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**Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease participating in voice and choral singing group therapy (VCST) versus a music appreciation activity**

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A thesis submitted in fulfilment of the requirements for the  
degree of Doctor of Philosophy in Speech Science

The University of Auckland, 2018

## Abstract

**Background:** Group singing as an effective non-pharmacological intervention for voice and wellbeing in people with Parkinson's disease is attracting attention, however a review of the literature indicates only a small number of studies completed in the past decade, all with methodological differences and an absence of randomised controlled trials (RCTs). LSVT® is the current mainstream voice treatment for people with PD. It is a formalised, high effort and intensive clinic based intervention. It is considered effective, however, there are limitations; insufficient availability and prescription, high administration costs related to the intensity of required client contact time and access limitations because of physical impairments can all result in significant numbers of participants dropping out.

**Aim:** The aim of this thesis is to evaluate how an alternative therapy, intensive choral singing, improves the phonatory and respiratory muscle control of people with PD and how the mutually supportive nature of group singing might facilitate social interaction and improve wellbeing. A preliminary study (Study 1) investigated five self-report measures of symptom severity, wellbeing and voice to determine whether they were acceptable, reliable and sensitive to the effects of PD. A two armed, parallel RCT design (Study 2) was used to compare outcomes for a Choir group who participated in singing, voice and respiration exercises and a Music group who participated in watching and discussing music videos. Both groups attended once per week sessions over nine consecutive weeks (16 hours).

**Findings:** Internal reliability of self-report measures in Study 1 was good to excellent. Analysis showed significant intra subject reliability with no significant change over two test administrations separated by four weeks, with the exception of the ACE-III. Analysis of variance of pre and post assessments of voice volume and quality, respiratory and glottal function and cognition and self-report measures in Study 2 showed significant within-group

improvement for the Choir group, but not for the Music group, for voice volume and quality, maximum sustained phonation time and functional symptom severity. Other measures of voice volume were improved for both groups. When outcomes were compared between groups at the end of the intervention period, significant between-group differences were observed in average and maximum voice volume (MSP), voice quality (VTI and SPI) and glottal function (ARES). Choir group and Music group attendance was over 96% during the treatment period suggesting that both groups found the nature and format of the activities enjoyable and worthwhile.

**Conclusion:** This study contributes further evidence of group singing as an effective voice intervention that has a high participation uptake and low drop out and provides further support for the use of group singing an effective alternative to LSVT®.

## **Acknowledgements**

First, and foremost, I express my heartfelt thanks and admiration to the extraordinary and inspirational people who volunteered to participate in this study, whose primary reason was to make a personal contribution to Parkinson's research and to help others.

Without the support and guidance of my supervisors: Professor Suzanne Purdy and Professor Lynette Tippett, this thesis would not have been possible. Huge thanks also go to Parkinson's New Zealand for their encouragement, financial support and the ceaselessly wonderful community educators - Janine Mair in the Waikato and Glennis Best and Liz Rapley-Jones in the Bay of Plenty, who assisted in the recruitment process as well as providing premises for the study. Heartfelt thanks also go to Fred Chell, pianist extraordinaire, for his outrageous commitment and to my two research assistants Laura Wood and Sara Jodache for their care and accuracy.

I owe a huge debt of gratitude to the The New Zealand Lottery Grants Board, acting through the Department of Internal Affairs for their award, which enabled me to purchase the necessary equipment to complete this study. Equally important to the study are the CEO and board at the Bay of Plenty District Health Board and Eric Coleman at the Bay of Plenty Medical Research Trust for their financial awards, scholarships and encouragement throughout.

Special thanks also go to AMP/Rothbury for their generous and timely scholarship and the Bay of Plenty Clinical Trials Unit for undertaking the randomisation process and for the use of their premises. Special thanks go to all UoA staff past and present who supported me throughout my PhD - Sue O'Shea, Adeline Fung, Kamalini Gnaniah and Liz Hardley.

Last, but certainly not least, my beautiful wife Sarah for her support, encouragement when I was feeling particularly lost, the endless coffee and for sitting with me for endless hours reading out data whilst I entered it onto various spreadsheets and tables.

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## List of Abbreviations

<b>ARES</b>	Aerodynamic resistance (sub glottic pressure)
<b>CVE</b>	Cerebrovascular Event
<b>dB</b>	Decibel
<b>F<sub>0</sub></b>	Fundamental Frequency
<b>MDS UPDRS</b>	Movement Disorder Society sponsored revision of the Universal Parkinson's Disease Rating Scale
<b>MSP</b>	Maximum Phonation Time/s
<b>MIP</b>	Maximal inspiratory pressure
<b>MDVP</b>	Multi-Dimensional Voice Program
<b>MEP</b>	Maximal expiratory pressure
<b>MT</b>	Music Therapist
<b>NMS</b>	Non-motor symptoms (Parkinson's)
<b>NSR</b>	Net speech rate
<b>NHR</b>	Noise-Harmonic Ratio
<b>PD</b>	Parkinson's disease
<b>PT</b>	Physiotherapy
<b>PDQ-8</b>	Parkinson's disease Questionnaire (8 questions)
<b>PEF</b>	Peak expiratory airflow
<b>RA</b>	Research Assistant
<b>RAP</b>	Relative Average Perturbation
<b>SPI</b>	Soft Phonation Index
<b>SPL</b>	Sound Pressure Level
<b>SPSS</b>	Statistical Product and Service Solutions
<b>VCST</b>	Voice and Choral Singing Therapy
<b>VTI</b>	Voice Turbulence Index
<b>VHI-10</b>	Voice Handicap Index (10 item)
<b>VHI-10P</b>	Voice Handicap Index Partner version

## Glossary

<b>ARES</b>	Aerodynamic resistance (sub glottic pressure). The amount of pressure required below vocal cords (glottis) to force them open.
<b>CVE</b>	Cerebrovascular Event (stroke). The death of brain cells owing to a lack of oxygen, caused either by a blockage of blood flow or a rupture of an artery to the brain. Symptoms include language or speech impairment, weakness, or paralysis of one side of the body.
<b>dB</b>	Decibel is logarithmic scale that increases in powers of ten: every increase of 10dB on the scale is equivalent to a 3 - fold increase in sound pressure which corresponds, broadly, with a doubling in loudness.
<b>F<sub>0</sub></b>	Fundamental Frequency or first harmonic is the lowest audio frequency with the highest intensity in a speech signal.
<b>Jitter%</b>	Fundamental frequency ( $F_0$ ) perturbation. Absolute difference between sequential vocal periods measured during a sustained phonation (measured in seconds or milliseconds) dividing it by the mean vocal period used during the phonation - measurement of vocal stability.
<b>MSP</b>	Maximum Sustained Phonation - is the longest period during which a person can sustain phonation of a vowel sound, typically /a/.
<b>RAP</b>	Relative Average Perturbation - the average absolute difference between a period and its average divided by the average interval (glottal period).
<b>Shimmer%</b>	Amplitude perturbation - measurement of vocal stability. Mean absolute cycle-to-cycle difference in vocal amplitude divided by the mean amplitude x 100.
<b>SPI</b>	Soft Phonation Index - an MDVP evaluation of the weakness of high-frequency harmonic components that may indicate loosely adducted vocal folds during phonation.
<b>SPL</b>	Sound Pressure Level - a ratio of the absolute, sound pressure and a standard reference level (20 Micropascals).
<b>VTI</b>	Voice Turbulence Index - average ratio of the spectral inharmonic high frequency energy in the range 2800-5800 Hz, where the influence of the frequency and amplitude variations, voice breaks and sub-harmonic components are minimal.
<b>PEF</b>	Peak expiratory airflow - maximum or peak positive rate of airflow observed in litres per second.
<b>MEP</b>	Maximal expiratory pressure - the strength of respiratory muscles, obtained from exhaling as strongly as possible against a mouthpiece. The maximum value is near total lung capacity.

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# Co-Authorship Forms - Study 1



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Chapter 3	
Matthews, R. M., Purdy, S. C., and Tippett, L (2018). (Pending) Stability over a one month period of self-rating measures of disease severity and impact in a clinical sample of adults with Parkinson's disease.	
Nature of contribution by PhD candidate	Collected Data, Statistical Analysis, Wrote Article Text
Extent of contribution by PhD candidate (%)	90

### CO-AUTHORS

Name	Nature of Contribution
Suzanne Purdy	Advice on literature and data analysis and editing of article text
Lynette Tippett	Advice on data collection and analysis. Article text editing

### Certification by Co-Authors

The undersigned hereby certify that:

- ❖ the above statement correctly reflects the nature and extent of the PhD candidate's contribution to this work, and the nature of the contribution of each of the co-authors; and
- ❖ that the candidate wrote all or the majority of the text.

Name	Signature	Date
Suzanne Purdy		18 February 2018
Lynette Tippett		23 February 2018

Last updated: 28 November 2017

## Co-Authorship Forms - Study 2



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Chapter 6	
Matthews, R. M., Purdy, S. C., and Tippett, L (2018). (Pending) Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease participating in voice and choral singing group therapy (VCST) versus a music appreciation activity	
Nature of contribution by PhD candidate	Collected Data, Statistical Analysis, Wrote Article Text
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# Chapter 1: Introduction - A Personal Journey

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## 1.1 Preamble

From an early age, music has played a very large part in my life. It earned me a living for a number of years before a significant life event introduced me, indirectly, to speech and language therapy. It occurred to me, whilst watching speech and language therapists at work that the inherent power of music as a means of communication and the linguistic sharing of emotion, meaning and intent are inextricably linked. I decided then that my love of music and interest in human communication and interaction were to coincide.

As a speech and language therapist, I have used music and singing as a means of enhancing therapeutic aims. Initially, when working with children with developmental language delay and more recently using singing to help the adult population; specifically, people with Parkinson's disease (PD).

I had used a range of therapy approaches in an attempt to improve voice in people with PD that have included one-on-one as well as group work. However, my impressions have been that, when using these approaches motivation, maintenance and attendance have been a recurring issue with user feedback describing the clinical environment, required frequency of attendance and mobility difficulty as common concerns. A review of the literature suggests that this is not an uncommon observation (Allen et al., 2012).

