on other days. Some of this time will be accumulated over the day rather than in a single session.

**Where will the testing take place?**

All testing will take place in Room HPE2-08 in the HPE Building on the Callaghan campus. This is the Human Performance Laboratory of Dr Callister. This building is next to the FORUM University Sports and Aquatic Centre.

**What are the risks and benefits of participating?**

All physical activity has some risk of injury. The risk of injury involved in participating in this study will be minimised as the exercise regimes will be tailored to each individual participant and based on their individual level of fitness.
The personal benefits of participating in this study are the opportunity to improve your fitness in a safe monitored situation and all the health benefits that result from a higher level of fitness. Also you will obtain a greater understanding of your personal physiology and which muscles are utilised to promote a safe and healthy vocal technique. Participants will also receive a pedometer that can be used for future fitness monitoring purposes.

**How will your privacy be protected?**

Any information collected by the researchers that might identify you will be stored securely and only accessed by the researchers. Data will be retained for at least 5 years. You will not be referred to by name or in any way that might identify you individually without your specific consent in the submitted thesis or any public report of this project.

**How will the information collected be used?**

Information obtained in this study will be submitted as part of Joelene Sara Griffiths Master of Philosophy degree. It may also be used in scientific presentations at conferences or published in scientific journals.

**What do you need to do if you want to participate?**

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, please contact one of the researchers. Ms Griffith can be contacted by phone: 0431674780 or by email: joelene.griffith@studentmail.newcastle.edu.au.

If you would like to participate, please complete the consent form and return it to Ms Griffith in person or you can mail it to:

- Ms Joelene Griffith
- Human Performance Laboratory
- HPE Building
- University of Newcastle
- Callaghan NSW 2308

Ms Griffith will then contact you to arrange a time for the initial proceedings.

Thank you for taking the time to consider this invitation.

Yours sincerely,

………………………………………

Dr Robin Callister
Associate Professor, School of Biomedical Science

Student researcher

………………………………………

Ms Joelene Griffith
Complaints about this research
This project has been approved by the University's Human Research Ethics Committee, Approval No. H-
Should you have concerns about your rights as a participant in this research, or you have a complaint about the
manner in which the research is conducted, it may be given to the researcher, or, if an independent person is
preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of
Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-
Ethics@newcastle.edu.au.
Consent Form for the Research Project:
Does exercise training improve singing performance?
Version 1 (1/8/09)

Chief Investigators: A/Prof Robin Callister (Project Supervisor); Dr Rosalind Halton

Student Researcher: Ms Joelene Griffith

I agree to participate in the above research project and give my consent freely. I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand I can withdraw from the project at any time and do not have to provide any reason for withdrawing.

I consent to:
- Complete a Pre-Exercise Health Screening Questionnaire prior to participating in any exercise
- Be interviewed informally about my regular physical activity
- Undertake a respiratory function test on 3 occasions
- Undertake an aerobic fitness test on 3 occasions
- Have the electrical activity of my muscles measured during a singing performance 3 times
- Complete a Performance Evaluation Questionnaire 3 times
- Monitor my physical activity with a pedometer
- Participate in an exercise training program for 12 weeks

I understand that my personal information will remain confidential to the researchers and that data collected from my participation may be used in journal publications, conference presentations and a thesis. My refusal to participate or withdrawal from the study will not affect my relationship with the University of Newcastle. I have had the opportunity to have questions answered to my satisfaction. I have the right to withdraw my information at any time.

By signing below I am indicating my consent to participate in the research project conducted by the researchers named above as it has been described to me in the information statement, a copy of which I have retained.

Print Name: 

Signature: ___________________________ Date: ________________

Contact Details: Phone ___________________________

(Email) ___________________________

Address if prefer results to be mailed: ___________________________
## Pre-exercise Screening Questionnaire

**Name** ____________________________  **Date** ____________

**Age (yrs)** ________  **Gender**  M  F  **Height (cm)** ______

**Weight (kg)** ________  **Occupation** ____________________________

### PART 1

1. Have you ever had a heart attack or coronary revascularisation surgery?  
   - [ ] No  
   - [ ] Yes

2. Have you ever had a stroke?  
   - [ ] No  
   - [ ] Yes

3. Has your doctor ever told you that you have heart trouble or vascular disease?  
   - [ ] No  
   - [ ] Yes

4. Has your doctor ever told you that you have a heart murmur?  
   - [ ] No  
   - [ ] Yes

5. Do you suffer from pains in your chest, especially when you exercise?  
   - [ ] No  
   - [ ] Yes

6. Do you ever get pains in your calves, buttocks or the backs of your legs during exercise, which are not due to soreness or stiffness?  
   - [ ] No  
   - [ ] Yes

7. Do you ever feel faint or have spells of severe dizziness, particularly with exercise?  
   - [ ] No  
   - [ ] Yes

8. Do you experience swelling or accumulation of fluid around the ankles?  
   - [ ] No  
   - [ ] Yes

9. Do you ever get the feeling that your heart is suddenly beating faster, racing or skipping beats, either at rest or during exercise?  
   - [ ] No  
   - [ ] Yes

10. Do you have chronic obstructive pulmonary disease, interstitial lung disease or cystic fibrosis?  
    - [ ] No  
    - [ ] Yes

11. Have you ever had an attack of shortness of breath, which developed when you were not doing anything strenuous, in the last 12 months?  
    - [ ] No  
    - [ ] Yes

12. Have you ever had an attack of shortness of breath, which developed after you stopped exercising, at any time in the last 12 months?  
    - [ ] No  
    - [ ] Yes

13. Do you have diabetes (Type I or Type II)?  
    - [ ] No  
    - [ ] Yes
    If YES, do you have trouble controlling your diabetes?  
    - [ ] No  
    - [ ] Yes

14. Do you have any ulcerated wounds or cuts on your feet that don't seem to heal?  
    - [ ] No  
    - [ ] Yes

15. Do you have any liver, kidney or thyroid disorders?  
    - [ ] No  
    - [ ] Yes

16. Do you experience unusual fatigue or shortness of breath with usual activities?  
    - [ ] No  
    - [ ] Yes

17. Is there any other physical reason or medical condition that could prevent you from undertaking exercise or that you are concerned about?  
    - [ ] No  
    - [ ] Yes
PART 2

<table>
<thead>
<tr>
<th>Question</th>
<th>No</th>
<th>Yes</th>
<th>Don’t know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you smoke tobacco or cannabis regularly OR have you quit smoking in the last 6 months?</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Do you have a close male relative (father, son, brother) who has had a heart attack, coronary bypass surgery or died suddenly due to a heart attack before the age of 55 years?</td>
<td>No</td>
<td>Yes</td>
<td>Don’t know</td>
</tr>
<tr>
<td>Do you have a close female relative (mother, daughter, sister) who has had a heart attack, coronary bypass surgery or died suddenly due to a heart attack before the age of 65 years?</td>
<td>No</td>
<td>Yes</td>
<td>Don’t know</td>
</tr>
<tr>
<td>Do you have impaired fasting blood glucose?</td>
<td>No</td>
<td>Yes</td>
<td>Don’t know</td>
</tr>
<tr>
<td>Do you have high resting blood pressure or do you take medication for blood pressure?</td>
<td>No</td>
<td>Yes</td>
<td>Don’t know</td>
</tr>
<tr>
<td>Do you have high serum cholesterol or low HDL levels or take lipid-lowering medication?</td>
<td>No</td>
<td>Yes</td>
<td>Don’t know</td>
</tr>
<tr>
<td>Do you have an occupation where you sit for long periods of time?</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Do you do LESS than 150 minutes of moderate physical activity per week?</td>
<td>No</td>
<td>Yes</td>
<td></td>
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PART 3

<table>
<thead>
<tr>
<th>Question</th>
<th>No</th>
<th>Yes</th>
</tr>
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<tbody>
<tr>
<td>Do you currently use any medication for asthma?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Do you have any medical condition that the people conducting this exercise test need to be aware of for your safety during exercise testing?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>If yes, please provide details below</td>
<td></td>
<td></td>
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<tr>
<td>Other medical conditions:</td>
<td></td>
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Risk classification: HIGH MODERATE LOW

Developed from:
Sports Medicine Australia (SMA) pre-exercise screening system 2005
Performance Evaluation Questionnaire

Please answer the following questions in relation to your performance. Each question asks you to provide a rating on a scale of 1 to 10 where 1 is easy and 10 is hard. Please circle your answer.

1. How would you evaluate your overall performance?

   1  2  3  4  5  6  7  8  9  10

2. How would you rate your level of effort? (How hard did you need to work?)

   1  2  3  4  5  6  7  8  9  10

3. How would you rate the efficiency and ease of your breath control?

   1  2  3  4  5  6  7  8  9  10

4. How would you rate your connection with your abdominal support muscles?

   1  2  3  4  5  6  7  8  9  10

5. How would you rate your intonation? (How in tune were you?)

   1  2  3  4  5  6  7  8  9  10

6. How would you rate your control of phrasing, articulation and emotional expression?

   1  2  3  4  5  6  7  8  9  10

7. How would you rate your mental alertness?

   1  2  3  4  5  6  7  8  9  10

8. How would you rate your enjoyment level while singing this piece.

   1  2  3  4  5  6  7  8  9  10
Individual

Participant

Training Plans
Pre intervention

Average daily steps 5708
Vo2 max 39.4 ml/kg/min
Speed at which VO₂ max was reached 12km/h at 2% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

The Forum, Harbourside - Sara Woolnough 4985 4446 or Sara.Woolnough@newcastle.edu.au

The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 6700 per day
Week 2 = 7700 per day
Week 3 = 8700 per day
Week 4 = 9700 per day
Week 5 = 10700 per day
Week 6 = 11700 per day
Week 7 = 12700 per day
Week 8 = 13700 per day
Week 9 = 14700 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**

**Target speed 8km/h**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO\(_2\) max for the full 30min. To reach two thirds of your VO\(_2\) max your target speed is ~8km/h or a heart rate of 158 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.

**Please keep a journal in the form of a word document to record your daily activity**

**This should include**

Your step counts per day

The duration and speed of any formal exercise
The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

**Sample week of exercise journal**

Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warn up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 5415
Vo2 max 48.3 ml/kg/min
Speed at which VO2 max was reached 16km/h at 4% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts
Formal aerobic training including some singer specific breathing variations
Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

The Forum, Harbourside - Sara Woolnough 4985 4446 or Sara.Woolnough@newcastle.edu.au

The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program
During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 6400 per day
Week 2 = 7400 per day
Week 3 = 8400 per day
Week 4 = 9400 per day
Week 5 = 10400 per day
Week 6 = 11400 per day
Week 7 = 12400 per day
Formal aerobic training
Target speed 14km/h

Speed and Duration
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO\textsubscript{2} max for the full 30min. To reach two thirds of your VO\textsubscript{2} max your target speed is \textasciitilde14km/h or a heart rate of 170 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

Warm up.
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

Singer specific respiratory muscles work.
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

Cool down and Stretch
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

Core strengthening and stretching
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 8628
Vo2 max 39.3 ml/kg/min
Speed at which VO\textsubscript{2} max was reached 9km/h at 6% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts
Formal aerobic training including some singer specific breathing variations
Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

The Forum, Harbourside - Sara Woolnough 4985 4446 or Sara.Woolnough@newcastle.edu.au

The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 9600 per day
Week 2 = 10600 per day
Week 3 = 11600 per day
Week 4 = 12600 per day
Week 5 = 13600 per day
Week 6 = 14600 per day
Week 7 = 15000 per day
Week 8 = 15000 per day
Week 9 = 15000 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**
**Target speed 8km/h**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO\(_2\) max for the full 30min.
To reach two thirds of your VO\(_2\) max your target speed is ~8km/h or a heart rate of 175 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 2400
Vo2 max 33.1 ml/kg/min
Speed at which VO$_2$ max was reached 6km/h at 6% gradient.