The nature of the condition - the physical and communication impairment - limits the extent to which people with PD can attend for regular therapy or take part in social activities. Music and group singing has the potential to provide an accessible therapeutic option for people with physical and communication difficulties, and if engagement in group activity is shown to improve mood and self-esteem, group singing may have additional benefits over

singing alone because of the additional psychosocial and health benefits associated with social integration (Cohen, 2004).

I have led a community based singing group, the Brainwave Singers (BWS) in New Zealand for a number of years using voice and choral singing therapy (VCST) as an intervention for people with PD. Membership of the choir has grown steadily with a regular and enthusiastic weekly attendance of 60 - 70 people who have established a mutually supportive group with a strong sense of community, connectedness and wellbeing. As choir leader, the improvement in voice and respiration through weekly exercise and singing has been tangible. Positive data taken from informal questionnaires to measure choir satisfaction as well as anecdotal accounts from choir members and their partners of the perceived improvement to voice, breathing and wellbeing have been compelling.

## **1.2 Current and Potential Interventions**

A gap exists between the number of people with PD with voice problems (estimated by Ramig, Fox, & Sapir, 2008; Fogg-Rogers et al., 2015 to be up to 90%) and the number receiving therapy (estimated by Mutch, Strudwick, Roy, & Downie, 1986; Yarrow, 1999; Ramig, Fox, & Sapir, 2008; Miller et al., 2011 to be between only 4% and 37%).

Established speech and language treatments for people with PD such as the Lee Silverman Voice Treatment LSVT-X<sup>®</sup> (Ramig, Countryman, Thompson, & Horii, 1995) are expensive to administer due to the intensive therapy input required and are not widely available.

Di Benedetto et al. (2009) suggested that singing has the potential to be a long-term accessible therapy for people with PD to maintain vocal ability and delay decline, but added that well-designed controlled studies are needed before choral singing can be recommended for widespread clinical use.

### **1.3 Aims of the Thesis**

The overall aim of this thesis is to develop an understanding and to contribute new evidence that VCST improves voice and respiration as well as facilitating social interaction and boosting psychological wellbeing in people with PD. The next chapter presents a review of the clinical motor and non-motor characteristics of PD that significantly impact on the physiological, psychological and psychosocial wellbeing of people with PD. The difficulties associated with the pharmacological management and associated symptomatology (side effects) and potential benefits of non-pharmacological treatments, including singing are also considered. Study One (Chapter 3) is a preliminary investigation of the intersubject and intrasubject reliability of five self-report measures of symptom severity, wellbeing and voice to determine acceptability, reliability and sensitivity to the effects of PD of these measures. Chapter 4 presents a review of the group singing approach reported in the literature and its potential effects on psychosocial wellbeing and motor speech difficulties. Chapter 5 describes the researcher's perspective of running a singing group with explanations regarding the format and components of the choir sessions and a rationale for the song choices.

Chapter 6 provides an overview of the Study Two design with descriptions of the acoustic and respiratory dependent variables selected to measure the effects of group singing on voice, respiration and glottal function following a nine week singing intervention. Chapter 7 describes the Study Two method, including recruitment, participant demographics, and outcome measurement. Chapter 8 describes the instrumental and self-report results of Study Two and Chapter 9 describes the self-report Participation Activity Evaluation results of Study Two. Finally, Chapter 10 provides a general discussion of the results of both studies and summarises the main outcomes of this thesis. It defines the limitations and implications for clinical practice, and concludes with suggestions for future research.

## Chapter 2: Parkinson's Disease Clinical Features

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This chapter describes the clinical motor and non-motor characteristics of Parkinson's disease (PD) that significantly impact on the physiological, psychological and psychosocial wellbeing of people with the condition. The difficulties associated with pharmacological management and the associated symptomatology and side effects are also discussed. The findings relating to disease progression particularly in relation to voice, prosody, respiration and the non-motor symptoms (NMS) and, in particular, those relating to the common neuropsychiatric problems that include depression and anxiety are drawn together. Questions are posed on the relevance of the medical model (Hofmann, 2005) of illness to people's day-to-day experience of PD and a selection of non-pharmacological interventions that include singing therapy, the core focus of this thesis.

### 2.1 Summary

James Parkinson first observed a condition he called "paralysis agitans" and published a detailed description in his work, *An Essay on the Shaking Palsy* in 1817 (Parkinson, 1969). Later in the 19<sup>th</sup> century neurologist and professor of anatomical pathology, Frenchman Jean Martin Charcot coined the term "maladie de Parkinson" or "Parkinson's disease" (Schroder et al., 2010). Charcot also recognised non-tremulous forms of PD and correctly pointed out that slowness of movement should be distinguished from weakness or "lessened muscular power", a term originally used by Parkinson (Kempster, Hurwitz, & Lees, 2007). Over 100 years (1919) after Parkinson's original description, Russian neuropathologist Konstantin Tretiakoff discovered that patients with PD lose cells in the substantia nigra (Leas, 2017) and 140 years after (in 1957), dopamine was discovered as the assumed neurotransmitter by Avrid Carlsson in Lund, Sweden (Hornykiewicz, 2006). Other than the predominant motor symptoms of the condition, it was not until the 1950s that alterations of cognition and its

effect on people with PD were beginning to be recognised (Lees & Smith, 1983). Cognitive alterations are now regarded as one of the most common NMS of PD affecting around 27% of non-demented PD patients (Sitek, Slawek, & Evans, 2014).

Evidence indicates that in comparison with age-matched groups without PD, people with PD exhibit more rapid decline in a number of cognitive domains, in particular, executive, attentional and visuospatial domains, but also memory (Aarsland et al., 2017). Present studies are now able to confirm and differentiate cognitive deficits in PD using a battery of different neuropsychological tests on large numbers of people. One such study examining the neuropsychiatric symptoms of people with PD with associated dementia using a 10-item Neuropsychiatric Inventory, found a commonality of symptoms depression (70%), anxiety (69%), apathy (48%) and irritability (47%) (Aarsland et al., 2007). A large scale study by Kulisevsky, Pagonabarraga, Pascual-Sedano, García-Sánchez, and Gironell (2008) on the prevalence and correlates of neuropsychiatric symptoms in Parkinson's disease without dementia found similar commonality of symptoms of depression (58%), apathy (54%), anxiety (49%) and hallucinations (44%) and suggested that neuropsychiatric symptoms are common in non-demented PD patients and are an integral part of PD from the beginning of the disease with worsening symptom severity related to disease progression. Current research is developing our understanding of alterations in cognition in people with PD and how they can impact upon social communication skills and on the quality of life of the person with PD and their families (Möbes, Joppich, Stiebritz, Dengler, & Schröder, 2008; Jankovic, 2008).

## **2.2 Parkinson's Disease**

PD or idiopathic Parkinsonism is a chronic, progressive neurodegenerative condition more commonly seen in the elderly population with most cases occurring after the age of 50 and affecting 1-2% of people older than 60 years of age (Skodda, Visser, & Schlegel, 2011). The average age of onset of PD is 60 (Sage, 2017). The onset and progression are so gradual

and so insidious that it is common for patients with PD to receive their diagnosis quite late in the disease process (Shulman, 2007).

PD is the most common form of movement disorder and the second most common neurodegenerative disorder, currently affecting an estimated five million people worldwide and predicted to increase to 9 million by 2030 as the prevalence of PD increases exponentially as the population ages (Dorsey et al., 2007; Xia & Mao, 2012). The country of this present study, New Zealand has an estimated 10,000 people living with PD (Parkinson's New Zealand, 2018).

There are several indications of gender differences in PD. Epidemiological studies have shown that both incidence and prevalence of PD are 1.5–2 times higher in men than in women. Furthermore, in 6 out of 8 incidence studies mentioning gender specified age at onset, onset in women was slightly later than in men (by a mean of 2.2 years, range 1–4) (Haaxma et al., 2007; Shulman, 2007; Shulman, Taback, Rabinstein, & Weiner, 2002; Wooten, Currie, Bovbjerg, Lee, & Patrie, 2004).

PD is a disorder of the central nervous system and is described by Pavao, Helene, and Xavier (2012) as a progressive degeneration of dopaminergic neurons and tracts located in the corpus striatum and lesions located in the substantia nigra resulting in a specific disorganisation of the complicated basal ganglia circuits. The relay functions at the level of the striatum are out of balance leading to a disturbance to subcortical interactions which, at a functional level, is observed by timing and scaling problems when performing movements, along with problems with initiation known as bradykinesia and dysarthria (Bartels & Leenders, 2009).

The clinical diagnosis of probable PD is usually considered when an asymmetric Parkinsonism (asymmetric or unilateral resting tremor) has slowly progressed in the absence of early postural instability or falls at least a year from symptom onset. Postural impairment

with falls within or shortly after a year would be considered a red flag against the diagnosis of PD (Martino, Espay, Fasano, & Morgante, 2016).

### **2.3 Motor Symptoms**

At initial assessment, clinicians use simple observation of volitional spontaneous movements for clues regarding motor impairments that include bradykinesia, hypokinesia and akinesia (loss or impairment of power of voluntary movement) presenting as reduced facial gesticulation (hypomimia) or decreased speed and associated arm movements when walking (Martino et al., 2016). Observing gait is particularly informative since it may demonstrate *gait ignition failure* (inability to transition into stepping from a stationary upright posture) and *festination* (progressive but ineffective increase in cadence at the expense of corresponding reductions in stride length) as the failures of movement initiation and movement sustainability (Hughes, Daniel, Ben-Shlomo, & Lees, 2002).

There are four cardinal features (system complex) of PD often grouped under the acronym TRAP: Tremor at rest, Rigidity, Akinesia (or bradykinesia) and Postural instability. In addition, flexed posture and freezing (motor blocks) have been included among classic features of PD (Jankovic, 2008). The severity of these symptoms varies considerably from person to person with PD (Bartels & Leenders, 2009; Murdoch, 2010). Bartels and Leenders' (2009) description of the pathogenesis and pathophysiology of PD refer to three cardinal or primary motor symptoms, asymmetrical onset of bradykinesia, rigidity and tremor. PD is a heterogeneous disease since akinetic rigidity and bradykinesia are the major complaints in some patients, whereas tremor is predominant in others with different clinical phenotypes exhibiting different prognoses such as faster progression in patients with bradykinesia and rigidity and a milder progression in those presenting with tremor dominant disease (Xia & Mao, 2012).

Fritsch et al. (2012) stated that a clinical diagnosis of two of the cardinal signs along

with a positive response to anti Parkinson's medication are essential for the clinical diagnosis of PD. Equally or even more disabling than the cardinal features, and discussed further below, is the bulbar dysfunction manifested by dysarthria, hypophonia, dysphagia and sialorrhoea; these symptoms are thought to be related to orofacial–laryngeal bradykinesia and rigidity which are frequently observed in people with PD (Martino et al., 2016).

As described by Murdoch (2010) the loss or impairment of power of voluntary movement refers to three related symptoms: 1. Marked poverty of spontaneous movements. 2; Loss of associated movements like arms swinging when walking; 3. Slowness in the initiation and execution of all voluntary movements. Murdoch adds that a characteristic of this symptomatology is the 'mask' face or lack of facial expression (hypomimia); this is often seen as a marked absence of both volitional and emotional responses with the resultant reduction in non-verbal cues, such as facial expressions and hand gestures also described by Jankovic (2008).

### **2.3.1 Bradykinesia**

The most distinguishing clinical feature of PD is slowness of movement referred to as bradykinesia. It is the primary characteristic of basal ganglia disorders and encompasses difficulties with planning, initiating and executing movement and performing sequential and simultaneous tasks (Ray et al., 2008). Early observed symptomatology (often before any formal neurological examination) is bradykinesia and associated slow reaction times and sluggishness when performing activities of daily living, including difficulties with tasks requiring fine motor control like fastening buttons when dressing and handling utensils when eating (Miller, Noble, Jones, & Burn, 2006; Rahman, Griffin, Quinn, & Jahanshahi, 2008). Other observable indicators of bradykinesia include impaired swallow (dysphagia), drooling (sialorrhoea), monotonic speech (hypokinetic dysarthria) reduced speech volume (hypophonia), loss of facial expression and loss of spontaneous movement and gesturing

(Jankovic, 2008; Miller et al., 2006). Bradykinesia can be dependent on someone's emotional state, for example, a person presenting with typically slow movement who becomes excited may be able to make quick movements such as catching a ball. This phenomenon (kinesia paradoxa) suggests that people with PD may have intact motor programmes, but have difficulties accessing them without an external trigger, such as a loud noise or a visual cue (Jankovic, 2008).

### **2.3.2 Rigidity and Tremor**

Muscle rigidity and tremor are other significant components of PD. Tremor is the rhythmical alternating muscular contractions at rest, whilst vocal tremor is an involuntary rhythmic modulation of voice pitch and loudness best perceived on sustained phonation and vowel production (Barkmeier-Kraemer, Lato, & Wiley, 2011; Murdoch, 2009). Jankovic (2008) described resting tremor as the most common and easily recognised symptom of PD with unilateral tremors occurring at a frequency between 4 and 6 Hz, usually prominent in the distal part of an extremity. Hand tremors are described as supination–pronation (“pill-rolling”) tremors that spread from one hand to the other.

Resting tremor in people with PD can also involve the lips, chin, jaw and legs, but unlike essential tremor, rarely involves the neck, head or voice (Thenganatt & Louis, 2012). Rigidity is characterised by increased resistance, usually accompanied by the “cogwheel” phenomenon, a ratchet-like start-and stop movement through the range of motion of a joint, particularly when associated with an underlying tremor present throughout the range of passive movement of a limb and may occur proximally (neck, shoulders, hips) and distally (wrists, ankles) and with associated pain, and painful shoulder is an initial manifestation of PD (Jankovic, 2008; Findley, Gresty, & Halmagyi, 1981). Progress of symptomatology of people with PD can differ depending on presentation with rigidity and bradykinesia

progressing faster than those with predominant tremor appearing at the early stages of the condition

### **2.3.3 Freezing**

Also referred to as motor blocks, freezing is a form of akinesia (loss of movement) and is one of the most disabling symptoms of PD (Jankovic, 2008). Although freezing is a characteristic feature of PD, it does not occur universally (Bloem, Hausdorff, Visser, & Giladi, 2004). Freezing most commonly affects the legs during walking, but the arms and eyelids can also be involved. Typically, manifestations are a sudden and transient inability to move, which may include hesitation when beginning to walk or a sudden inability to move the feet when turning or walking through a narrow passageway (Jankovic, 2008). Freezing is often associated with significant social and clinical consequences for patients as it is a common cause of falls (Bloem et al., 2004; Jankovic, 2008; Rahman, Griffin, Quinn, & Jahanshahi, 2008; Xia & Mao, 2012). This researcher's review of the published literature on group singing did not find any reported effects of singing on freezing or reports of whether freezing is occurring during singing sessions. Also, the researcher has not observed freezing gait characteristics or gait initiation difficulties in PD choir members before or after singing sessions that he has lead.

### **2.4 Hypokinetic Dysarthria**

The motor and cognitive symptomology of PD can also be precursors of disorders of speech. Motor impairments such as muscular rigidity, tremor, and bradykinesia are the most apparent dopaminergic symptoms, however, the majority of people with PD develop further voice and speech problems over the course of their illness, which commonly are interpreted as the manifestation of bradykinesia (Skodda et al., 2009, 2011). These voice and speech problems include speech that is quiet, hoarse and breathy (Stegemöller, Radig, Hibbing, Wingate, & Sapienza, 2016). Speech changes tend to increase as the condition progresses and

impact significantly on communication as reduced voice quality, respiration and changes to the prosodic features of utterances reduces intelligibility (Dromey, Ramig, & Johnson, 1995; Elefant, Baker, Lotan, Lagesen, & Skeie, 2012). Prosodic features of speech affected in PD include loudness (intensity), speech rhythm and velocity, articulation rate, speech to pause ratio and pitch variation (Skodda et al., 2009).

Hypokinetic dysarthria (disturbance of speech) is a common and prominent manifestation of PD which increases in frequency and intensity with the progress of the disease (Deane, Whurr, Playford, Ben-Shlomo, & Clarke, 2001). A review of the literature shows a prevalence of between 60-90% of people with PD developing speech and voice disorders over the course with worsening symptoms (pitch variability) of the disease that can restrict the 'whole health' quality of life; limiting the ability, and willingness to participate in conversations (Darley, Aronson, & Brown, 1975; Di Benedetto et al., 2009; Fogg-Rogers et al., 2015; Mahler, Ramig, & Fox, 2015; Stegemöller et al., 2016; Tanner et al., 2016; Abel et al., 2017).

Murdoch (2010) described the speech characteristics associated with hypokinetic dysarthria as being part of a general pattern of hypokinetic motor disorder. Hypokinetic motor disorder is characterised by a marked reduction in amplitude of voluntary movements, slowness of movement, movement initiation and rigidity. PD dysarthria is unique among dysarthric patients as speech can also be more rapid than is typical (Yorkston, Hammen, Beukelman, & Traynor, 1990). People with PD can have a slightly faster than average speaking rate and, in some individuals, this is seen as a progressive acceleration of rate towards the end of a sentence, which severely reduces the level of intelligibility (Darley et al., 1975; Troche, Troche, Berkowitz, Grossman, & Reilly, 2012). As the basal ganglia are supposed to regulate temporospatial aspects at the motor cortex, speech rate abnormalities should be expected in patients with PD (Skodda et al., 2013). Hypokinetic dysarthria, often

referred to as Parkinsonian speech, results from an impairment of phonation, articulation and prosody with a clinical manifestation typically including hypophonia, monotonicity, breathiness/hoarseness and imprecise articulation and rate problems (Sapir, 2014; Hartelius, Elmberg, Holm, Lövberg, and Nikolaidis 2008). Of the characteristics described by Murdoch (2010), the limitation of movement (hypokinesia) to the muscles of the speech mechanism and the restriction in range and rate of movement in speech production are the most obvious, observed in people with PD as reduced speech volume level. A reduction in the range of intensity is common in individuals with PD, which is attributed to decreased phonatory and respiratory support for speech (hypophonation); this is sometimes referred to as vocal support (De Letter et al., 2007). Hypophonation is characterised by a voice of breathy quality, reduced ability to produce vocal intensity, reduced ability to sustain prolonged phonation and poor synchronisation of exhalation and speech production (Darley et al., 1975; De Letter et al., 2007). Hypophonation may reflect a lack of flexibility of function and reduced control of laryngeal movements, but may also reflect a hypo-respiratory pattern resulting in reduced excursion or rigidity of thoracic and abdominal musculature (Darley et al., 1975).

The perceptual speech characteristics of hypokinetic dysarthria include mono pitch, mono loudness and reduced stress, all of which represent alterations in the prosodic aspects of speech (Orbelo, Testa, & Ross, 2003; Pell, Cheang, & Leonard, 2006; Walsh & Smith, 2011). Enderby (1986) also described changes in general stress and lack of variation in both pitch and loudness based on patient data from the Frenchay Dysarthria Assessment (Enderby & Palmer, 1983). From these data, Enderby and Palmer also identified reductions in phonation, intonation, speech rate, intelligibility, control of volume and phonation time. Benke, Bösch and Andree (1998) describe dysprosody in people with PD as being distinguished by the inability to maintain stable pitch and by a significantly reduced pitch range and variation, both of which result in speech production that has decreased intensity,

vocal tremor, and variations in the velocity of their speech. Altered speech in patients with PD, Brown and Marsden (1998) suggest, might be caused by increased rigidity and hypokinesia of the speech production system. Alongside Murdoch's (2010) description provided above of hypophonia, monopitch is also widely considered an obvious observable characteristic of dysprosody in people with PD (Benke et al., 1998; Möbes et al., 2008). Monopitch speech appears to be sufficiently proven as a characteristic feature of PD dysprosody. Temporal speech features are less clear in the literature. Skodda, Rinsche and Schlegel (2009) suggested that, as the basal ganglia are supposed to regulate temporospatial aspects at the level of the motor cortex, speech rate abnormalities should be expected in people with PD. However, results of previous studies on speech rate in people with PD are inconsistent, probably as a consequence of methodological differences and small sample sizes (Skodda & Schlegel, 2008). Changes in articulatory velocity have been reported (Yorkston, Hakel, Beukelman, & Fager, 2007; Di Benedetto et al., 2009; Yinger & Lapoint, 2012; Mahler, Lorraine, Ramig, & Fox, 2015), but are ambiguous because of the variety (design, dosage, frequency and duration) of behavioural therapy approaches (Lee Silverman Voice Treatment, LSVT; Voice and Choral Singing Therapy, VCST; Standard Speech and Language Therapy, SLT; Pitch Limiting Voice Treatment, PVL) and methodological differences with regard to the measuring and recording of data in groups of participants with PD that differ in sample size, age, gender balance and disease duration.