**The intervention program will be comprised of three aspects.**

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

**Participants will receive a gym membership card.**

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

**Intervention Step targets for 12-week program**

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 3400 per day
Week 2 = 4400 per day
Week 3 = 5400 per day
Week 4 = 6400 per day
Week 5 = 7400 per day
Week 6 = 8400 per day
Week 7 = 94000 per day
Week 8 = 10400 per day
Week 9 = 11400 per day
Week 10 = 12400 per day
Week 11 = 13400 per day
Week 12 = 14400 per day

**Formal aerobic training**

**Target speed 6km/h**

**Speed and Duration**

A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min. To reach two thirds of your VO$_2$ max your target speed is ~6km/h or a heart rate of **170 BPM**. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**

Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**

During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**

Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**

Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 5782
Vo2 max 32.2 ml/kg/min
Speed at which VO₂ max was reached 11km/h at 2% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1=6700 per day
Week 2=7700 per day
Week 3=8700 per day
Week 4=9700 per day
Week 5=10700 per day
Week 6 = 11700 per day
Week 7 = 12700 per day
Week 8 = 13700 per day
Week 9 = 14700 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**
*Target speed 8km/h*

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min. To reach two thirds of your VO$_2$ max your target speed is ~8km/h or a heart rate of 125 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can't make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 9204  
Vo2 max 24.5 ml/kg/min  
Speed at which VO₂ max was reached 9km/h at 2% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts  
Formal aerobic training including some singer specific breathing variations  
Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program  
During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1=10000 per day  
Week 2=11000 per day  
Week 3=12000 per day  
Week 4=13000 per day  
Week 5=14000 per day  
Week 6 = 15000 per day  
Week 7 = 15000 per day
Weekly Activity

Week 8 = 15000 per day
Week 9 = 15000 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

Formal aerobic training
Target speed 6km/h

Speed and Duration
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO\(_2\) max for the full 30min.
To reach two thirds of your VO\(_2\) max your target speed is ~6km/h or a heart rate of 116 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

Warm up.
Before any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

Singer specific respiratory muscles work.
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

Cool down and Stretch
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

Core strengthening and stretching
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.

Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day
The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856  
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800  
40min walk. Stretch.  
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900  
General activity no formal exercise

**Thursday**
Steps 10300  
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009  
70 min walk. Stretch.

**Saturday**
Steps 14058  
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.  
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000  
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 6016  
VO2 max 37.5 ml/kg/min  
Speed at which VO2 max was reached 13km/h at 0% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program

During the program increase your daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 7000 per day

Week 2 = 8000 per day

Week 3 = 9000 per day

Week 4 = 10000 per day

Week 5 = 11000 per day

Week 6 = 12000 per day

Week 7 = 13000 per day
Week 8 = 14000 per day
Week 9 = 15000 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**

**Target speed 9km/h**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min.

To reach two thirds of your VO$_2$ max your target speed is ~9km/h or a heart rate of 163 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal

Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 11000
VO2 max 43.5 ml/kg/min
Speed at which VO2 max was reached 10km/h at 4% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 12000 per day
Week 2 = 13000 per day
Week 3 = 14000 per day
Week 4 = 15000 per day
Week 5 = 15000 per day
Week 6 = 15000 per day
Week 7 = 15000 per day
Week 8 = 15000 per day
Week 9 = 15000 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**

**Target speed 8km/h**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min. To reach two thirds of your VO$_2$ max your target speed is $\sim 8$km/h or a heart rate of 150 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

Week 1. 20/09/10-27/09/10

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises. 15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 5000
Vo2 max 25.0 ml/kg/min
Speed at which VO₂ max was reached 9km/h at 2% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts
Formal aerobic training including some singer specific breathing variations
Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 6000 per day
Week 2 = 7000 per day
Week 3 = 8000 per day
Week 4 = 9000 per day
Week 5 = 10000 per day
Week 6 = 11000 per day
Week 7 = 12000 per day
Week 8 = 13000 per day
Week 9 = 14000 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**
**Target speed 7km/h**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO\textsubscript{2} max for the full 30min. To reach two thirds of your VO\textsubscript{2} max your target speed is \textbf{\sim 7km/h} or a heart rate of \textbf{144 BPM}. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal

Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 13000
Vo2 max 49.4 ml/kg/min
Speed at which VO\textsubscript{2} max was reached 15km/h at 4% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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The Forum, University - Larissa Lenton 4921 7878 or Larissa.Lenton@newcastle.edu.au

Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 13000 per day
Week 2 = 14000 per day
Week 3 = 15000 per day
Week 4 = 15000 per day
Week 5 = 15000 per day
Week 6 = 15000 per day
Week 7 = 15000 per day
Week 8 = 15000 per day
Week 9 = 15000 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min.
To reach two thirds of your VO$_2$ max your target speed is ~11km/h or a heart rate of 140 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch.

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 8600
Vo2 max 47.8 ml/kg/min
Speed at which VO₂ max was reached 13 km/h at 4% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1=9600 per day
Week 2=10600 per day
Week 3=11600 per day
Week 4=12600 per day
Week 5=13600 per day
Week 6 = 14600 per day
Week 7 = 15000 per day
Week 8 = 15000 per day
Week 9 = 15000 per day
Week 10 = 15000 per day
Week 11 = 15000 per day
Week 12 = 15000 per day

**Formal aerobic training**
**Target speed 9km/h**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min.
To reach two thirds of your VO$_2$ max your target speed is ~9km/h or a heart rate of 157 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

**Sample week of exercise journal**

Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 3000
Vo2 max 19.7 ml/kg/min
Speed at which VO2 max was reached 6km/h at 5% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts

Formal aerobic training including some singer specific breathing variations

Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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Intervention Step targets for 12-week program
During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

Week 1 = 3000 per day
Week 2 = 4000 per day
Week 3 = 5000 per day
Week 4 = 6000 per day
Week 5 = 7000 per day
Week 6 = 8000 per day
Week 7 = 10000 per day
Week 8 = 11000 per day
Week 9 = 12000 per day
Week 10 = 13000 per day
Week 11 = 14000 per day
Week 12 = 15000 per day

**Formal aerobic training**

**Target speed 5km/h**

**Speed and Duration**
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min. To reach two thirds of your VO$_2$ max your target speed is ~5km/h or a heart rate of 92 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can’t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadriceps muscles.

**Core strengthening and stretching**
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.
Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

**Week 1. 20/09/10-27/09/10**

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warm up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Pre intervention

Average daily steps 17000  
Vo2 max 55.5 ml/kg/min  
Speed at which VO$_2$ max was reached 16km/h at 4% gradient.

The intervention program will be comprised of three aspects.

Daily activity measured in step counts  
Formal aerobic training including some singer specific breathing variations  
Core strength and stretching

Participants will receive a gym membership card.

Please contact the appropriate Centre Manager to arrange a time to complete the necessary membership paperwork as well as an orientation of the facility and an explanation of the equipment and how to use it.

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Intervention Step targets for 12-week program

During the program increase you daily step counts by 1000 steps per day each week until you reach 15,000 per day. Maintain the 15,000 steps per day for the remainder of the 12 week program. Time spent in formal aerobic training will be included in these step counts however on the days when there is no formal training make sure you still make your step targets whenever possible.

As your step counts are already in excess of 15 000 you may either maintain your current daily activity level or work up to a higher step count as in the example below. However your main focus should be on your higher intensity aerobic activity.

Week 1=18000 per day  
Week 2=19000 per day  
Week 3=20000 per day  
Week 4=20000 per day  
Week 5=20000 per day
Week 6 = 20000 per day
Week 7 = 20000 per day
Week 8 = 20000 per day
Week 9 = 20000 per day
Week 10 = 200000 per day
Week 11 = 20000 per day
Week 12 = 20000 per day

**Formal aerobic training**  
**Target speed 13km/h**

**Speed and Duration**  
A minimum of three days a week include 30min or more of aerobic training. Try and maintain your intensity at two thirds of your VO$_2$ max for the full 30min. To reach two thirds of your VO$_2$ max your target speed is ~13km/h or a heart rate of 147 BPM. This is more easily measured on a treadmill at the gym however if sometimes you can‘t make it to the gym or feel like using some other form of aerobic equipment try and maintain a speed that is challenging but that you can keep up for 30min.

**Warm up.**  
Prior to any intense activity it is important to warm up for at least 10min. This time should be in addition to the recommended 30min.

**Singer specific respiratory muscles work.**  
During the warm up phase of the program use some of the quiet breathe exercises from singing training such long drawn out sibilant SSS sounds and Sh sounds. Maintain the duration of the sound as long as possible. Doing this while the respiratory muscles are already working will place an extra load on the muscles and condition them to be stronger. Do five to ten of these long exhalations each time you warm up.

**Cool down and Stretch**  
Always cool down by walking for a few minutes after intense aerobic activity. It is a good idea to stretch after each session. After running or walking focus on stretching the calf, hamstrings and quadiceps muscles.
Core strengthening and stretching
Core strength is important to maintain good posture. Ask the gym staff to recommend some suitable core strengthening exercises. To maintain flexibility especially in the abdominal muscles remember to always stretch after working the muscles.

Please keep a journal in the form of a word document to record your daily activity

This should include

Your step counts per day

The duration and speed of any formal exercise

The duration and type of muscular work and stretching that you have done.

If you are sick or unable to exercise this should also be noted in your journal

Sample week of exercise journal
Your journal should look something like this.

Week 1. 20/09/10-27/09/10

**Monday**
Steps 10856
Jog on treadmill at gym 30min at 6km/h +10min warn up with breathing exercises and cool down. Stretch.

**Tuesday**
Steps 9800
40min walk. Stretch.
10min core strength exercises. Planks (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.

**Wednesday**
Steps 8900
General activity no formal exercise

**Thursday**
Steps 10300
Treadmill at 6km for 35min + warm up/breathing exercises/cool down. Stretch.

**Friday**
Steps 8009
70 min walk. Stretch.

**Saturday**
Steps 14058
Treadmill at 7km/h for 40 min. Warm up with breathing exercises.
15min Core strength. Side planks (5 sets of 10 seconds each side), Planks (3 sets of 40 seconds) ect. Stretch

**Sunday**
Steps 8000
10min Core strength. (3 sets of 40 seconds), Held V position (2 sets of 80seconds), Bridge position lifts (3 sets of 40 lifts). Stretch.
Data Profiles

Benchmark singers
Code. Classical Benchmark

Singer Classification: Classical

Muscle Trace Data

Neck:

![Graphs showing average maximum, minimum, range, and duration for neck muscle activation.

Upper Thorax:

![Graphs showing average maximum, minimum, range, and duration for upper thorax muscle activation.

These graphs illustrate the benchmark range for classical singers, focusing on key metrics such as average maximum and minimum values, range, and duration of muscle activation. The data is presented in a visual format to facilitate easy understanding and comparison.
Lower Thorax:

Upper Abdominal:
Lower Abdominal:

- **Average Maximum Value**
  - Classical
  - Benchmark

- **Average Minimum Value**
  - Classical
  - Benchmark

- **Average Range**
  - Classical
  - Benchmark

- **Average Duration of Muscle Activation**
  - Classical
  - Benchmark
Comparative Muscle Activation across the Range of the Torso

Max Value Classical Benchmark

Min Value Classical Benchmark

Range Value Classical Benchmark

Duration Value Classical Benchmark
General Description and Examples of each Trace

Muscle excursions happen at breath points and generally not at any other times. The neck trace shows a consistent tremble in the line indicative of a regular level of vibrato as well as some larger excursions possibly indicating breath pressure control and laryngeal tilt.

The upper thoracic trace is the most inactive of all the traces showing very few movements. Unlike the majority of the traces there is no indication of upper thoracic muscle activation during inspiration.

The lower thoracic and upper abdominal traces move in a similar motion with the emphasis on muscle contraction. They have the largest excursions on the chart and their movements are primarily associated with inhalation.