Motor symptoms of rigidity, weakness, bradykinesia and hypokinesia result from dopamine deficiency (Bartels & Leander, 2009), but do not completely account for the voice and speech abnormalities associated with Parkinson disease (Mahler et al., 2015). Sensory deficits in internal monitoring and maintenance of amplitude of movements across the speech production mechanism, Sapir, Ramig, and Fox (2011) suggest, may also be significant factors that contribute to decreased loudness, imprecise articulation and monotone.

Elfmarková et al. (2016) assessed the impact of PD and levodopa on MRI resting-state functional connectivity underlying speech prosody control and observed a relationship between treatment-induced changes in the acoustic parameters underlying speech prosody and changes in resting-state within the cognitive basal ganglia-thalamo-prefrontal loop. This loop might contribute to the recruitment of brain regions for orchestrated speech processing and to motor speech network changes engaged in generating laryngeal and speech muscle movements controlling overt speech production and pitch. Elfmarková et al.'s (2016) study is the first to assess the effects of medication on the resting-state functional connectivity within brain networks associated with prosody in people with PD and suggest that levodopa may improve prosody in some PD patients via increased connectivity within the associative striato-prefrontal and motor speech networks.

Schneider et al. (1987) studied speech output in individuals with PD in relation to sensory problems and concluded that sensory problems may play an important role in motor speech disorders. The sensory problems that they observed were marked sensorimotor deficits in the orofacial and limb systems; in particular the tactile localisation on tongue, gums, and teeth of people with PD. Hallett (1997) noted that, for successful voice treatment for individuals with PD, there is a need for focus on problems with sensory perception, with self-perception of effort needing to be recognised and re-calibrated. When individuals with PD are asked to produce loud speech it is often observed that they are unable to and instead increase their 'habitual' speech to a level that the listener considers within normal limits or to a pre PD level (Fox et al., 2005; Sapir, 2013). This finding relates to the phenomenological observation that people with PD complain that they are 'too loud' when they try to increase their loudness to a normal level. The individual will often perceive themselves as shouting or at least talking too loudly and report that the listener is most likely hard of hearing rather than recognise that their speech has become quiet (Ramig et al., 2008; Miller, 2017). This

characteristic of PD speech is described by Miller (2017) as a disruption to voice intensity arising from an inability to monitor voice intensity adequately, so despite having the ability to produce greater volume in response to environmental cues or listener requests, people with PD do not reach full intensity or even if they do, cannot hold it. This is exacerbated by impaired self-monitoring and reduced awareness of voice intensity and is a frequent presentation of altered speech in people with PD that is explored further in Chapter 4.

#### **2.4.1 Affective Prosody - Paralinguistic Features of Language**

Affective prosody, the ‘melody of speech’ that provides emotional and attitudinal information during discourse, imparts vitality to discourse and greatly influences the content and impact of the message (Orbelo, Testa, & Ross 2003). Ross (2000) found that, if a statement contains an affective prosodic intent that is at variance with its literal meaning, the former usually takes precedence in the interpretation of the message. As a consequence of this ambiguity, the sentence "I had a really great day", spoken with an ironic tone of voice, should be understood as communicating an intent that is opposite to its linguistic meaning. Ross contends that the paralinguistic features of language, as exemplified by affective prosody, thus play a more important role in human communication than the exact choice of words.

The acoustic features found within the ‘melody of speech’ include the qualities of frequency, duration and intensity. For the listener, varying fundamental frequency ( $F_0$ ) over time is perceived as a variation in pitch or intonation. Loudness (intensity) and timing (duration) also provide acoustic cues to affective prosodic intent (Orbelo et al., 2003). McNeil, Rosenbek and Aronson (1984) observed that  $F_0$  variability in speech is consistently reduced in individuals with PD when compared with a non-disordered control group. This finding supports the typically observed perceptual characteristics of monopitch or monotonous speech in people with PD. Individuals with PD have been reported to have

increased  $F_0$  values during speech tasks (Goberman & Blomgren, 2008). Increased  $F_0$  is thought to be a result of rigidity in the laryngeal musculature (Goberman, Coelho, & Robb, 2002). In addition to the laryngeal rigidity other studies have found a decrease in laryngeal stability (Tanaka, Nishio, & Niimi, 2011). Specifically, and of relevance to the current study, increases in variability or stability of  $F_0$  have been documented for sustained vowel tasks (Goberman, Coelho, & Robb, 2002).

Sabine Skodda has made a large contribution to PD voice research and is cited widely in the published literature and in this section of this present study. She has completed wide-ranging studies on PD associated dysarthria and its effect on different aspects of speech such as phonation, articulation, and prosody and has completed a unique study relating the progression of these aspects over the progression of the disease.

Skodda et al. (2011) analysed fundamental frequency ( $F_0$ ),  $F_0$  variability (measured as  $F_0$  standard deviation,  $F_0SD$ ) and net speech rate (NSR - syllables per second related to net speech time) while people with PD were reading. The aim of their study was to test if motor instability found in limb movement is also present in dysarthric speech. They examined changes in  $F_0SD$  and NSR from the first to the last sentence of a reading task. They achieved this by examining 138 people with PD and 50 age matched controls using a standardised reading task with acoustic analysis of  $F_0SD$  and NSR. A further 'subgroup' of 20 people with PD underwent a standardised levodopa challenge.  $F_0SD$  in the people with PD was significantly reduced compared with the control group when based on the measurement of the entire reading speech sample. In the PD group, NSR and  $F_0SD$  suggesting that these aspects of dysarthric speech were affected by sustained speaking required for the reading task.

Skodda et al. (2011) found no effect on NSR and  $F_0SD$  for the entire reading passage in the standardised levodopa sub-group, but the reduction in  $F_0$  variability in the course of the reading task appeared to be corrected by levodopa administration. Global motor function in

the sub-group also responded to levodopa, however stimulation appeared not to ameliorate dynamic intonation changes over the course of reading. They concluded that the effect of dopaminergic stimulation on overall speech parameters and dysprosody remains inconclusive. They noted that impaired  $F_0$  variability might be one PD symptom independent of dopaminergic control, whereas pitch variability might be a Parkinsonian feature responding only to long-term dopaminergic stimulation. Results from Skodda et al. (2011) confirmed previous findings of reduced  $F_0$ SD in PD (Skodda et al., 2009) and this study was the first to show an increasing reduction of  $F_0$  variability over the course of reading.

#### **2.4.2 Dysprosody Related to Gender**

Skodda et al. (2009) analysed prosodic parameters in 169 people with PD and 64 healthy controls in relation to gender, disease specific parameters, and motor symptoms over a three year period. They did an acoustic analysis of speech from a four sentence reading task for two groups. Assessment of general motor impairment was performed using the Unified Parkinson's Disease Rating Scale/Motor Score III (UPDRS). They found that  $F_0$  variability was reduced only in males with PD, not in females. No significant difference in overall articulatory rate was found between the people with PD and the controls, but the people with PD showed a reduction of pause time within polysyllabic words. Females with PD showed an additional reduction of pause ratio (PR%). Skodda et al. (2009) hypothesised that changes in intonation variability and speech velocity (prosody) seem to be affected by different pathophysiological conditions (gender, sexual dimorphism of laryngeal size, PD induced changes). They added that, whilst considering some gender differences, several distinct aspects of dysprosody can also be interpreted as axial (speech, neck rigidity, posture, gait and stability assessed using the UPDRS) and akinesia symptoms of PD.

In a later study, Skodda et al. (2011) found some gender differences. A longitudinal study on the progression of dysprosody in PD by Skodda et al. (2011) examined ( $N = 23$ )

people with PD and ( $N = 50$ ) age matched healthy controls on two occasions, with time ranging from 7 to 79 months between first and second examinations, found that the  $F_0$  variation in both male and females with PD was significantly reduced compared to the control group but progression of prosodic impairment over time showed no correlation with disease duration or the UPDRS motor score. Pitch variability in the PD females declined over time, whereas the PD males' intonation variability remained relatively stable.

### **2.4.3 Progression of Voice Disorders**

There is general consensus in the published literature that between 70% and 90% of people with PD will have speech difficulties (Di Benedetto et al., 2009; Skoda et al., 2009; Skodda, Grönheit, & Schlegel, 2011; Miller, 2007, 2011; Stegemöller et al., 2017), although it is not clear how this figure is derived or at what point during the progress of PD it is calculated.

In speech, hypokinetic dysarthria presenting as an impairment of phonation, articulation, and prosody affects quality of life (QoL) that can restrict the ability and readiness of the person to engage in conversation. As previously described, voice impairments in PD are typically mono-pitch, mono-loudness, reduced vocal intensity, reduced vocal pitch and a harsh, breathy voice (Darley et al., 1975; Logemann, Fisher, Boshes, & Blonsky, 1978).

A study by Skoda et al. (2013) recorded different measures of voice performance (perceptual and acoustic analysis) over the clinical progression of PD and revealed a significant deterioration in the observed speech measures. In this longitudinal study of voice and speech impairment Skodda et al. (2013) tested and retested (over 12 months, average time interval: 32.5 months) 80 people with PD and 60 healthy controls matched by age and gender to reveal normal age related changes and found that voice changes were generally independent of the stage of the disease. They suggest that the data captured at baseline

showed that changes to phonation could occur before the observed early stages of PD and could continue to worsen over the duration of the disease progression.

Although not a longitudinal study these data are similar to an earlier study by Holmes, Oates, Phyland and Hughes (2000) who compared the perceptual and acoustic voice characteristics of 30 people with early stage PD and 30 people with later stage PD with data from 30 normal control subjects matched for gender and found that several of the variables evaluated (including amplitude, pitch and perturbation) demonstrated significant differences between the early and later stage PD groups, suggesting a gradual worsening of those voice features with progression of the disease.