The lower abdominal trace is held at a consistently high tension with regular excursions in a downward direction emphasizing muscle release. The lower abdominal trace moves in contrary motion to the upper abdominal and lower thoracic traces.
Code. Contemporary Benchmark

Singer Classification: Contemporary

Muscle Trace Data

Neck:

Upper Thorax:
Lower Thorax:

Average Maximum Value

Average Minimum Value

Average Range

Average Duration of Muscle Activation

Upper Abdominal:

Average Maximum Value

Average Minimum Value

Average Range

Average Duration of Muscle Activation
Lower Abdominal:

Average Maximum Value

Average Minimum Value

Average Range

Average Duration of Muscle Activation
Comparative Muscle Activation across the Range of the Torso

**Max Value Contemporary Benchmark**

**Min Value Contemporary Benchmark**

**Range Value Contemporary Benchmark**

**Duration Value Contemporary Benchmark**
General Description and Example Trace

The contemporary benchmark’s trace shows regular muscle excursions. There is evidence of a very small wobble in the neck trace with very few larger excursions. Activity in both the abdominal traces is very limited with the majority of the movement coming from the lower and upper thorax. The lower thorax moves in sharp peaks while the upper thorax undulates in a smoother wave-like formation. On occasion the excursions in the upper abdominal trace become a little more dramatic shadowing the lower thorax.
Individual Test-subject Profiles
S1’s post-intervention Vo2 max figure did not increase beyond that of the baseline test however it was greater than that achieved in the pre-intervention test session.

**S1 Heart Rate Chart**

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<th>Gradient (°)</th>
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<td>Post-Intervention</td>
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While S1’s Vo2 max figure did not increase their heart rate chart shows considerable improvement in the post-intervention data showing a drop of eight to ten beats per minute at the same workload as the pre-intervention data. The participant also increased their maximum speed from 12kmph at 2% gradient to 13 kmph at 4% gradient indicating an increase in stamina. Their maximum heart rate of 191 bpm was reached at a greater workload in the post–intervention test.
S1 showed significant improvement in all three respiratory functions in the post-intervention test.
S1 showed no significant improvement in their post-intervention self perception test. However like their Vo2 max results the post-intervention answers were more positive than the pre-intervention.
Muscle Trace Data

Neck:

Upper Thorax:
Lower Thorax:

![Average Maximum Value](image1)

![Average Minimum Value](image2)

![Average Range](image3)

![Average Duration of Muscle Activation](image4)

Upper Abdominal:

![Average Maximum Value](image5)

![Average Minimum Value](image6)

![Average Range](image7)

![Average Duration of Muscle Activation](image8)
Lower Abdominal:

### Average Maximum Value

<table>
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### Average Minimum Value

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### Average Range

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### Average Duration of Muscle Activation

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Test Phase

Range
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions
Value of Average Minimum Muscles Excursions

**Min Value Baseline**

-6 -5 -4 -3 -2 -1 0
Neck Upper Thorax Lower Thorax Upper Abdominal Lower Abdominal

**Min Value Pre Intervention**

-7 -6 -5 -4 -3 -2 -1 -0.5 0
Neck Upper Thorax Lower Thorax Upper Abdominal Lower Abdominal

**Min Value Post Intervention**

-5 -4.5 -4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0
Neck Upper Thorax Lower Thorax Upper Abdominal Lower Abdominal
Average Range of Muscle Excursions

Range Value Baseline

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscles Excursions

**Duration Value Baseline**

**Duration Value Pre Intervention**

**Duration Value Post Intervention**
**Muscle Trace General Description and Observations**

**Baseline**

S1’s baseline chart presents an even appearance with regular muscle excursions. The neck trace has a wide wobble that possibly indicates the presence of vibrato. The upper thoracic trace moves in a smooth wave pattern in similar motion with the lower thoracic and upper abdominal traces. The lower thoracic and upper abdominal traces show sharp pointed muscle contractions in a regular pattern indicating regular controlled breaths. The lower abdominal trace does not show large excursions however it moves in contrary motion on a regular basis with the remaining torso traces.

**Pre-Intervention**

The pre-intervention chart is very similar in pattern and the distribution of muscular effort to the baseline chart.

**Post-Intervention**

The most marked difference in the post-intervention chart is the shape of the muscle excursions in the upper abdominal trace. Instead of being triangular type peaks the excursions are of a more square and less regular appearance. This suggests that the muscle contractions are being held at the peak of their contractions instead of being released. This may suggest a more labored inhalation.

The other notable difference is in the lower abdominal trace. The excursions are once again less even and this time they move primarily in an upwards direction. This would suggest an emphasis on muscular contraction as opposed to release.

**Fitness**

While there was no improvement in S1’s Vo2 max there was a significant improvement in all three respiratory function tests. The heart rate also showed a significant reduction throughout the post-intervention test. S1’s self evaluation did not show a significant improvement during the post-intervention stage.

**Possible Conclusions**

The inversion of the direction of muscle excursions in the lower abdominal trace could be due to an increase in tension in the abdominal muscles inhibiting the sharp release of the lower abdominal region during the inhalation. It is also possible that due to the improvement in S1’s respiratory functions, that the muscular activity required to maintain the same level of effort while singing is much less than had previously been necessary. This could result in the same sensation of using air without using the most efficient mechanism of control. Possibly if S1 were to re-integrate the principles of the “SPLAT” breath on top of this increased breath capacity it could result in a vast improvement in their ability to control their breath.
Code. S2

Note! (S2 was unable to attend the pre-intervention test)

**Singer Classification:** Classical

**Change in Vo2 max:**

![VO2 Max Chart]

S2 shows an improvement in Vo2 max in the post-intervention test.

**S2 Heart Rate Chart**

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<tr>
<th>Time</th>
<th>Baseline</th>
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</table>

While S2’s heart rate is at a comparative level in the early stages of both tests there is a marked improvement in the post-intervention data from the eight minute mark onwards with a considerable drop in the heart rate compared to the baseline test at the same work load. S2 also increased their test time by one minute and their maximum speed from 16 km/ph to 17 km/ph.
**Change in Respiratory Function**

**MVV Note!** (No MVV was taken for S2 due to machinery difficulties)

S2 shows a small improvement in FVC but not in PEF.
S2 shows a significant improvement in their self perception with every question answered post-intervention returning a higher answer, except effort level which was equal to the baseline test.
Muscle Trace Data

Neck:

![Graphs showing average maximum, minimum, range, and duration of muscle activation for Neck.](image)

Upper Thorax:

![Graphs showing average maximum, minimum, range, and duration of muscle activation for Upper Thorax.](image)
Lower Thorax:

Average Maximum Value

Baseline Pre Intervention Post Intervention

Average Minimum Value

Baseline Pre Intervention Post Intervention

Average Range

Baseline Pre Intervention Post Intervention

Average Duration of Muscle Activation

Baseline Pre Intervention Post Intervention

Upper Abdominal:

Average Maximum Value

Baseline Pre Intervention Post Intervention

Average Minimum Value

Baseline Pre Intervention Post Intervention

Average Range

Baseline Pre Intervention Post Intervention

Average Duration of Muscle Activation

Baseline Pre Intervention Post Intervention
Lower Abdominal:

**Average Maximum Value**

**Average Minimum Value**

**Average Range**

**Average Duration of Muscle Activation**
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

Max Value Baseline

Max Value Post Intervention
Value of Average Minimum Muscle Excursions

Min Value Baseline

Min Value Post Intervention
Average Range of Muscle Excursions

Range Value Baseline

Range Value Post Intervention

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal
Average Duration of Muscle Excursions

**Duration Value Baseline**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal

**Duration Value Post Intervention**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal
**Muscle Trace General Description and Observations**

**Baseline**

The neck trace consists of a series of large fast excursions mixed with frequent larger more protracted muscular activity. The range of excursions is 19.15332 which is very large for movement in the neck. The largest movements occur in the lower thoracic and upper abdominal area with very large positive excursions progressing in concurrent similar motion forming a regular pattern. At the beginning of the song the upper thorax is very active showing quite large excursions, however these decrease until by 1:50 min. the trace is almost completely static. The lower abdominal trace forms a regular pattern of negative excursions moving concurrently in contrary motion with the other traces.

**Pre-Intervention NA**

**Post-Intervention**

There is a smaller range of movement in neck and upper and lower thoracic traces compared with the previous test. However the range of movement has increased in both the upper and lower abdominal areas. The range of movement in the upper abdominals has increased dramatically with a leap from 62.1317 to 145.1671. The lower abdominal trace now moves in similar motion to the upper traces with excursions in a positive direction.

**Fitness**

S2 shows a clear improvement in Vo2 max however the respiratory functions are slightly decreased. There is a strong improvement in S2’s self perception with all questions returning answers higher on the scale during the post-intervention stage except for effort level which was equal in both tests. S2’s heart rate shows considerable improvement in the higher intensity workload range of the post-intervention test.

**Possible Conclusions**

S2 shows a clear indication of an improvement in fitness level and an improvement in their personal perception of singing facility. The inversion of direction of excursions in the lower abdominal trace could be due to extra strength in the abdominal muscles making the engagement of the support muscles easier but possibly not the release of these same muscles, resulting in more tension in this region and the emphasis being transferred from the release to the engagement of the lower abdominal region.
Singer Classification: Classical

Change in VO2 max:

![VO2 Max Chart]

S3 shows a large improvement in VO2 max.

**S3 Heart Rate Chart**

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<tr>
<th>Time</th>
<th>Speed</th>
<th>Gradient</th>
<th>Heart Rate</th>
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S3’s heart rate showed a considerable improvement throughout the post-intervention test with a drop of up to 15 bpm less at times. S3 increased their time by one minute and their maximum speed from 9 km/ph to 11 km/ph.
S3 showed a strong improvement in all three respiratory function tests.
S3’s self perception questionnaire showed a definite improvement in the post-intervention test. In particular the effort level was considerably less while all the performance factors showed a distinct improvement.
Muscle Trace Data

Neck:

Upper Thorax:
Lower Thorax:

- **Average Maximum Value**
- **Average Minimum Value**
- **Average Range**
- **Average Duration of Muscle Activation**

Upper Abdominal:

- **Average Maximum Value**
- **Average Minimum Value**
- **Average Range**
- **Average Duration of Muscle Activation**
Lower Abdominal:

### Average Maximum Value

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### Average Minimum Value

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### Average Duration of Muscle Activation

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88
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

**Max Value Baseline**

**Max Value Pre Intervention**

**Max Value Post Intervention**
Value of Average Minimum Muscle Excursions

Min Value Baseline

Min Value Pre Intervention

Min Value Post Intervention
Average Range of Muscle Excursions

Range Value Baseline

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscle Excursions

**Duration Value Baseline**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal

**Duration Value Pre Intervention**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal

**Duration Value Post Intervention**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal
Muscle Trace General Description and Observations

Baseline
The neck trace shows the presence of a steady wobble possibly indicating the presence of vibrato as well as some larger incursions correlating with the onset of phrases perhaps indicating laryngeal involvement in the build up of breath pressure.

The excursions in the upper thoracic trace go in both positive and negative directions with no emphasis on either contraction or release. Excursions are regular and in conjunction with breath motions in the other traces. The sharpest and largest muscle excursion peaks are in the lower thoracic and lower abdominal traces. The peaks in the lower thorax are in a positive direction indicating muscle contraction and the peaks in the lower abdominal are in a negative direction indicating muscular release. There is on occasion a very small wobble in the lower thoracic line similar to that caused by vibrato only more subtle.

The upper abdominal trace moves in conjunction with the other traces however it has a much smoother line with wave type motions as opposed to sharp peaks. There is also the appearance of a small wobble in the line on occasion.

Pre-Intervention
The pre-intervention chart presents a very similar appearance to the baseline chart. The only significant difference is a decreased level of activity in the upper thoracic trace.

Post-Intervention
The range in muscular movement is greatly reduced across all the traces except the upper thorax. Another notable change is that of the directions of excursions in the lower abdominal trace. The excursions now move in an upwards direction instead of in a downwards direction indicating that the muscle is now contracting instead of releasing.

Fitness
S3 showed a significant improvement in both Vo2 max and all three respiratory function tests. S3’s heart rate chart shows that they are far more comfortable at both higher and lower intensity workloads in the post-intervention test. The self evaluation questionnaire shows a significant improvement especially in the effort level which is now far less than it was in both the baseline and the pre-intervention tests.

Possible Conclusions
Once again the change in the direction of the muscle excursions in the lower abdominal trace could be due to the improvement in S3’s respiratory functions. The muscular activity required to maintain the same level of effort while singing is much less than had previously been necessary. This could result in the same sensation of using air without using the most efficient mechanism of control. Possibly if S3 were to re-integrate the principles of the “SPLAT” breath on top of this increased breath capacity it could result in a vast improvement in their ability to control their breath.
**Code. S4**

**Singer Classification:** Classical

**Change in VO2 max:**

![VO2 Max Chart]

S4 showed a decrease in their VO2 max.

**S4 Heart Rate Chart**

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S4 shows a significant improvement in their heart rate especially at the lower intensity workloads. This suggests that the majority of their training was done at low intensity workloads. As S4 did not submit a training diary and did not attend the gym it is possible that they increased the amount of low intensity activity while not engaging in high intensity training.
S4’s respiratory function tests show an increase between the baseline and pre-intervention test but a decrease in the post-intervention test.
Self Perception Questionnaire Ratings out of 10:

S4’s self perception shows an improvement in musical expression and mental alertness in the post intervention test phase.
Muscle Trace Data

Neck:

Upper Thorax:
Lower Thorax:

Average Maximum Value

Average Minimum Value

Average Range

Average Duration of Muscle Activation

Upper Abdominal:

Average Maximum Value

Average Minimum Value

Average Range

Average Duration of Muscle Activation
Lower Abdominal:

- **Average Maximum Value**
  - Baseline: 0
  - Pre Intervention: 2
  - Post Intervention: 10

- **Average Minimum Value**
  - Baseline: -16
  - Pre Intervention: -10
  - Post Intervention: 0

- **Average Range**
  - Baseline: 0
  - Pre Intervention: 15
  - Post Intervention: 25

- **Average Duration of Muscle Activation**
  - Baseline: 0.2
  - Pre Intervention: 1.2
  - Post Intervention: 1.8
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

Max Value Baseline

Max Value Pre Intervention

Max Value Post Intervention
Value of Average Minimum Muscle Excursions

Min Value Baseline

Min Value Pre Intervention

Min Value Post Intervention
Average Range of Muscle Excursions

Range Value Baseline

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscle Excursions

**Duration Value Baseline**

**Duration Value Pre Intervention**

**Duration Value Post Intervention**
Muscle Trace General Description and Observations

Baseline
The neck trace shows a small wobble the entire way through, indicating the presence of vibrato. There are a few larger excursions in the line that usually coincide with inhalation. The upper thorax moves in a series of very wide quite long lasting excursions that do not always follow the pattern of the breath. The lower three traces move in a regular pattern following the breath. The lower thoracic and upper abdominal trace move concurrently in a positive direction indicating the contraction of the muscles. The lower abdominal trace moves in a negative direction indicating that muscle release is the emphasis.

Pre-Intervention
The only marked difference in the pre-intervention chart is the decrease in activity of the upper thoracic trace. This trace now has only a couple of excursions throughout the full length of the test. There is no significant change to the remaining traces.

Post-Intervention
The most notable change is that the excursions in the lower abdominal trace are in a positive direction. The pattern of the breath is less regular and the upper abdominal trace moves in a variety of different shaped excursions as opposed to the regular peak pattern that it followed in both pervious tests. Excursions in the upper abdominal trace are not as large as pervious traces. The neck trace has an increase in longer peak shaped excursions.

Fitness
While S4 did not improve their Vo2 max they showed a significantly lower heart rate in the post-intervention test at lower intensity workloads. Respiratory function did not improve significantly and neither did their self perception. however their questionnaire showed that they felt their musical expression and mental alertness had improved beyond that of the baseline and pre-intervention test.

Possible Conclusions
Once again we see the change in direction of the excursions in the lower abdominal trace. As S4 did not show a significant improvement in respiratory functions or Vo2 max, it is possible that this is due to tension in the muscles which is inhibiting the relaxation in the lower abdominal region on the inhalation and making the engagement of the muscles more pronounced.
**Code. S5**

**Singer Classification:** Music Theatre

**Change in Vo2 max:**

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S5 showed a considerable improvement in Vo2 max.

**S5 Heart Rate Chart**

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While S5’s heart rate was comparable at the beginning of all three tests it was significantly lower in the higher intensity stages of the post-intervention test. S5 also increased their maximum speed from 11 km/ph to 12 km/ph and their test time by one and a half minutes.

**Change in Respiratory Function**
S5 showed an increase in MVV but a decrease in the remaining two respiratory function tests.

Self Perception Questionnaire Ratings out of 10
S5 showed a marked improvement in their self perception. With a notable drop in their effort level and a two point increase in their rating of their breath control.

**Muscle Trace Data**
Neck:

Upper Thorax:

Lower Thorax:
Upper Abdominal:

Lower Abdominal:
Comparative Muscle Activation across the Range of the Torso
Value of Average Maximum Muscle Excursions

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</table>
Average Range of Muscle Excursions
Average Duration of Muscle Excursions
Muscle Trace General Description and Observations

Baseline
The majority of the muscle movement occurs in the lower thoracic and upper abdominal traces. The excursions can move in either a positive or a negative direction indicating no particular emphasis either in the expansion or the contraction of the torso. The neck trace is quite active having a continuous small wobble as well as frequent larger excursions. The lower abdominal trace appears to be completely inactive at the beginning of the song however towards the mid point it starts producing a wobble which gradually gets larger until it develops into negative breath excursions. The upper thorax is also very inactive in the beginning of the song however it develops some gentle wave like excursions towards the end.

**Pre-Intervention**

The pre-intervention stage chart is very similar to the baseline chart. The upper thoracic trace has a slightly smaller range of movement and the lower abdominal trace has a slightly increased range of motion. The remaining traces have no significant differences.

**Post-Intervention**

Once again the lower abdominal trace becomes far more active towards the end of the song. The range of muscle movement in the upper abdominal trace has significantly increased. The remaining traces are at a comparable level to the previous test.

**Fitness**

S5 improved their Vo2 Max by a large margin. S5’s respiratory function tests showed an improvement in MVV but a decreased in the PEF and FVC. While S5’s heart rate was comparable at the beginning of all three tests it was significantly lower in the higher intensity stages of the post-intervention test. S5 also increased their maximum speed from 11 km/ph to 12 km/ph and their test time by one and a half minutes.

**Possible Conclusions**

The increase in muscle movement in the lower abdominal trace in S5’s post-intervention test is perhaps indicative of an increase in strength or awareness in the lower abdominal region enabling S5 to more fully relax and engage their lower abdominal support muscles. This could explain S5’s marked improvement of their perception of breath control in the self perception questionnaire.

S6, S7 and S8 withdrew from this project.
S9 showed a similar VO2 Max in the baseline and post-intervention test however the pre-intervention result was higher.

S9’s post-intervention heart rate chart showed an improvement in the mid range intensity stage of the test. This is most significant between the 3 min and 9 min marks. S9 also increased their maximum speed from 9 km/ph to 10 km/ph and added half a minute to their test time. This perhaps suggests that S9 did the majority of their training at a mid level of intensity.
Change in Respiratory Function

S9 did not show improvement in any of their respiratory function tests.
S9 showed a significant improvement in their self perception questionnaire with the only question that did not receive an improved answer in the post-intervention test being effort level.
Muscle Trace Data

Neck:

Upper Thorax:
Lower Thorax:

Upper Abdominal:
Lower Abdominal:

**Average Maximum Value**

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**Average Duration of Muscle Activation**

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Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

Max Value Baseline

Max Value Pre Intervention

Max Value Post Intervention
Value of Average Minimum Muscle Excursions

Min Value Baseline

Min Value Pre Intervention

Min Value Post Intervention
Average Range of Muscle Excursions

Range Value Baseline

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscle Excursions

**Duration Value Baseline**

- Neck: 0.0013
- Upper Thorax: 0.00135
- Lower Thorax: 0.0014
- Upper Abdominal: 0.00145
- Lower Abdominal: 0.0015
- Abdominal: 0.00155
- Abdominal: 0.0016
- Abdominal: 0.00165
- Abdominal: 0.0017

**Duration Value Pre Intervention**

- Neck: 0.0014
- Upper Thorax: 0.00145
- Lower Thorax: 0.0015
- Upper Abdominal: 0.00155
- Lower Abdominal: 0.0016
- Abdominal: 0.00165
- Abdominal: 0.0017
- Abdominal: 0.00175
- Abdominal: 0.0018
- Abdominal: 0.00185

**Duration Value Post Intervention**

- Neck: 0.0013
- Upper Thorax: 0.00135
- Lower Thorax: 0.0014
- Upper Abdominal: 0.00145
- Lower Abdominal: 0.0015
- Abdominal: 0.00155
- Abdominal: 0.0016
- Abdominal: 0.00165
- Abdominal: 0.0017
- Abdominal: 0.00175
Muscle Trace General Description and Observations

Baseline
The baseline chart shows a clear regular appearance. Excursions occur at the same time in all three lower traces. The lower abdominal trace moves in a negative direction indicating muscle release as the upper abdominal and lower thoracic traces move in a positive direction indicating muscle contraction. The upper thorax moves in a smooth wave pattern generally synchronizing in its maximum point of contraction with the in-breath. The neck trace consists of a series of small incursions forming a wobble like appearance indicating the presence of vibrato. There are very few larger excursions in the neck trace perhaps indicating that the larynx was not particularly active.

Pre-Intervention
S9’s pre-intervention chart shows an increase in activity in the upper thorax and a decrease in the activation of the upper and lower abdominal region. Emphasis in the lower abdominals is still on muscle release indicated by the downwards direction of excursions. The sizes of excursions in the lower thoracic trace have also increased significantly. There are still no larger excursions in the neck trace however the presence of the wobble is less consistent.

Post-Intervention
The most notable difference in the post-intervention chart is the size and direction of the excursions in the lower abdominal trace. The excursions now move in a positive or upwards direction indicating that the muscles are being contracted instead of released. The upper thorax is once again less active with the majority of its excursions moving in a negative direction indicating muscle release during the in-breath. The neck trace still contains a small wobble with no indication of any larger movements.

Fitness
While S9 did not show an improvement in Vo2 max or respiratory functions the heart rate showed an increase in their comfort at a mid intensity level. S9 showed a significant improvement in their self perception questionnaire with the only question that did not receive an improved answer in the post-intervention test being their effort level.

Possible Conclusions
The direction change of the excursions in the lower abdominal trace possibly indicates that the muscles that had formerly been released on the inhalation are now being engaged. This could be due to tension in the muscles which is inhibiting the relaxation in the lower abdominal region on the inhalation and making the engagement of the muscles more pronounced. However even in the baseline and pre-intervention stages of the study S9 did not have a consistent release of the abdominal region throughout the tests.
Code. S10

Note: S10 was recovering from a viral infection during the post-intervention test session.

Singer Classification: Music Theatre

Change in Vo2 max:

S10 showed a decrease in their Vo2 max, this could have been due to the fact that S10 was sick during the post-intervention test session.

Heart Rate Chart

S10 was suffering from a viral infection and this could have influenced her heart rate during the post-intervention test. However while S10’s test time is considerably shorter she undertook the whole test at a 4% gradient. S10’s highest heart rate reached at the workload of 8 km/ph at 4% gradient is 11 BPM lower than it was in the pre-intervention test.

Change in Respiratory Function
S10 showed a significant increase in their MVV however the remaining two respiratory functions decreased.

**Self Perception Questionnaire Ratings out of 10**
S10’s effort level is much higher in the post-intervention test which could be due to the virus that they were suffering from at the time. Other noticeable differences are that the post-intervention abdominal support and enjoyment lever are much lower than either the baseline or pre-intervention tests which might also be due to the virus.
Muscle Trace Data

Neck:

Upper Thorax:
Lower Thorax:

![Average Maximum Value](image1)

![Average Minimum Value](image2)

![Average Range](image3)

![Average Duration of Muscle Activation](image4)

Upper Abdominal:

![Average Maximum Value](image5)

![Average Minimum Value](image6)

![Average Range](image7)

![Average Duration of Muscle Activation](image8)
Lower Abdominal:

**Average Maximum Value**

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**Baseline Pre Intervention Post Intervention Test Phase**

**Average Minimum Value**

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**Baseline Pre Intervention Post Intervention Test Phase**

**Average Range**

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**Baseline Pre Intervention Post Intervention Test Phase**

**Average Duration of Muscle Activation**

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**Baseline Pre Intervention Post Intervention Test Phase**
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

Max Value Baseline

Max Value Pre Intervention

Max Value Post Intervention
Value of Average Minimum Muscle Excursions

Min Value Baseline

Min Value Pre Intervention

Min Value Post Intervention
Average Range of Muscle Excursions

Range Value Baseline

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscle Excursions

Duration Value Baseline

Duration Value Pre Intervention

Duration Value Post Intervention
Muscle Trace General Description and Observations

Baseline
The overall appearance of S10’s lab chart is of fairly even muscle excursions with the largest muscle activations appearing in the upper abdominal and lower thoracic traces. The lower abdominal trace moves in contrary motion to the upper abdominal and lower thorax suggesting that the emphasis in the release of the lower abdominals during inspiration.