## **2.5 Non Motor Symptoms**

Non-motor symptoms (NMS) are a common occurrence in PD and are often an underappreciated and under treated feature (Zesiewicz, Sullivan, & Hauser, 2006). This is a view reinforced by Santos-García and de la Fuente-Fernández (2013) who stated that, in contrast to motor dysfunction, NMS remain frequently unreported unless specifically investigated. Their study found that NMS have a direct negative impact on the QoL of PD patients. Included within the range of NMS variables (Table 1) are: autonomic dysfunction - urinary dysfunction, constipation, light-headedness when standing, cognitive function, depression, anxiety, apathy, fatigue, sleep disturbance and daytime sleepiness.

Using a PD quality of life questionnaire (PDQ-39) and a subjective assessment of perceived quality of life (PQ-10 self-rated QoL on a scale from 0 worst to 10 best), they identified that both health-related and perceived QoL are affected by NMS. They found that, compared to PD specific motor dysfunction, the unique contribution of NMS to health-related QoL is relatively small whilst, in contrast, NMS have more pronounced negative impact on perceived QoL (PQ-10). Müller, Assmus, Herlofson, Larsen and Tysnes (2013) state that, although a large number of NMS are recognised in PD, most studies in a systematic review

(Soh, Morris, & McGinley, 2011) dealing with health related quality of life issues (HRQoL) focussed on the impact of single symptoms or a small selection of non-motor variables.

### **2.5.1 Early Symptoms**

NMS can appear early in the course of PD with insidious onset of perceptive olfactory disturbance (hyposmia) is one example (Fritsch et al., 2012). Olfactory deficits are often an early symptom of PD with one European study finding olfactory deficits in 97% of people with a clinical diagnosis of PD (Haehner et al., 2009). Studies by Ponsen et al. (2004, 2009) suggest that olfactory dysfunction may be an early marker and may help predict the development of PD with a 10% increased risk for the disease after 2 years compared with other asymptomatic relatives. Other sensory symptoms such as pain, tingling in the fingers (paraesthesia), akathisia, oral pain and genital pain are frequent, but are often not recognised as parkinsonian symptoms (Fil et al., 2013). As well as these sensory symptoms, mild or 'vegetative' symptoms or mild cognitive impairment (MCI) signs are also often found to precede the motor symptoms in patients with PD (Braak, Rüb, Gai, & Del Tredici, 2003).

### **2.5.2 Cognitive and Neurobehavioural Difficulties**

Jankovic (2008) described neuropsychiatric disturbances (Table 1) as being as disabling as motor symptoms. The Sydney Multicentre Study of PD also found that, of the people evaluated, 84% showed cognitive decline, of which 48% met the diagnostic criteria for dementia after 15 years of follow-up (Hely, Reid, Adena, Halliday, & Morris, 2008). These findings mirror that of Wood et al. (2016) who found in their 4 year longitudinal study on MCI that some 60% of patients with PD may develop dementia (PDD) within 12 years of their motor symptoms and over 80% ultimately reach PDD, although they acknowledge that an individual's time course to dementia is highly variable.

PDD is also associated with a number of other neuropsychiatric comorbidities. In a study exploring the profile of neuropsychiatric symptoms in people with PD it was found

that out of 537 of people having a diagnosis of PDD, depression (58%), apathy (54%), anxiety (49%) and hallucinations (44%) were also frequently reported (Aarsland et al., 2007; Bartels & Leenders, 2009; Leroi et al., 2007; Sage, 2017)).

In addition to PDD many patients with PD exhibit features of compulsive and impulse control disorders (ICD). ICD are a group of complex behavioural disorders, of which occur more commonly in people with PD than in the general population, with a prevalence of 13.6% reported in some studies (Vilas, Pont-Sunyer, & Tolosa, 2012). Behaviours include craving, binge eating (4.3%), compulsive foraging, hyper sexuality (3.6%), pathological gambling (5%) and, compulsive shopping (5.7%) sometimes characterised by an intense fascination with repetitive handling, examining, sorting and arranging of objects (Miyasaki, Al Hassan, Lang, & Voon, 2007). These behavioural symptoms, sometimes referred to as hedonistic homeostatic dysregulation, have been attributed to dopamine dysregulation syndrome associated with dopaminergic drugs, particularly dopamine agonists, (discussed further below) but the mechanism of these aberrant behaviours is not well understood (Vilas et al., 2012).

**Table 1***The Non-Motor Symptom Complex of PD (Chaudhuri, Healy, & Schapira, 2006)*

Neuropsychiatric symptoms	Depression, apathy, anxiety Anhedonia Attention deficit Hallucinations, illusion, delusions Dementia Obsessional behaviour (usually drug induced), repetitive behaviour Confusion Delirium (could be drug induced) Panic attacks
Sleep disorders	Restless legs and periodic limb movements Rapid eye movement (REM) sleep behaviour disorder and REM Non-REM-sleep related movement disorders Excessive daytime somnolence Vivid dreaming Insomnia Sleep disordered breathing
Autonomic symptoms	Bladder disturbances Urgency Nocturia Frequency Sweating Orthostatic hypotension Falls related to orthostatic hypotension Coat-hanger pain Sexual dysfunction Hypersexuality (likely to be drug induced) Erectile impotence Dry eyes (xerostomia)
Gastrointestinal symptoms (overlaps with autonomic symptoms)	Dribbling of saliva Ageusia (taste) Dysphagia and choking Reflux, vomiting, Nausea Constipation Unsatisfactory voiding of bowel Faecal incontinence
Sensory symptoms	Pain, Paraesthesia, Olfactory disturbance
Other symptoms	Fatigue, Diplopia, Blurred vision Seborrhoea Weight loss Weight gain (possibly drug induced)

### 2.5.3 Anxiety and Depression

Similarly to the findings relating to motor voice disorders described by Skodda et al. (2013), Chaudhuri et al. (2006) state that NMS (of which include anxiety and depression are often present before diagnosis), as with motor symptoms, almost inevitably emerge with disease progression. NMS tend to dominate the clinical presentation of PD in the later stages of its progression contributing to increased severity of disability, which becomes a significant

burden on quality of life (Chaudhuri et al., 2006).

Several studies (Stefanova, Ziropadja, Petrovic, Stojkovic, & Kostic, 2013; Walsh & Bennett, 2001) describe anxiety syndromes in people with PD and state that up to 40% of patients with PD experience clinically significant anxiety and contend that although anxiety can present in isolation, anxiety and depression frequently coexist. Reijnders et al. (2010) conducted a systematic meta-analysis of 36 papers and found a prevalence of clinically depressive symptoms present of 35% in the PD population. Other studies have found higher values such as a study of 1351 people with PD without dementia which found that the most frequently observed neuropsychiatric symptoms were depression (70%), anxiety (69%), apathy (48%) and that 87% of subjects had at least one neuropsychiatric symptom (Kulisevsky, Pagonabarraga, Pascual-Sedano, García-Sánchez, & Gironell, 2008). Stefanova et al. (2013) found that anxiety and depression “exceeds both the prevalence in general population and in individuals with chronic medical conditions. Panic disorder, generalised anxiety disorder and social phobia were the most common anxiety disorders reported” (p. 34). Interestingly, Stefanova et al. (2013) also found that females were nearly three times more susceptible to anxiety than male patients with PD. Although pharmacological or dopaminergic treatment can improve or maintain motor function, retrograde changes to quality of life and non-motor concerns that might include depression and anxiety may be influenced with a focus on education, exercise and behavioural/alternative therapies (Uitti, 2012). This hypothesis is very relevant to the present study and is explored further in Chapters 4 and 5.

A study investigating depression and voice handicap in people with PD assessed dysphonia severity in 147 people with PD and 30 non-PD controls using the Voice Handicap Index (VHI)-10 and PD severity and depression using the Geriatric Depression Scale and Unified Parkinson's Disease Rating Scale (UPDRS) found that dysphonia in PD is strongly

associated with depression rather than with a PD related motor disability. Their analysis revealed that depression was the only factor significantly associated with the presence of dysphonia, whereas the non-PD controls did not show this association (Sunwoo et al., 2014).

#### **2.5.4 Apathy**

Although limited by sample size, one investigation into a potential relationship between psychological, psychiatric and motor factors with apathy in people with PD, found an association between apathy and deficits of executive function (Meyer et al., 2015). Meyer et al. (2015) found that initiation, which in their study included measures of semantic and phonemic fluency, correlated with apathy but not depression and concluded that initiation dysfunction in a person with PD is suggestive of apathy and contended that apathy and depression can be separated. Additionally, Meyer et al. (2015) found that apathy is influenced by age and gender: older age correlated with apathy in men, whereas in women it protected against it. Starkstein and Brockman, (2011) discussed three associated studies that describe a correlation or ‘significant association’ between apathy, depression, and PDD. These studies suggest that “apathy identifies a subgroup of patients with increased depression, more severe cognitive deficits, and greater functional impairments” (Starkstein and Brockman, 2011, p. 269).

#### **2.5.5 Autonomic Dysfunction**

Although more typically associated with multi system atrophy (clinical features of MSA overlap with those of PD), autonomic failure can be a presenting feature of PD (Jankovic, 2008). Autonomic features include orthostatic hypotension, sweating dysfunction, sphincter dysfunction and erectile dysfunction (Stacy, 2002; Stacy, 2011).

#### **2.5.6 Hypotension**

Common symptoms of autonomic failure in PD include orthostatic or postprandial light-headedness and orthostatic hypotension. A community based study found that 47% of

PD patients met the diagnostic criteria for orthostatic hypotension (Stacy, 2011). Orthostatic hypotension is reported in 10%–20% of patients, but this increases with age and severity of the condition eventually leading to possible emergency evaluations for dizziness or syncope (Truong, Bhidayasiri, & Wolters, 2008). Symptoms include light-headedness or dizziness when standing, fatigue, and aching across the back of the shoulders and neck and requires frequent monitoring with standing and sitting blood pressures (Truong et al., 2008).

Dopaminergic treatment can precipitate some of the non-motor problems in PD such as orthostatic hypotension with cardiac sympathetic denervation linked to genetic forms of PD (Chaudhuri et al., 2006; Polymeropoulos et al., 1997).