The direction of the lower abdominal trace is not always consistent and there is some smaller more rapid excursions making a wobble like appearance in the line of all three lower traces. The neck trace shows small yet more frequent muscle excursions indicative of a small amount of narrow vibrato. There is also some larger more erratic movements possibly indicative of inspiration or laryngeal manipulation of sound. At one point there is a very sharp excursion in the neck trace with smaller corresponding movements in the lower thorax and upper abdominals however very little movement in the lower abdominal trace. This could possibly indicate a quick snatch breath into the chest with out the involvement of the lower portion of the torso. The upper thorax is the most static of all the traces with very little indication of any muscle activity at all.

Pre-Intervention
The pre-intervention chart has an overall similar appearance to the baseline chart however the lower abdominal trace has become as static as the upper thorax indicating very little engagement or release of the lower abdominal region, either during inspiration or phonation. The size of the excursions in the neck trace have increased and become more frequent possibly suggesting that the work load has been transferred from the lower abdominals to the larynx. The small rapid vibrato wobble is less apparent than in the previous trace.

Post-Intervention
The neck trace is now almost completely static with no excursions and very little vibrato wobble. The upper thoracic trace which was static in both previous tests has now become active with large excursions moving in similar motion to both the lower thoracic and upper abdominal traces. The lower abdominals have once more become active however the direction of the excursions has become more erratic with large excursions in both directions indicative of sharp contraction and release of the muscles, whereas in the baseline test the emphasis was primarily on the release of the muscle.

Fitness
S10 showed a decrease in Vo2 max and in all respiratory functions apart from MVV. S10 was suffering from a viral infection and this could have influenced their readings in all tests. S10’s treadmill test time is considerably shorter in the post-intervention, however she undertook the whole test at a 4% gradient. S10s highest heart rate reached at the workload of 8 km/ph at 4% gradient is 11 BPM lower than it was in the pre-intervention test. In the self perception questionnaire S10’s effort level is much higher in the post-intervention test which could be due to the virus. Other noticeable differences are that the post-intervention abdominal support and enjoyment level are much lower than either the baseline or pre-intervention tests which might also be due to the virus.

Possible Conclusions
The deterioration in Vo2 max and in some of the respiratory function test may be accounted for by the viral infection that S10 was suffering from during the post-intervention testing stage. This could also account for the inactivity of the neck trace in the post-intervention test, because if this area was inflamed the participant would be less inclined to engage the muscles in the larynx as it would be painful to do so. It is also possible that S10’s fitness level was affected not only by the virus itself but also through physical inactivity due to feeling unwell. Once again we see the change of direction in the excursions in the lower abdominal trace during the post-intervention test phases.
Singer Classification: Pop

Change in VO2 max:

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S11 Heart Rate Chart

S11 heart rate was considerably lower throughout their post-intervention test. It was only 168 Bpm at the maximum work load of the post-intervention test compared to 182 Bpm at the same work load in the pre-intervention stage.
S11 showed a substantial improvement in FVC and PEF. The MVV result decreased in between the pre-intervention and post-intervention tests however both values were higher than the baseline data.
S11’s self perception is on a similar level in all three tests. One exception is the connection to abdominal support question which is higher in the post-intervention test than it is in either of the previous tests.
Muscle Trace Data

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Lower Abdominal:

**Average Maximum Value**

**Average Minimum Value**

**Average Range**

**Average Duration of Muscle Activation**
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

Max Value Baseline

Max Value Pre Intervention

Max Value Post Intervention
Value of Average Minimum Muscle Excursions

**Min Value Baseline**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal

**Min Value Pre Intervention**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal

**Min Value Post Intervention**

- Neck
- Upper Thorax
- Lower Thorax
- Upper Abdominal
- Lower Abdominal
Average Range of Muscle Excursions

Range Value Baseline

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscle Excursions

Duration Value Baseline

Duration Value Pre Intervention

Duration Value Post Intervention
Muscle Trace General Description and Observations

Baseline
S11’s baseline chart shows a generally smooth appearance with the majority of movement in the upper abdominal and lower thoracic traces. The lower abdominal trace has some small curved movement but no sharp peaks of muscle activity. The lower abdominal excursions do not always coincide with the movement in the remaining traces. The lower abdominal trace usually moves in contrary motion to the traces from the rest of the torso. The neck trace has some frequent small smooth movements however they are different from the vibrato wobble seen in the traces of other participants. There are also some larger sharp excursions in the neck trace that coincide with breathing motions in the remaining traces indicative of laryngeal activation in the breathing mechanism. This activation is particularly evident when the lower abdominal trace is inactive. This example shows breath with a sharp peak in abdominal trace and little activation of neck trace.

Pre-Intervention
The pre intervention trace shows a marked increase in the activity of the upper thoracic trace. Excursions are very large and indicative of sharp muscle contractions. These contractions coincide with smaller, smoother excursions in the lower thoracic and upper abdominal traces. The lower abdominal and neck traces are almost completely inactive with no sharp muscle contractions or release evident. Small wobbles in the lower abdominal trace go in both directions. There is a slight wave in the neck trace coinciding with breath motions in the remaining traces.

Post-Intervention
The post-intervention chart shows a marked increase in lower abdominal activity and an almost completely static neck trace. There is no longer any breath activation in the neck trace and very little wobble of any sort. The upper thoracic, lower thoracic and upper abdominal traces all move in similar motion at a comparable level of activation. The upper abdominal trace shows some sharp excursions that do not coincide with movement in the other traces. The excursions in the lower abdominal trace move primarily in an upwards direction indicative of muscle contraction instead of muscle release.

Fitness
While S11’s Vo2 max decreased in the post-intervention test phase S11 showed an overall improvement in respiratory function with their FVC and PEF showing substantial increases. S11 heart rate was considerably lower throughout their post-intervention test. It was only 168 Bpm at the maximum work load of the post-intervention test compared to 182 Bpm at the same work load in the pre-intervention stage. S11’s self perception is on a similar level in all three tests. One exception is the connection to abdominal support which is higher in the post-intervention test than it is in either of the previous tests.

Possible Conclusions
The marked increase in lower abdominal muscle activity could be related to the static neck trace showing that the sound is now being controlled in the abdominal region instead of in the neck. This could correspond with the lack of any breath activation in the neck trace.
Code. S12

Singer Classification: Contemporary

Change in Vo2 max:

S12 showed a slight decrease in their Vo2 Max between their pre and post-intervention tests.

S12 Heart Rate Chart

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<th>Heart Rate</th>
<th>Time</th>
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S12 showed a similar heart rate in both the pre and post-intervention tests. In the baseline test the chest strap sensor that transmits the heart rate slipped off and due to this the heart rate data could not be recorded.
Change in Respiratory Function

- **Maximum Voluntary Ventilation (MVV)**
  - Baseline: Litres
  - Pre Intervention: Litres
  - Post Intervention: Litres
  - Test Phase: Litres
  - There is a dramatic increase in MVV but a decrease in both other respiratory tests.

- **Forced Vital Capacity (FVC)**
  - Baseline: Litres per Second
  - Pre Intervention: Litres per Second
  - Post Intervention: Litres per Second
  - Test Phase: Litres per Second

- **Peak Expiratory Flow (PEF)**
  - Baseline: Litres per Minute
  - Pre Intervention: Litres per Minute
  - Post Intervention: Litres per Minute
  - Test Phase: Litres per Minute

---

153
S12 showed improvement in their self perception of overall performance, effort level, breath control, intonation, musical expression and articulation.
Muscle Trace Data

Neck:

Upper Thorax:
Lower Thorax:

Upper Abdominal:
Lower Abdominal:

- **Average Maximum Value**
  - Baseline: 0
  - Pre Intervention: 25
  - Post Intervention: 0

- **Average Minimum Value**
  - Baseline: -10
  - Pre Intervention: 10
  - Post Intervention: 0

- **Average Range**
  - Baseline: 5
  - Pre Intervention: 10
  - Post Intervention: 5

- **Average Duration of Muscle Activation**
  - Baseline: 0
  - Pre Intervention: 1.5
  - Post Intervention: 0.5

The graphs show the comparison of values between Baseline, Pre Intervention, and Post Intervention phases for each metric.
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

Max Value Baseline

Max Value Pre Intervention

Max Value Post Intervention
Value of Average Minimum Muscle Excursions

Min Value Baseline

Min Value Pre Intervention

Min Value Post Intervention
Average Range of Muscle Excursions

Range Value Baseline

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscle Excursions

- **Duration Value Baseline**

- **Duration Value Pre Intervention**

- **Duration Value Post Intervention**
Muscle Trace General Description and Observations

Baseline
S12’s baseline chart has the largest and sharpest muscular activity in the lower thoracic and upper abdominal traces. The upper abdominal trace mirrors the lower thorax almost exactly with a slight variation in the size of excursions. The neck trace is also quite independent with a series of small yet rounded excursions happening when the other traces are inactive. The muscular activity in the lower abdominal region is very limited with very small wave movements indicating a slight release in tensions on occasion. These releases coincide with breath movements in the upper abdominal and lower thorax areas. Movement in the upper thorax is also fairly limited with excursions being only slightly larger than the lower abdominal trace. The excursions one again move in a gentle wave like pattern. The excursions in the upper thorax do not habitually coincide with the remaining traces.

Pre-Intervention
S12’s pre-intervention chart shows a very similar pattern to the baseline however the lower abdominal trace shows a much higher level of tension throughout the entire test. Looking at the measurements we can see that the pre-intervention minimum value is 13.90034 whereas the baseline data shows a reading of -6.07112. The range of movement is similar for both tests however the lower abdominals were engaged far more strongly throughout the pre-intervention test.

Post-Intervention
The post-intervention chart shows a smaller range of activity than the previous two tests. The muscle contractions are not held for as long or contracted as hard. The lower abdominal trace is back to a similar position as it was in the baseline test with muscle contraction rather than release being the main emphasis. Lower abdominal contractions occurred in conjunction with contractions in the remaining traces indicative of the engagement of the lower abdominal area during inspiration.

Fitness
S12 showed a slight decrease in their Vo2 Max between their pre and post-intervention tests. S12 showed a similar heart rate in both the pre and post-intervention tests. In the baseline test the chest strap sensor that transmits the heart rate slipped off and due to this the heart rate data could not be recorded. There is a dramatic increase in S12’s MVV but a decrease in both other respiratory tests. S12 showed improvement in their self perception of overall performance, effort level, breath control, intonation, musical expression and articulation however the remaining answers did not show significant improvement.

Possible Conclusions
As S12 did not have a regular pattern of muscle engagement in any of their tests it is hard to make comparisons however as there was very little difference in S12 fitness level between the pre and post-intervention stages it is unlikely that any changes were due to their fitness level.
S13 withdrew from this project

**Code. S14**

Note (S14 joined the study after the control period was already completed, resulting in no baseline data)

**Singer Classification:** Choral

**Change in Vo2 max:**

S14 showed small decrease in Vo2 max in the post-intervention test.