### **2.5.7 Gastrointestinal Disturbances**

There is growing recognition of gastrointestinal dysfunction in PD and that nearly all parts of the gastrointestinal tract can be affected (Pfeiffer, 2003). A study that assessed the bowel habits of 7000 men over a period of 24 years reported that those with initial constipation (less than one bowel movement per day) had a threefold risk of developing PD after a mean interval of 10 years from initial constipation (Abbott et al., 2001; Chaudhuri et al., 2006). Often preceding the onset of PD by many years, constipation is associated with a sensation of incomplete evacuation and is one of the most frequent non-motor symptoms (Chaudhuri et al., 2007). Constipation does not respond well to dopaminergic treatment, suggesting that non-dopaminergic mechanisms could be implicated (Djaldetti, Baron, Ziv, & Melamed, 1996). The mechanism underlying constipation is multifactorial, involving both colon motility and anorectal dysfunction (Magerkurth, Schnitzer, & Braune, 2005). Difficulty with the act of defecation (defecatory dysfunction) characterised by excessive straining and accompanied by pain and a sense of incomplete evacuation is the more prevalent form of bowel dysfunction in PD (Pfeiffer, 2003). Constipation is an important aspect of gastrointestinal dysfunction in PD, although other characteristics such as severe swallow

impairment (dysphagia) as a result of oral, pharyngeal, and oesophageal dysfunction rarely occur (Chaudhuri et al., 2006; Pfeiffer, 2003).

Gastrointestinal dysfunction in people with PD has potentially profound pharmacokinetic implications in that delayed gastric emptying and subsequent delayed levodopa arrival at intestinal absorptive sites can cause inconsistent responses to the drug. These absorptive vagaries Djaldetti et al, (1996) state, may constitute one mechanism for the development of motor fluctuations in people with PD. Prolonged gastrointestinal (GI) transit time is seen in the vast majority of PD patients (Stacy, 2011).

Weight loss is common, but poorly understood in people with PD with a cause for the progressive, unintended loss either a result of reduced energy intake or increased energy expenditure (Pfeiffer, 2003). Reduced energy intake can also result from impaired food absorption and people with PD are four times more likely than controls to report significant weight loss (Pfeiffer, 2003).

### **2.5.8 Sexual Dysfunction**

Sakakibara, Uchiyama, Yamanishi, and Kishi, (2010) stated that sexual dysfunction in men with PD range from 12% to 60%. In a later review by Stacy (2011) of sexual functioning of 32 women and 43 men with PD, women reported difficulties with arousal (87.5%), reaching orgasm (75.0%), and sexual dissatisfaction (37.5%). Men reported erectile dysfunction (68.4%), sexual dissatisfaction (65.1%), premature ejaculation (40.6%), and difficulties reaching orgasm (39.5%).

### **2.5.9 Sleep Disturbance**

Sleep disturbances (excessive sleepiness, sleep attacks) have, in the past, been attributed to the pharmacological therapy of the condition, however, clinicians now consider that these features are an integral part of the disease and supported by observations that rapid eye movement sleep behaviour disorder occurs in approximately one-third of patients with

PD is also considered a significant risk factor for the development of the condition (Jankovic, 2008). Although the occurrence is variable among people with PD, sleep disturbance, particularly sleep fragmentation, is prevalent in 50% and characterised by an increase in violent dream content accompanied by talking, yelling, swearing, grabbing, punching, kicking, jumping and other dramatic, violent and potentially injurious activity which may also involve the bed partner (Jankovic, 2008; Stacy 2011).

#### **2.5.10 Sensory Abnormalities**

Symptoms such as olfactory dysfunction (hyposmia), pain, paresthesia (tingling), oral and genital pain are frequent, but often not recognised as PD symptoms (Fil et al., 2013). Similarly to sleep disturbance, olfactory dysfunction (affecting up to 90% of people with PD) is also a potential pre-clinical marker of motor symptoms correlated with a 10% increased risk for the disease (Chaudhuri, Healy, & Schapira, 2006; Muzerengia, Donatella, Contrafatto, & Chaudhuri 2007).

#### **2.5.11 Pain**

Pain is one of the most frequently experienced NMS in people with PD but, clinically, is poorly responsive to dopaminergic treatments, often requiring specific treatment (Muzerengia, Donatella, Contrafatto, & Chaudhuri 2007). Failure to recognise and adequately treat is in contrast to that of motor symptoms. Approximately 30 to 50% of people experience pain, which may relate to motor fluctuations, early morning dystonia, or secondary causes such as musculoskeletal pain, however, there is no consensus regarding the mechanisms and classification of pain in PD (Fil et al., 2013).

Gallagher and Schrag (2014) state that the NMS of psychiatric complications are now increasingly documented, however symptoms that include pain, fatigue, and sleep problems (also major correlates of poor quality of life) and those often perceived as embarrassing or unrelated and remain under reported.

## 2.6 Epidemiology

The Hoehn and Yahr (H&Y) scale (Appendix 1) was introduced in 1967 and since has become the most commonly and widely scale used to estimate the severity of PD (Hoehn & Yahr, 1967). The scale was devised to be a simple staging assessment that evaluates severity of PD dysfunction based on bilateral motor involvement and the compromise of gait and balance. Originally a 5 point scale (Stage 1–5), it was subsequently modified to a 7 point scale that included stages 1.5 and 2.5 in the 1990s and has been used as a gold standard for the testing of newly developed scales and good correlations (Goetz et al., 2008).

Hoehn and Yahr's (1967) study (Hoehn & Yahr, 1998) in which they examined 802 people with PD from 1949 to 1964 inclusively, is summarised below:

They found that two thirds of all patients with primary PD have their onset of illness between the ages of 50 and 69. Approximately one quarter of the patients with PD who had their disease for less than five years were already severely disabled or dead. By five to nine years this had increased to two thirds and by ten to fourteen years' duration, to over 80%. Among the patients with primary PD there is a small group of atypical patients who, with slow evolution of the disease process, maintained balance and righting reflexes for ten or more years and were not severely disabled for twenty or more years. Within the limits of their data, there were no definitely significant correlations among sex of the patient, age at onset of the disease, severe infections or other events preceding the onset of PD, positive family history of PD or other neurological disease or rate of progression of the disease (Hoehn & Yahr, 1998). They also found that tremor was most frequently the initial symptom. There was some indication that, at least during the first ten years of illness, PD with tremor as the initial symptom progresses more slowly than PD with other heralding symptoms.

PD does shorten life and does so substantially, regardless of the age at onset or the type of PD. The observed mortality is three times that of the general population of the same age,

sex, and colour. The relative mortality risk is less for men than women and less for those in whom tremor was the initial symptom rather than rigidity bradykinesia, or other non-tremor manifestations (Hoehn & Yahr, 1998). At the time of Hoehn and Yahr's study, there was no evidence that the introduction of newer methods of medical treatment and supportive care had substantially prolonged life. Bronchopneumonia and urinary infections are a cause of death more frequently in people with PD of all ages than they are in the general population. In certain age and sex groups of people with PD there are also more deaths due to accidental injury, peptic ulcer, and vascular lesions of the central nervous system. There is no evidence that people with PD are in any way resistant to malignant neoplastic disease (Hoehn & Yahr, 1998).

Like the Hoehn and Yahr study, Kasten, Chade, and Tanner (2007) reported that, although PD is rare before age 40, after age 50 the prevalence rises almost exponentially and by age 80 the estimated prevalence in European and North American populations is between 1000 and 3000 cases per 100,000 population. More recent epidemiological studies that include work by Kasten et al. (2007) and Van Den Eeden et al. (2003) indicate that the contemporary incidence of PD very much mirrors that of the earlier H&Y study, although they state that new considerations have to be built into the equation as estimates of age and gender distribution of the population change. For example, in the next fifty years, the average age of individuals in both developed and developing countries is expected to show a progressive increase (Hely, Morris, Reid, & Trafficante, 2005). In USA alone, the phenomenon of population aging is predicted to result in a three to four fold increase in PD frequency, or several million persons with the disease (De Lau & Breteler, 2006).

Although PD is intimately related to aging, it has been well documented that its underlying process is distinct from natural aging (Fearnley & Lees, 1991; Gibb, Scott, & Lees, 1991). Differences in the age distributions in the PD population along with diagnostic

criteria, methods of determination, access to health care and survival rates may explain much of this variation, with international variation in PD frequency seen even after adjusting for many of these inconsistencies (Zhang & Román, 1993).

Men are diagnosed with PD about twice as often as women, irrespective of geographic location or race with a pattern seen in both prevalence and incidence studies (Muthane, Ragothaman, & Gururaj, 2007). In a meta-analysis of seven incidence studies, men were found to have a 1.5 times greater relative risk for PD than women (Haaxma et al., 2007; Wooten et al., 2004). De Lau and Breteler (2006) stated that the increased risk in men may reflect biological differences between men and women, such as the effects of sex hormones or X-chromosome-linked susceptibility genes. Alternatively, culturally determined differences in male and female behaviour, with associated differences in exposure to risk factors, could also explain the pattern.

Others also suggest that hormonal differences between men and women may explain these differences, although the relationship does not appear to be a simple one and posit that further epidemiologic studies, along with experimental laboratory studies, will be necessary to determine whether men are at greater risk for PD (Benedetti et al., 2001; Popat et al., 2005).

### **2.6.1 Risk Factors**

Although the cause of PD remains unknown, both environmental triggers, e.g. toxins, and genetic predispositions are being discovered and are thought to play an important function in the development of the disease (Bartels & Leenders, 2009). A generally accepted hypothesis is that PD is the result of an interaction between genetic and environmental factors. Previous epidemiological studies support the view that both genetic, occupational and environmental factors are possible causes of PD and posit the notion of final common mechanisms in PD pathogenesis (Ascherio et al., 2003; Bartels & Leenders, 2009; Betarbet et

al., 2000; De Lau & Breteler, 2006). Several possible mechanisms have been proposed, such as exogenous toxins, inflammation, genetic mutations and combinations of these factors (Betarbet et al., 2000; De Lau & Breteler, 2006).

One such study undertaken in 1983 found that several people developed typical signs of PD after intravenous injections of drugs that had been contaminated with 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP). Subsequent findings showing that MPTP selectively damages dopaminergic cells in the substantia nigra led to the hypothesis that exposure to environmental toxins might be related to the risk of PD (Bartels & Leenders, 2009; De Lau & Breteler, 2006). Since then, many epidemiological studies have been done to examine the association between exposure to pesticides and herbicides, as well as hypothesised surrogate measures, such as farming, living in rural areas, and drinking of well water (Ascherio et al., 2006; De Lau & Breteler, 2006; Elbaz et al., 2009; Kim, Kabir, & Jahan, 2017; Tanner et al., 2011).