**S14 Hear Rate Chart**
S14’s heart rate was in general higher throughout the post-intervention test however as they increased their speed but not their gradient it is difficult to compare the maximum workload and resulting heart rate from both tests.
S14 showed an increase in MVV but a decrease in FVC and PEF.
S14 showed considerable improvement in their breath control, abdominal support, intonation, articulation and musical expression and mental alertness in the post-intervention test phase.
**Muscle Trace Data**

**Neck:**

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<th>Baseline</th>
<th>Pre Intervention</th>
<th>Post Intervention</th>
</tr>
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**Upper Thorax:**

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Lower thorax:

- Average Maximum Value
- Average Minimum Value
- Average Range
- Average Duration of Muscle Activation

Upper Abdominal:

- Average Maximum Value
- Average Minimum Value
- Average Range
- Average Duration of Muscle Activation
Lower Abdominal:

![Graphs showing data comparison](image-url)
Comparative Muscle Activation across the Range of the Torso

Value of Average Maximum Muscle Excursions

Max Value Pre Intervention

Max Value Post Intervention
Value of Average Minimum Muscle Excursions

Min Value Pre Intervention

Min Value Post Intervention
Average Range of Muscle Excursions

Range Value Pre Intervention

Range Value Post Intervention
Average Duration of Muscle Excursions

Duration Value Pre Intervention

Duration Value Post Intervention
Muscle Trace General Description and Observations

Pre-intervention
S14’s chart shows large dramatic peaked excursions in the lower thoracic and upper abdominal traces. The neck and the upper thorax have a very limited range of motion with only one or two slightly larger excursions. The lower abdominal trace has a consistent wobble similar to that caused by vibrato in the neck trace suggesting that the lower abdominal muscles are not consistently engaged in a supportive function.

Post-Intervention
Excursions in the upper abdominal and lower thorax are much smaller. However the excursions in the neck trace have become much larger with the average range of movement increasing from 3.611467 to 9.870047. There is less wobble in the lower abdominal trace however there are no regular patterns of muscle movement that generally correlate with breath.

Fitness
While S14 did not show a significant improvement in their VO2 Max or heart rate or in FVC and PEF. However, they did show an increase in MVV. S14 showed considerable improvement in their personal perception of their breath control, abdominal support, intonation, articulation and musical expression and mental alertness in the post-intervention test phase.

Possible Conclusions
While it is hard to judge if this subject increased in their level of fitness due to their inconsistent choice of speed and gradient in their treadmill test. They showed a considerable improvement in their singing self perception and MVV respiratory function test. S14’s muscle activation was inconsistent throughout all test phases and it is unclear if any changes could be related to fitness.
Track List of live recital performances

CD 1 (26/08/10)

“Storm Tossed Cantatas”

‘Non Sa che sia dolore’ J.S. Bach. 1685-1750 (16:08min)
Soprano, Flute, Two Violins, Viola, Cello, Harpsichord
1. Recitative. Non sa che sia dolore
3. Recitative. Tuo saver
4. Aria. Ricetti gramezza

‘Or che d’orrido verno’ Nicola Porpora. 1686-1768 (15:20min)
Soprano, Flute, Two Violins, Cello, Harpsichord
5. Sinfonia
6. Recitative. Or che d’orrido verno
7. Aria. Lungi dal ben che s’ama
8. Recitative. Pur fra tanta mia pena
10. Comparison track. Aria. Nocchier ce mira vicino al lido (5:40min)
(Recorded 09:05:2009)

CD 2 (22/12/10)

“Natività”

1. ‘Ad Arma, O Spiritus Rebelles’ Isabella Leonarda. 1620-1704 (9:42min)
(Duet for two sopranos and organ)

Three Arias from ‘Nine German Arias’ Georg Frederic Handel. 1685-1759 (18:09min)
2. Kunft’ger Zeiten eitler Kummer (soprano, baroque oboe and harpsichord)
3. Meine Seele hört im Sehen (soprano, baroque oboe and harpsichord)
4. Das Zitternde Glänzen der spielenden Wellen (soprano, violin, cello and organ)
‘Jam Sole Clarior’ Alessandro Scarlatti. 1660-1725. (5:53 min)
Soprano, Two Violins, Cello and Organ
5. Aria Iam Sole clarior
6. Recitative. Novus iste defensor veritatis
7. Aria. Et forti animo

8. ‘Pargoletto in Rozze fasce’ from Cantata per la Notte di Natale, 1705, Alessandro Scarlatti. 1660-1725 (5:30 min)
(soprano, baroque oboe and harpsichord)

CD 3 (live performances, 19/03/11 and 28/05/11)
“Madrid meets Naples”

Track 1.
‘Tornada a San Francisco’ Juan del Vado. 1625-1691 (2:46min) 19.3.11
Soprano, cello, baroque guitar, harpsichord
La mas pura azucena (2 stanzas sung)

Track 2.
‘Cantata al Santisimo con violins’ Sebastian Duron. 1660-1716 (9:03min) 19.3.11.
Soprano, 2 violins, basso continuo (cello, baroque guitar, harpsichord)
   Ay que me abraso
   O Guerra Misteriosa
   Non deje de arder
   Coplas x 3
   Y en tan celestials
   Ay que me abraso
Track 3.

Duet. ‘O come bello’ Alessandro Scarlatti. 1660-1725 (10:18 min) 19.3.11
Two sopranos and basso continuo (cello, theorbo, harpsichord)
Aria 1. O come bello (Stanza 1, Tirsi; Stanza 2, Clori)
Recitative. Clori del vicin fiume
Aria. Or tu piu non dirai (Stanza 1, Tirsi, Stanza 2, Clori)
Recitative. Non do fede al ruscello
Duet. Cosi puro

“German and Italian Masters”

Cantata ‘Quanto dolce e quell’ardore’ Francesco Mancini. 1672-1737 (11:58min) 28.5.11
Soprano, Oboe and Basso
Track 4. Aria. Quanto dolce e quell’ardore
Track 5. Recitative. Purche a te sia vivinia
Track 6. Aria. Aprimi il petto

Cantata ‘Non ho vita, ho viva morte’ Nicola Porpora (1711). 1686-1768. (07:13min) 28.5.11
Soprano, cello, and harpsichord
Track 8. Recitative. Aure, deh voi portate
 Track 9. Aria. Senza governo
Program Notes
Masters Recital

Storm Tossed Cantatas for Soprano, Flute, Strings and Continuo

And

Violin Sonata
“The Annunciation”
Cantata. Non sa che sia dolore  
Johann Sebastian Bach

Violin Sonata. No 1 (from the Mystery Sonatas)  
- The Annunciation  
Heinrich Ignaz Franz Biber

Cantata. Or che d’orrido Verno  
Nicola Antonio Porpora

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Johann Sebastian Bach

The translation of the Bach cantata seems to indicate that the piece is a farewell cantata addressed to a young man who is leaving his home town. The first recitativo refers to Minerva who was the Roman goddess of arts, medicine and commerce. This reference has been taken to imply that the person departing is a scholar.

“From the text we learn that the traveller is a scholar returning to his homeland in order to serve it.” (Dürr, 2005, p.924)

The nature of the text has led to sum debate as to the authorship of this cantata. “the unresolved questions being with the text, which is written in Italian at times poor enough to be incomprehensible.” (Dürr, 2005, p.923)

Dürr suggests that the text was taken from several different sources by a text editor who was largely unfamiliar with the Italian language and who molded it to fit the occasion. (Dürr, 2005, p.923)

There are two possibilities for the traveler that this cantata is dedicated to. Johann Mathias Gesner (1691-1761) who left Weimar in 1729 to return to his native Ansbach and Lorenz Christoph Mizler (1711-78) who left Weimar in 1734. Dürr feel that the latter is far more likely as the text suggests a young man and Gesner would have been thirty eight at the time of his departure. (Dürr, 2005, p. 924)
Non sa che sia dolore

Recitative
He does not know what sorrow is who parts from his friend and does not die.
The child who weeps and groans and then is more afraid, his mother comes to console.
Go therefore at the signs from heaven,
Fulfil now the zeal of Minerva.

Aria
Depart then and with sorrow leave to us sorrowing hearts.
You will delight your fatherland, in its service you will do your duty;
Cross now from shore to shore, may you see the wind and waves favourable to you.

Recitative
Your knowledge contrasts with the time and age,
virtue and valour alone are sufficient to conquer;
but who will make you greater than you were
Ansbach, full of so many distinguished people?

Aria
Do away with anxiety and dread,
like the steersman, when the wind is calmed,
who no more fears or turns pale but content on his prow goes singing in the face of the sea.
Heinrich Ignaz Franz Biber (1644 - 1704)

Sonata No 1 (from the Mystery Sonatas) - The Annunciation
Prelaudium
Aria Allegro – Variation – Adagio - Allegro
Finale

A defining musical entity of the 17th century, Biber’s name is synonymous with some of the most virtuosic violin music from the period. Born and educated during his early life in Bavaria, Biber worked in Graz and Kroměříž before settling in Salzburg, where he produced the majority of his music, of which a substantial amount has survived, although much of this is rarely performed. His left hand technique and virtuosic compositional style was crucial in the evolution of higher position playing on the violin, as it allowed him to easily reach 6th and 7th positions, an unprecedented height for the time. He also incorporated multiple stopping, counterpoint and polyphonic textures into his music, and contributed significantly to the art of scordatura (alternative tuning for stringed instruments).

The Rosary sonatas are one of two major works which Biber wrote in scordatura, the other being the Harmonia artificioso-ariosa. The divinely inspired collection of pieces, which depict the fifteen mysteries of the rosary, was probably played during the composer’s lifetime only once, by Biber himself, as a set of postludes for October 1676 or 1677 in Salzburg, the month dedicated to the Rosary at Salzburg Cathedral. It has since gained popularity amongst performers of early music for its virtuosic requirements of the player. Many of the sonatas necessitate retuning of the violin in various combinations. The first sonata is written in the standard tuning and is in D minor.
Nicola Antonio Porpora

Although internationally acclaimed as a composer and singing teacher during his lifetime Nicola Antonio Porpora has fallen into relative modern obscurity. The most famous of his singing pupils was the Italian castrato Farinelli (1705-1782) for whom much of his vocal music is said to have been written. Porpora entered the Conservatorio dei Poveri di Gesù Cristo in Naples at the age of ten where he studied for the next ten years. He held the position of maestro di cappella to the Prince of Hessen-Darmstadt from 1711 until 1725 during which time he wrote some of his best know operas. He is said to have collaborated with Domenico Scarlatti, co writing the opera Berenice Regina d'Egitto in 1718. He had many other notable students including Metastasio, Caffarelli, Antonio Uberti (known as "Porporino"), Regina Mingotti and the composer Franz Joseph Haydn.
Or che d’orrido verno

Recitative

Or che d’orrido verno
L’usata pioggia I nostril
campi inonda,
E l’erba, il fior, la
fronda
Strugge de’ venti il fiero il
soffio e cade,
E la vicina selva,
Che tanto or Borea ed Aquilon minaccia,
Nuda rivolge al ciel l’antiche
braccia,

Ora che villanello in sé
raccolto
S’agita, trema e bagna
Per soverchio rigor
di pianto il volto,
Piu non potremo, oh Clori,
Andar pei campi a pascolar il
gregge
E gl’ininnocent amor
A vicenda narrar d’un faggio all’ombra,
Come facciam tal’ora
Che Febo il piano e la collina
ingombra.
Ah! ch’or lungi da te carco d’affanni,
Di mestizia ripien miseró e
solo,

Dovrò spendere i giorni in preda alduolo.

Now the dread Winter
drenches our fields with his customary
rain,
and the grass, the flowers and the trees
are afflicted and uprooted by the fierce
blast of the wind;
Now that the nearby wood,
threatened by Boreas and
Aquilo,
turns naked to the sky her ancient arms;
Now that the worried young peasant
shudders, trembles and bathes his face in
tears because of such hardships:
We can not, Oh Chloris,
go into the fields to graze our flocks
and talk about our innocent loves
in the shade of the beech,
as we do when
Phoebus floods hill and vale with
sunshine.
Alas! Now, far from you and burdened
with affliction,
full of sadness, wretched and alone,
I must spend my days a prey to sorrow.
Aria

Lungi dal ben che s’ama
Come si possa, oh Dio
Vivere un sol momento
Dirti non so ben mio.
Tutta la pena al cor.
Al suo fatal periglio, Madre che perde il figlio,
Non ha dolor si fiero,
Non ha si rio dolor.

I cannot tell you, my dear,
how it is possible, oh God,
to live far from the beloved
even for a single moment.
I only know that I feel in my heart
all the pain of death.
a prisoner
nearing his fatal hour,
a mother who has lost her son,
do not feel such fierce agony,
do not feel such cruel grief.

Recitative

Pur fra tanta mia pena,
Fra tanti affanni miei prendo ristoro
Dal pensar che fra noi

La placida e serena
Stagione amica un farà ritorno,
E splenderà per noi più lieto il giorno.

Questo pensier sol puote
Al miser Fileno
Scemar l’affanno e rasciugar le gote;
E senza te morrei
diletta Clori
Sotto la sferza del crudel tormento
Tal’ è il dolore che d ate lungi io sento.

Yet amid my great pain,
amid my innumerable afflictions, I take
comfort
in the thought that one day
the peaceful, calm and
kindly season will return to us,
and a happier day will shine for us.
Only this hope can
lessen the suffering
and dry the tears of poor Fileno:
Without you, dear Chloris, I would die
under the lash of cruel torments,
such is the grief I feel when far from you

Aria

Nocchier che mira
Vicino il lido
Più non s’addirà
Col vento infido
Ma solca intrepido
L’ire del mar.
Del suo dolore
Così quest’alma
Soffre il rigore
Perché la calma
Quasi vicina
Deve sperar.

A helmsman who sees
that the shore is near
feels no rage

for the treacherous wind,
but ploughs fearlessly
through the sea’s wrath.
In the same way, my soul
suffers the cruelty
of its sorrows
because it must hope
for that calm
which is close at hand.
NATIVITÀ!

Christmas Music from the 17th Century

Saint John’s Church 22nd of December 2010
Program

Ad arma, o spiritus  Isabella Leonarda
Samantha Cobcroft, Joelle Griffith Soprani
Rosalind Halton, Organ

Ad gaudia, ad jubila  Maria Xaveria Peruchona
Samantha Cobcroft, Soprano
Rosalind Halton, Organ
Bridget Hall, Ben Lambert, violins
Arran Hamilton, cello

Three Arias – Nine German Arias  Georg Frederic Handel
Künft’ger Zeiten eitler Kummer
Das Zitternde Glänzen der spielenden Wellen
Meine Seele hört im Sehen
Joelene Griffith, Soprano
Bridget Hall, Violin
Neil Simpson, Oboe
Rosalind Halton Harpsichord

Capriccio Pastorale  Girolamo Frescobaldi
Rosalind Halton Organ

Iam Sole Clarior  Alessandro Scarlatti

Premier Trio en Sol  Claude Debussy
Andantino con moto allegro
!!!. Andante espressivo
IV Finale: Appassionato.
Bridget Hall, violin; Arran Hamilton, cello;
Gregory Smith, piano

Pargioletto in rozze fasce  Alessandro Scarlatti
Aria from Cantata for Christmas Eve, Rome 1705
Joelene Griffith (soprano), Neil Simpson (baroque oboe)
Ad Arma, O Spiritus Rebelles.

Isabella Leonarda (1620 -1704)

We begin the program with two works by Italian nuns of the Ursuline Order. Isabella Leonarda, who composed and published both vocal and instrumental music to the end of her long life, and Maria Peruchona.

Ad arma, o spiritus rebelles, ad arma. Tormenta parate, Furentes certate,
Crudeles saevite In artus imbelles, Ad arma venite, O spiritus rebelles.

To arms to arms, O warlike spirits, to arms. Prepare your missiles, strive furiously, be cruelly fierce, to these unwarlike limbs; come to arms, O warring spirits come.

Recit: Non timet furores, Non pavet horrors Nec specula mortis. Inermis pugnabit,
Imbellis certabit, Haec anima fortis.

She does not fear fury, is not frightened at terrors or the stings of death. Unarmed she will fight; unwarlike she will strive, this brave soul.

O rarum spectaculum. O admirabile prodigium.

O rare spectacle, O wonderful prodigy.

Cadit hostis derelictus, Et bellatrix triumphat. Dum fugit triumphat Et duces tartareos debellat.

The enemy, abandoned, falls and the female warrior triumphs. While the enemy flees, she triumphs and vanquishes the leaders of hell.

Ad arma,....

To arms,....

Dum odit amores, Est animo Clemens, Et sarvat in sinu Vignes flores. Mundana
dum fugit, Est animo fortis. Sic enim sit miles Divine cohortis. While she hates earthly loves, hers is a gentle nature, and she keeps virgin flowers in her bosom. While she flees worldly things, she is brave in spirit. For thus may a soldier of the divine cohort be.

O virgo fortunata, o triumphatrix gloriosa.

O fortunate virgin, O glorious victor. In reward for such great victory, behold you are betrothed to the most high.

Jam laeta supernae Dent jubila voces, Et tibi veloces, O anima fortis. Jam donent aeternae Confortia sortes Et tibi veloces, O anima fortis.

Alleluia.

Now may the celestial voices swiftly give you exulting jubilation, O brave soul. Now may eternal destinies swiftly grant you comfort O brave soul.

Alleluia
Ad gaudia, ad iubila

Maria Xaveria Peruchona (ca. 1652 – after 1709)

This cantata in D Major tells the Christmas story using three characters: an angel, a narrator and Jesus’ mother, and ending with a cradle song to the Baby Jesus.

**Angel**

Ad gaudia, ad iubila, Pastores vos invito, si currite lætantes populi. Omnes unanimes lætate.

To joy, to songs of joy, shepherds, I invite you, yes, run happy people. All in one mind rejoice.

**Narrator**

Est natus Dominus in nostro stabulo, in feno arido unde frigescit. Vagitus, Clamitent, “mater carissima,

Born is the Lord in our stable, on dry hay he grows cold, Crying baby, calling, “mother dearest,

**Recitativo**

Nudus in palea liquesco. Naked in chaff, I waste away

**Angel**

Quid ergo moramini accurrite et nato puerulo, currite, una cunctis lætitia, vera Cæli delitia in terra orta est.

Why do you delay? Run to the newborn little boy, run, one united joy, true Heaven’s delight on earth is born.

**Mother**

Dormi puer blande mi, tace si, nec suspira sine vi, care cor amate, audi me, rogo te.

Sleep boy, my gentle one, be still, yes, not sighing so, dear heart, beloved, hear me, I beseech you,

**Dormi et tace, dormi in pace.**

Sleep and be quiet, sleep in peace. Translation Samantha Cobcroft
Handel’s ‘Neun Deutsch Arien’ (Nine German Arias) are among the very few examples of the composer setting texts in his native language. This collection of delightful arias, with unspecified obbligato instrument, centre around themes of joy at the beauty of nature and the miracle of creation.

**Künft’ger Zeiten eitler Kummer**

*‘Neun Deutsch Arien’*

George Frideric Handel (1685-1759)

Künft’ger Zeiten eitler Kummer  
Stört nicht unsern sanften Schlummer,  
Ehrgeiz hat uns nie besiegt.  
Mit dem unbesorgten Leben,  
Das der Schöpfer uns gegeben,  
Sind wir ruhig und vergrügt.  
Vain concerns for the  
future  
Do not disturb our gentle  
slumber,  
Ambition has never vanquished us.  
With the carefree life  
That the Creator has given us  
We are content and satisfied.

**Meine Seele hört im Sehen**

Meine Seele hört im Sehen,  
Wie, den Schöpfer zu erhöhen,  
Alles jauchzet, alles lacht.  
Höret nur,  
Des erblüh’nden Frühlings Pracht  
Ist die Sprache der Natur,  
Die sie deutlich, durchs Gesicht, Allenthalben  
mit uns spricht.  
My soul hears, through seeing,  
How all things rejoice and laugh  
To magnify the Creator.  
Hark! The Spring’s blossoming splendour  
The blossoming splendour of the spring  
Is the language of nature  
Which through sight,  
Speaks clearly to us everywhere.

**Das Zitternde Glänzen der spielenden Wellen**

Das Zitternde Glänzen der spielenden Wellen  
Versilbert das Ufer, beperlet den Strand. Die rauschenden Flüsse, die sprudelnden Quellen  
Bereichern, erfrischen das Land  
Und machen in tausend vergnügenden Fällen  
Die Güte des herrlichen Schöpfers bekannt.  
The shimmering gleam of  
dancing waves  
Silvers the shore, brings pearls to the sand. Rushing rivers,  
bubbling springs  
Make the land rich, fertile and fresh,  
And in a thousand delightful ways  
Reveal our glorious  
Creator’s goodness.
**Girolamo Frescobaldi (1683-1743)** was the most famous organist of the early seventeenth century, moving early in his career from Ferrara in the north of Italy to Rome, where he was organist at St. Peters for the remainder of his career.

**Iam Sole Clarior**

**Alessandro Scarlatti (1660-1725)**

**Concerti Sacri**, ed. Luca della Libera

1. *Aria with violins*

   Iam sole clarior
   amictus lumine,
   caelesti gloria,
   Nicolaus ad ethera spirat.

   Et plenus meritis,
   ornatus gratia,
   amore fervidus,
   caelum petit, ad astra suspirat.

2. *Recitativo*

   Hic magnus ille Nicolaus,
   gloria sacerdotum,
   qui potens fuit semper,
   in opere et sermone.

   Here is the great Nicolas,
   glory of the priests,
   who was always powerful,
   in deeds and words.

3. *Aria with basso continuo*

   Inter undas fluctuantes,
   tanquam lapis angularis.
   Inter fluctus jam spumantes,
   seper constans, immortalis.

   Amid the tossing waves,
   like a corner stone.
   Amid the now foaming flood,
   always constant, immortal.

4. *Recitativo*

   Novus iste defensor veritatis
   non minas judicum timuit,
   nec terrena dignitatis
   gloriamque scivit.

   That new defender of truth
   did not fear the threats of the
   judges, nor did he know
   the glory of earthly dignity.

5. *Aria with violin solo*

   Et forti animo,
   ingenti gaudio,
   pro Christi fide
   pugnavit, superavit et vicit.

   And with a strong spirit
   with great rejoicing,
   for the faith of Christ
   he fought, overcame,
   and was victorious.
**Premier Trio en Sol**

Claude Debussy  I. 1862-1918

**Andantino con moto allegro**

**I. Andante espressivo**

**IV Finale: Appassionato.**

One of Debussy's earliest completed chamber works, the Trio dates from 1880 when the composer was in Florence.

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**Pargoletto in rozze fasce**

Alessandro Scarlatti (1660-1725)

**Cantata per la Notte di Natale:**

**The Five Prophets (Cinque Profeti)**

This beautiful aria with obbligato oboe is sung by Daniel in this oratorio depicting the wonderment of five prophets, Daniel, Ezekiel, Isaiah, and Abraham, and the lamenting apprehension of Jeremiah. This aria represents the Infant Jesus - in Siciliano rhythm and traditionally accompanied by reed instruments - and predicts the icy chill to which he has been born into the world. This work was composed for performance on Christmas Eve in the Apostolic Palace, Rome, 1705.

Pargoletto in rozze fasce
sta ristretto il mio Signore
e devien l'istesso amore
un oggetto di pietà.
Agli affanni in terra nasce
la beata eterna prole,
e chi accende gl'astri e il sole
fedeltà gel tremar lo fa.

My lord is become a little child
wrapped in coarse clothing
he is Love incarnate and so becomes
the object of my devotions.
The blessed eternal offspring
is now born into earthly affliction
and he who lights the sun and the
stars makes him to fear the icy chill.