Although not statistically significant, trends in Wooten et al.'s data suggested that hysterectomy and early menopause may be associated with increased risk along with oestrogen use after menopause, which was also inversely associated with PD risk (Wooten et al., 2004). Several subsequent case control studies have also suggested that factors associated with oestrogen deficiency such as hysterectomy and early menopause may increase PD risk (Ascherio et al., 2003; Ragonese, D'amelio, & Savettieri, 2006).

Other aspects of gender may also determine the effects of risk or protective factors associated with PD as women appear to have different risk profiles to at least some of the exposures linked to PD in men, as considered above (Kasten et al., 2007). Although the explanation for these differences is not known, further investigation of the combined effects of risk factors may explain some of these differences (De Lau & Breteler, 2006). For example, in two prospective cohort studies, the combined effects of caffeine consumption and

supplemental oestrogen use influenced PD risk. Ascherio et al. (2003) state that women using supplemental oestrogens with low caffeine consumption were at a lower risk of PD, but this effect was attenuated or reversed in women who had high caffeine consumption who were at higher risk of PD.

De Lau and Breteler (2006) also state that the causes and aetiology are still largely unknown and add that for most of the factors evidence is still inconclusive and, thus far, older age and smoking habits are the only risk factors for PD that have consistently been found across studies. They conclude that many of the initial studies on the epidemiology of PD were too small or had methodological limitations that hampered the interpretability of their findings and that the paucity of well-designed and sufficiently large studies has been a serious limiting factor in epidemiological research of PD in the past.

## **2.7 Pharmacological Therapeutic Interventions for Motor Symptoms**

Ehringer and Hornykiewicz discovered in 1960 that dopamine concentrations were markedly decreased in the striatum of patients with PD, which established the path for the first trials of levodopa (synthetic dopamine) in PD patients the following year (Hornykiewicz, 2006). Dopamine is synthesised from the amino acid levodopa and this synthetic or exogenous replacement of levodopa has been highly effective in treating motor symptoms (Stacy, 2009).

Genetic mutations, abnormal handling of misfolded proteins by the ubiquitin–proteasome and the autophagy–lysosomal systems, increased oxidative stress, mitochondrial dysfunction, inflammation and other pathogenic mechanisms have, more recently, been identified as contributing factors in the death of dopaminergic and non-dopaminergic cells in the brains of patients with PD (Olanow & McNaught, 2006; Pan, Kondo, Le, & Jankovic, 2008).

The medical management of PD is based on compensating for the death or catecholamine depletion due to the loss of dopamine producing cells in the substantia nigra through delivery of additional dopamine or directly stimulating the postsynaptic striatal neurons (Obeso et al., 1989; Stacy, 2009). A positive response to dopamine-replacement (Levodopa) therapy (dopamine challenge) may help confirm the initial diagnosis as a great majority of patients with PD exhibit a good initial response to Levodopa (Xia & Mao, 2012). Martino et al. (2016) state that, given the importance of the medication response on the diagnostic certainty, the initial impression is often tentative and 'possible' PD becomes 'probable' PD once Levodopa brings about marked and sustained benefits.

Medications used for the symptomatic management for PD like Levodopa are highly effective and continue to work throughout the course of the disease and remains the gold standard of drug therapy (Xia & Mao, 2012). However, although producing a robust and predictable response initially, with disease progression and nigrostriatal neuronal death, motor fluctuations and drug related dyskinesias develop as a complication of the long-term therapy broadly classified as "wearing-off reactions" and "on-off reactions" (Shulman, 2007; Stacy, 2009; Xia & Mao, 2012). Schrag and Quinn (2000) state that up to 50% of people on long term (after five years) levodopa will experience motor fluctuations and dyskinesias, and describe motor fluctuations as alterations between periods of being "on," during which the person experiences a positive response to medication, and being "off," during which the person experiences a re-emergence of the Parkinson symptoms suppressed during the "on" state. People with PD typically experience a smooth and even response to the early stages of levodopa treatment, but as the condition advances the effect of levodopa begins to wear off several hours after some or even all doses, leaving people aware that the duration of action of a dose of levodopa is not being sustained (Sage, 2017).

After years of dopaminergic therapy, people with PD become progressively disabled despite complex combinations of the available anti-parkinsonian treatments. Eventually they suffer from ‘dopa resistant’ motor symptoms which include impairment to speech, mobility and balance and NMS that include cognitive, neuropsychiatric and autonomic impairment and the drug related side effects of psychosis, motor fluctuations and dyskinesias (Truong et al., 2008).

Pharmacological treatment to relieve the motor symptoms and improve physical functioning are largely designed to replenish decreased levels of dopamine in the brain (Buetow et al., 2013). However, loss of dopamine alone cannot explain many of the disabling, non-motor symptoms of PD such as cognitive impairment and low mood, which also strongly predict Quality of life (QoL) (Buetow, Talmage, McCann, Fogg, & Purdy, 2013; Martinez-Martin et al., 2011).

Why motor fluctuations occur is not completely understood, but current thinking suggests that they progress as PD progresses because the advancing degeneration of the nigro-striatal dopaminergic pathway reduces the ability of nerve terminals to store and release dopamine physiologically (Melo, Chien, & Barbosa, 2010). As a result of this loss of ‘storage capacity’ the response to exogenous levodopa defaults to a more pulsatile or episodic manner with the effect of each levodopa dose progressively reduced and reaching a plasmatic (90 minute) half-life, even though the dynamic of the drug is unaltered during the course of the disease (Melo, Chien, & Barbosa, 2010).

For this reason, dopamine agonists, medications that bypass the presynaptic neuron and directly stimulate striatal dopamine receptors, are often used. Calandrella and Antonini (2012) state that all studies comparing levodopa versus early therapy of a dopamine agonist indicate that initiation with agonists is associated with a reduced risk of motor complications in particular, dyskinesias possibly because the agonists’ longer half-lives provide continuous

dopaminergic delivery. Indeed, non-dopaminergic therapeutic strategy may delay the emergence of motor fluctuations and dyskinesia which Calandrella and Antonini (2012) say is essential to maintaining satisfactory quality of life.

Dopamine agonists (Table 2) are medications that directly stimulate striatal dopamine receptors and consist of monoamine oxidase type B (MAO-B) inhibitors: *Rasagiline*, *Oral Selegiline*, *Selegiline*. Ergoline dopamine agonists: *Bromocriptine*, *Pergolide*, *Cabergoline*, *Lisuride*. Nonergoline dopamine agonists: *Pramipexole*, *Ropinirole*, Catechol-O-methyltransferase (COMT) Inhibitors: *Tolcapone*, *Entacapone* and Non-competitive N-methyl-D-aspartic acid (NMDA) antagonist: *Amantadine* (Diaz & Waters, 2009).

Dopamine agonists (Table 2) may be used as initial and adjunctive therapy in people with PD and reduce off time in levodopa-treated patients by 20% to 40% or an average of two hours per day. As an adjunctive or mono therapy, common side effects from dopamine agonists are many and frequently experienced by users and include symptoms of nausea, headaches, tiredness, dizziness, drowsiness, sweating, dry mouth, vomiting, decreases in BP, orthostatic hypotension, nightmares, hallucinations, paranoid reactions, confusion, weight gain, sleep disorders (Xia & Mao, 2012).

Stacy (2009) states that treatment of PD symptoms should be sub-classified into motor and non-motor categories with motor symptoms highlighted in the early stages of PD. Decisions to initiate therapy at the early stage of PD are based on the patient's perceptions of disability, and appropriate therapies may include MAO-B inhibition, dopamine agonists, and levodopa as listed above.

In the event of motor complications, Stacy (2009) recommended a balanced approach to dopamine agonists and levodopa and states that, eventually, non-motor symptoms will become the primary focus of care, and a careful review of the array of these symptoms may lead to interventions that greatly improve the patient's quality of life.

**Table 2**  
**Current Pharmacological Therapies Available For PD**  
*(Nthenge-Ngumbau & Mohanakumar, 2017)*

<b>Drugs</b>	<b>Actions</b>	<b>Shortcomings</b>
DA replacement therapies L-DOPA	As the DA precursor, it elevates DA synthesis; usually co-administered with peripheral ADC inhibitors for maximum effects	Low BBB permeability (10–20%) and tolerance development, causing requirements of higher doses and therefore administration of peripheral AADC inhibitors; severe side effects include LID and ‘on/off’ phenomena
AADC inhibitors (benserazide, carbidopa)	Co-administered with L-DOPA to reduce L-DOPA conversion to DA in the periphery, allowing for more L-DOPA to cross the BBB. These reduce the side effects of elevated peripheral DA	AADC inhibitors cause liver toxicity
MAO inhibitors (selegiline, rasagiline)	Crosses the BBB and helps to reduce the catabolism of DA at the synapses in the brain and to maintain the DA level for longer periods in the synapses	Limited to preserving available DA, which is already reduced in the PD brain. The disease progresses with less DA reaching the striatum, and the efficacy of this class of drugs vanishes
COMT inhibitors (tolcapone, entacapone)	When AADC is inhibited, as in the case of the above levodopa/AADC inhibitor preparations, the <i>O</i> -methylation pathway becomes prominent. COMT inhibitors reduce this catabolism step, thus helping to maintain DA level; they also approximately double the bioavailability of L-DOPA	As with MAO inhibitor, the efficacy vanishes with progression of the disease
Dopaminomimetics Ergoline DA receptor agonists (dihydroergocryptine, pergolide, bromocriptine, lisuride, cabergoline) Non-ergoline DA receptor agonists (ropinirole, amipexole, piribedil, apomorphine)	Ergoline-derived DA receptor agonists with higher affinity for D2-type receptors and less affinity for D1-type receptors Not derivatives of ergoline; D2-type receptor agonists with a marked preference for D3 receptor subtype	Drowsiness, hallucinations, insomnia, nausea, constipation, not cost-effective  Drowsiness, hallucinations, insomnia, nausea, constipation, not cost-effective
Non-DA-ergics as therapeutics for PD Anticholinergics (trihexyphenidyl, biperiden, orphenadrine, procyclidine, benzotropine, bormapriner, ethopropazine, scopolamine, propantheline, benapryzine, cycrimine, elantrine, diphenhydramine)	Acetylcholine has an inverse relation to DA in the striatum and affects direct and indirect pathways of motor control. Anticholinergics help to reduce this effect of acetylcholine, thus balancing the disequilibria between striatal dopamine and acetylcholine, yielding anti-PD effects most notably tremor and enhanced motor function	Neuropsychiatric effects, blurred vision, constipation, aggravation of L-DOPA side effects
Glutamate antagonists (amantadine, memantine, ifenprodil, budipidine, dextromethorphan)	Bind to NMDA receptor and reduce NMDA-induced membrane currents, normalising the activity of the glutamatergic corticostriatal and subthalamicopallidal pathways, which may be overactive in PD, particularly in dyskinesia; amantadine enhances release of stored catecholamines from intact dopaminergic terminals as well	Dizziness, anxiety, impaired coordination, insomnia, nervousness, nausea and emesis
Adenosinergics (istradefylline)	Block A2A receptor-induced modulation of the striatopallidal pathway and increase the pallidal output to the STN, restoring the balance of the basal ganglia–thalamocortical circuitry	Nausea, dyskinesia and dizziness