(Translation, Carolyn Gianturco)
Scots Kirk Baroque Band

Led by Rosalind Halton

Series Opening Concert **11am March 19**

“**Madrid Meets Naples**”

Cantatas, Arias and Duets

By

Alessandro Scarlatti, Juan de Navas and Sebastian Duron
Program

Per la Gloria d’adorarti (La Griselda)                  Giovanni Bononcini (1772-1750)
Vittoria, Vittoria                                   Giacomo Carissimi (1605-1674)

Samantha Cobcroft

Tocata for Keyboard                                  Juan Cabanilles (1644-1712)
Corrente italiana                                    

Rosalind Halton

Tocata for lute                                       Alessandro Piccinini (1566-1638)
Folias                                               

Simon Martyn-Ellis

Tonada a San Francisco                               Juan del Vado (fl.1625-1691)
La ma spur azucena                                   

Joelene Griffith

Cantada a la voz sola al Santisimo y de Pasion       Sebastian Duron (1660-1716)
Ay de mi                                              

Samantha Cobcroft

Jacaras                                               Antonio Santa Cruz (fl. 1700)
Simon Martyn-Ellis, baroque guitar                    

Simon Martyn-Ellis

Solo al Santisimo Sacramento                          Juan de Navas (1650-1790)
Ay, divino amore                                      

Samantha Cobcroft

Cantata al Santisimo con violins                     Sebastian Duron (1660-1716)
Ay, que me abrasso                                    

Joelene Griffith

Sonatas in D minor                                    D. Scarlatti (1685-1759)
Andante Moderato-Allegro K.9                         

Rosalind Halton

Duet, Tirsi e Clori                                   A. Scarlatti (1660-1725)
O come Bello                                          

Samantha Cobcroft, Joelene Griffith
During the seventeenth century the affairs of Spain and the kingdom of Naples were closely bound up together. Naples was ruled by a Vice-Roy from Madrid who demanded entertainment—which was delivered in both Italian and Spanish styles towards the end of the 17th century. When the Vice-Roy, Medina Celi, returned to Madrid, he took with him several artists whose work he had enjoyed in Naples—including his lover the singer Angela Voglia ‘La Giorgina’, the librettist F.M. Paglia (who composed many libretti for Alessandro Scarlatti), and the theatre designer Schor. Italian musicians were to follow, among them Domenico Scarlatti, employed first by the King of Portugal and then moving to the court of Spain in 1727. Both Scarlatti father and son were thus very familiar with Spanish taste.

The Spanish vocal pieces in this program share religious function with highly impassioned text and music very different from Italian opera or church music. Virtuoso arias with long florid passages were not in vogue in 17th century Spain. The usual forms have a refrain (estribillo) followed by stanza (coplas). Guitar (or harp) was the usual instruments of accompaniment, the composers of this repertoire for church or theatre were mostly performers of these instruments. The beautiful melodic lines—alternately joyful and penitential—and subtly shifting rhythmic patterns draw us in. (R. Halton)

**Texts**

**Tonada a San Francisco**, Juan del Vado (fl.1625-1691)

*La mas pura azucena su afecto ennoblecio. Your love ennobled the most pure lily by preserving forever its whiteness intact.*

**Cantada al a voz al Santisimo y de Pasion**, Sebastian Duron (1660-1716)

*Ay de mi. Woe is me, for weeping and sadness do not soften my rigidity. Create in me, Lord, piety and a clean, humble heart, so that my senses breathe, give pleasure and happiness to my ears. Let my afflicted love gain that grace which my soul unhappily lost. Even though I am unworthy, my Lord, do not remove your benign face from my heart that asks for forgiveness. But woe, no one can assure me of your forgiveness, since knowing why I weep, I do not know if my crimes are erased; with fear and hope I live and die.*

**Solo al Santisimo Sacramento**  Juan de Navas (2nd half of the 17th century)

*Ay, divino amore. Oh divine love, floating on the sea, your own obstacle, you found a safe port. Let the fields and forests, mountains and valleys, always do you service.*

**Cantata al Santisimo con violines**  Sebastian Duron (1660-1716)

*Ay, que me abraso. Oh how I burn in the flames of love! What sweet violence! What a tender gift! Celestial fires ignite the heart desiring torment which is the glory of the soul. O mysterious war, in glorious form, I contemplate intently my soul in anxiety. Aria. Do not let my faithful heart cease burning. And in such celestial, divine fires, let my breast repeat the soft amorous sigh its faithful consonance. Oh how I burn in the flames of love!*

**Duet, Tirsi e Clori**  A. Scarlatti (1660-1725)

*O come Bello. Tirsi and Clori discover each other by a brook. They find the image of someone lovely reflected in the brook—but is their own image they fall in love with, or the appealing person opposite? They find satisfaction in the thought that their love is ‘as pure as the water in the brook’.*
**The Band**

**Samantha Cobcroft** (Soprano) is a Newcastle based singer, singing teacher and choir director who holds a University Medal for Music in performance and research.

**Joelene Griffith** (Soprano) is an established baroque singer awarded a Faculty Medal for music currently completing a Masters Degree at the University of Newcastle.

**Bridget Hall** (Violin) has been concert master for community and university ensembles and is currently based in Sydney working as a teacher and freelance baroque violinist.

**Rosalind Halton** (Concert master and Harpsichord) performs internationally and is a highly respected researcher, lecture and Baroque specialist.

**Benjamin Lambert** (Violin) is both an accomplished violinist and violist studying as an undergraduate at the University of Newcastle who is equally capable of playing modern repertoire as early music.

**Rachel Pogson** (Cello) is a freelance cellist and teacher based in Newcastle who has played with classical, baroque and popular ensembles including The Christ Church Camerata, iOTA and Tim McCartney.

**Our Special Guest**

**Simon Martyn-Ellis** began playing the lute after finding the classical guitar repertoire too restrictive for ensemble performance: continuo accompaniment remains a mainstay of his activities. Simon completed an Honors degree at the university of New England in performance on the lute and related instruments in 1994, studying with Tommie Anderson. He has undertaken summer courses and private lessons with Hopkins Smith, Jakob Lindberg and William Carter. And completed postgraduate study with Rolf Lislevand at the Trossingen Hochschule fur Music, Germany.

Since moving to Germany in late 2002, Simon has appeared frequently with Akademie fur Alte Musik Berlin, Neue Hofkapelle Munchen, Neue Dusseldorfer Hofkapelle, and Freiburger Barockorchester, and with La Cetra Basel, the Balthasar-Neumann Ensemble, Main Barockorchester, Erato ensemble, the Accademia de Santa Cecelia Orchestra in Rome as well as in a variety of chamber music performances. He is co-founder of the prize winning ensemble Cadenza.

In Australia, he appeared in the Melbourne and Adelaide International Festivals with Collegium Vocale Gent and Ensemble 415 respectively. Simon has also appeared with leading Australian groups, including Opera Australia and the Adelaid and Melbourn symphony orchestras, and chamber ensembles such as the Elysium Ensemble, Salut! Baroque and the Sirius Ensemble.
Scots Kirk Concert Series 2011

Scots Kirk Baroque Band

Led by Rosalind Halton

Saturday 2pm May 28

‘German and Italian Masters’

Cantatas, Arias and Duets

By

Handel, Telemann, Mancini and Porpora.
Program

G.F. Handel
Joelene Griffith, soprano
Samantha Cobcroft, soprano
Rosalind Halton, harpsichord
Rachel Pogson, cello

Duetto I. London 1July 1741
Quel fior che all’alba ride -E un fior la vita-L’occaso
ha nell’aurora

Francesco Mancini
Joelene Griffith, soprano
Neil Simpson, oboe
Samantha Cobcroft soprano
Rosalind Halton, harpsichord
Rachel Pogson, cello

Cantata for soprano, oboe and basso
Aria: Quanto dolce enquell’adore
Recitative: Purche a te sia vicinia
Aria, Allegro: Aprimi il peto

J.S. Bach (attributed)
Matthew Hopcroft, flute
Rosalind Halton, harpsichord

Siciliana from Sonata for flute and harpsichord

J.S. Bach
Joelene Griffith, soprano
Neil Simpson, oboe
Bridget Hall, violin
Rosalind Halton, harpsichord
Rachel Pogson, cello

Aria from Cantata 84
Ich esse mit Freude mein wniges Brot

Nicola Porpora
Joelene Griffith, soprano
Rosalind Halton, harpsichord
Rachel Pogson, cello

No ho vita ho viva morte Naples, 1712
Aria – Recitative – Aria: Senza governo d’amor

G.Ph. Telemann
Matthew Hopcroft, flute
Neil Simpson, oboe
Bridget Hall, violin
Rosalind Halton, harpsichord
Rachel Pogson, cello

Trio for Flute, Oboe and Basso from Tafelmusik
Affettuoso – Allegro – Dolce – Vivace

G.F. Handel
Samantha Cobcroft soprano
Joelene Griffith, soprano
Rosalind Halton, harpsichord
Rachel Pogson, cello

Duetto VI, 31 August, 1745
Ahi, nelle sorti umane – Ma le speranze vane

G.F. Handel
Samantha Cobcroft soprano
Joelene Griffith, soprano
Rosalind Halton, harpsichord
Rachel Pogson, cello

Duetto II, London, 3 July 1741
No, di voi non vo’ fidarmi – Altra volta incatenarmi
– So per prova I vostri inganni
Program notes

Two of the Handel Duets performed here are well known to music lovers in a different form: Handel recomposed them as choruses a few years later for his great oratorio Messiah. These include: “His yoke is easy”, “For He shall purify” (Duet 1). “For unto us a Child is Born” and “We all like sheep have gone astray” (Duet 2). Both were composed within a few days in 1741. Johannes Brahms was the first to edit this music in the late 19th century.

The Italian texts give an unusual twist to this familiar well-loved music. Duet 1 is set to a poem on the short life of a flower, which “laughs at dawn, is killed by the sun and meets its tomb in the evening. It loses its spring in a single day”. Duet 2 “No, I will trust you, blind Love, cruel beauty. You are a liar and trickster. I know your deceits, twin tyrants.”

Duet VI did not make its way into the choruses of Messiah. “Ah in human fate, the happiness of the heart is greatest that is without passion. But vain hopes deceive our thought so that pain and pleasure become close companions.”

Francesco Mancini and Nicola Porpora were both esteemed composers of early 18th century Naples. Mancini remained throughout his career with the Neapolitan Cappella Reale, acting as Director of Music during the years of Alessandro Scarlatti’s years in Rome, only to be required to step down on Scarlatti’s return in 1709.

“Quanto dolce e quell’ardore ch’io sento nel core” (edition by Rosalind Halton)
Aria 1: “How sweet is that love which inflames my heart, my dearest. Though it may seem a source of suffering, for me it is only joy and attraction.”
Recitativo: “When I’m close to you and embrace you, I desire nothing more my dear Fileno. What joy it is to tell you, ‘tighten if you can the chains’.”
Aria 2: “Open my heart, my delight, so that I can show you your own beautiful face engraved there. I want you to see into my heart so that you can be certain of my faithfulness.”

Nicola Porpora, now known as the singing teacher of Farinelli, had a brilliant composing career which took him around the opera houses of Europe. His early cantata “No ho vita” is dated ‘Naples 1712’. His music is notable for innovative and virtuoso treatment of both voice and cello.

“I don’t live, I have living death if I have lost my love. The memory of my love is more cruel than separation.” The final aria portrays the soul “like a little boat without a pilot, buffeted by the waves of love, which longs for the shore of faithful love.”

J.S. Bach “Ich esse mit Freuden”
The only piece from a sacred cantata in today’s program, this soprano aria with oboe and violin obligato radiates devout contentment.

“I eat with joy my small bread and allow my neighbor his. A quiet conscience, a joyful spirit, a grateful heart which gives praise increases our blessing and contains need.”
Special Guests

Neil Simpson (baroque oboe) is a University of Newcastle graduate who has recently played with the early music studio. University of Sydney and Melbourne original instrument ensembles including the Ironwood Chamber Orchestra and Sydney Conservatorium Baroque Orchestra.

Mathew Hopcroft (baroque flute) is a recent graduate of the University of Newcastle and has increased his passion for early music by learning the wooden transverse flute.

Scots Kirk Baroque The Band

Samantha Cobcroft (Soprano) is a Newcastle based singer, singing teacher and choir director who holds a University Medal for Music in performance and research.

Joelene Griffith (Soprano) is an established baroque singer awarded a Faculty Medal for music currently completing a Masters Degree at the University of Newcastle.

Bridget Hall (Violin) has been concert master for community and university ensembles and is currently based in Sydney working as a teacher and freelance baroque violinist, where she performs with the Ironwood Chamber Orchestra (developing artists program).

Rosalind Halton (Concert master and Harpsichord) performs internationally and is a highly respected researcher, lecture and Baroque specialist.

Rachel Pogson (Cello) is a freelance cellist and teacher based in Newcastle who has played with classical, baroque and popular ensembles including The Christ Church Camerata, iOTA and Tim McCartney.

Our thanks to Scots Kirk Presbyterian Church for their ongoing support of our concert series.

It is also a great pleasure to have the support and expertise of Ray Hugo who records our concerts for broadcast on Hunter Rostrum.