Note. AADC aromatic amino acid decarboxylase, BBB blood–brain barrier, COMT catechol-O-methyltransferase, DA dopamine, L-DOPA L-3,4-dihydroxyphenylalanine, GABA  $\gamma$ -amino butyric acid, LID L-DOPA-induced dyskinesia, MAO monoamine oxidase, PD Parkinson’s disease

People at an advanced stage of PD and experiencing worsening motor fluctuations, increasing resistance to the oral therapeutic mechanisms described above, or who have

intractable NMS, and who have deep brain stimulation (DBS) contraindicated, can benefit from a subcutaneous infusion therapy by way of a subcutaneous infusion of apomorphine via an apomorphine pump (Diaz & Waters, 2009).

Auffret et al. (2017) state that apomorphine is proving to be an interesting option for treating advanced PD. In their evaluation of the general efficacy of add-on apomorphine on motor and NMS symptoms in 12 people assessed six months before and after treatment found induced metabolic changes throughout the motor, cognitive and limbic networks, improved function and a general clinical improvement. Their findings suggest beneficial effects of continuous administration of the dopaminergic agonist for people, particularly those with contraindications for DBS.

### **2.7.1 Surgical Interventions for Motor Symptoms**

Contiguous with the range of available pharmacological interventions, including the dopamine replacement therapies: postsynaptic dopamine receptor stimulation, dopamine catabolism inhibitors and the anticholinergics described above, surgical therapies like deep brain stimulation and ablative surgical techniques are also employed, particularly when severe bradykinesia, rigidity, tremor and unpredictable wearing off periods are present (Groppa et al., 2013).

Surgical treatments include ablative techniques such as surgical lesioning of the globus pallidus (pallidotomy), thalamus (thalamotomy) or subthalamic nucleus (subthalamotomy) (Nthenge-Ngumbau & Mohanakumar, 2017). These lesions are made unilaterally or bilaterally. Bilateral surgical ablations often evoke more severe side effects compared to unilateral ablation. Thalamotomy improves tremor, rigidity and L-DOPA induced dyskinesia. Unilateral pallidotomy shows marked improvement in contralateral tremor, rigidity, bradykinesia and dyskinesia. Subthalamic lesions improve tremor and

speech, but may cause worsening of gait or intractable hemiballism and are therefore a less preferred option (Nthenge-Ngumbau & Mohanakumar, 2017).

In the 20 years since its introduction into clinical practice, many studies have reported on its benefits, drawbacks, and insufficiencies including inducing voice impairment in some people with PD (Skodda et al., 2014). That notwithstanding, high-frequency DBS of the subthalamic nucleus (STN-HFS) is the preferred surgical treatment for advanced PD (Benabid, Chabardes, Mitrofanis, & Pollak, 2009). DBS is used in drug-resistant cases where long term pharmacological treatment has stopped responding to medication. The globus pallidus, subthalamic nucleus, pedunculopontine nucleus or thalamus, usually in conscious patients undergoes high frequency stimulation which modifies the electrophysiological function of the basal ganglia (Nthenge-Ngumbau & Mohanakumar, 2017). This is achieved by inserting a thin insulated wire through a small opening in the skull and implanting it in the specific brain areas described above. An insulated wire passed under the skin of the head, neck and shoulder is connected to an implantable pulse generator (IPG).

The IPG is usually implanted under the skin near the collar bone, on the chest or under the skin over the abdomen. Once in place, electrical impulses are emitted from the IPG through the lead and into the brain. The impulses alter the electrophysiological discharge in the basal ganglia circuitry. DBS effectively attenuates PD motor symptoms such as tremor, bradykinesia and rigidity, but unlike other surgical techniques, the process is reversible. One of its other advantages is the ability to modulate discrete functional domains within the basal ganglia circuitry, sparing uninvolved areas that are often disrupted with other methods of therapy (Nthenge-Ngumbau & Mohanakumar, 2017; Stefani, Trendavilof, Liguori, Fedele, & Galati, 2017; Xia & Mao, 2012).

## **2.8 Pharmacological Therapeutic Interventions for Non Motor Symptoms**

The evidence for treatment of the NMS complex is poor. A review of the pharmacological and surgical treatments of the disease by the Movement Disorders Society Task Force (Noyce et al., 2017) highlight insufficient evidence for treatment of the NMS of PD with dopaminergic drugs (Goetz et al., 2008).

Many non-motor symptoms of PD could have a non-dopaminergic basis with symptoms such as constipation, cognitive deficits, dysautonomia and olfactory deficits usually not responding to dopaminergic treatment. Clinically, dopaminergic treatment is considered unhelpful for most of the non-motor symptoms of the disease unless these are linked to motor fluctuations such as wearing off related non-motor symptoms like 'off period' pain. (Chaudhuri et al., 2006).

Truong et al. (2008) state that PD is considered now not only to be a motor disorder, but a neuropsychiatric, autonomic, and sleep disorder with important non-motor aspects and, consequently, there has been a shift of treatment focus to reduce disability, instead of merely reducing symptom severity. Therefore, early recognition of non-motor symptoms is essential for the care of patients with PD and the importance of a multidisciplinary approach that includes support for carers is very important (Chaudhuri et al., 2006).

## **2.9 Non-Pharmacological Therapeutic Intervention for Motor and MNS**

Overall, the literature suggests that conventional (pharmacological and surgical) treatments have been unconvincing in demonstrating how they might slow or stop the progression of PD (Bega, Gonzalez-Latapi, Zadikoff, & Simuni, 2014). As stated above, dopaminergic therapy is regarded as the gold standard for managing the motor symptoms associated with PD, but it has fallen short in managing all of the aspects of the disease that contribute to quality of life (Ghaffari & Kluger, 2014). Perhaps it is for this reason that an increasing number of people are searching for a more holistic healthy living, mind-body

practices approach to healthcare combining complementary therapies with standard PD pharmacological therapies (Bega et al., 2014).

Managing the side effects of PD drug treatment on top of the PD symptoms can result in a downturn in physical, psychological and psychosocial wellbeing, which can have a detrimental effect on quality of life, which for many can lead to social withdrawal and isolation for both the person with PD and their significant other (Vella-Burrows & Hancox, 2012). This in turn can put considerable strain on the relationship with breakdowns occurring as the significant other learns to cope with the burden of long term care or the premature separation following an admission into residential care for the person with PD (O'Reilly, Finnan, Allwright, Smith, & Ben-Shlomo, 1996).

It is for these reasons that there is a growing interest in alternative and complementary therapies or complementary and alternative medicine (CAM) sitting alongside conventional clinical – pharmacological support (Han, Wu, Chen, Zhang & Wang, 2017). The literature shows a number of commonly used non-pharmacological treatment approaches for people with PD that include: acupuncture, herbal medicine, massage, osteopathy, reflexology, Tai chi, Ai Chi, and yoga (de Amorim Aroxa, Fábio Henrique et al., 2017; Han et al., 2017; Kurt, Büyükturan, Büyükturan, Erdem, & Tuncay, 2017; Lee & Lim, 2017) of which the most common are described further below. These therapies have the potential to address some of the specific symptoms and problems of PD and broader quality of life issues, with few, or no, harmful side effects (Ghaffari & Kluger, 2014). However, Ghaffari and Kluger's (2014) review of common alternative and complementary therapies for people with PD suggests that, although many of these therapies show therapeutic potential, the efficacy of many of the treatments is modest or the effects are nonspecific. Most of the studies in Ghaffari and Kluger's review found that the treatments are generally safe with no reason for their use to be discouraged when used in addition to standard treatment. They did, however highlight a

notable exception, one of which included herbal therapies, which have shown drug interactions and/or the potential to induce dyskinesias.

### **2.9.1 Tai Chi**

Tai Chi has been performed as a martial art form in ancient China for millennia and for past centuries, it has transformed into a physical exercise form with smooth and elegant movements performed daily among the elderly (Han et al., 2017). A retrospective review of the effectiveness of traditional Chinese medicine for the treatment of PD by Han et al. (2017) suggested that ‘cardinal’ Tai Chi could improve motor function in people with PD.

One study that was included in the review compared one group performing Tai Chi and control group who were offered no Tai Chi indicated that the Tai Chi performed better than the control group in directional control, step length, functional reach and occurrence of falls after a 24 week period of Tai Chi treatment (Kim, Allen, Canning, & Fung, 2013; Low, Ang, Goh, & Chew, 2009). A systematic review by Wang et al. (2009) of fifteen randomised controlled trials on the effect of Tai Chi on psychosocial wellbeing found significant effects, specifically, eight studies found significant effect on the management of depression and six studies on anxiety, but suggest the results be interpreted with some caution because of substantial variation in the quality of the trials.

### **2.9.2 Yoga**

A systematic review and meta-analysis study by Mooventhan and Nivethitha (2017) found that yoga is superior to conventional physical activity interventions in elderly people especially in improving for self-rated health status, aerobic fitness, and strength. In general, yoga was reported to have a beneficial effect on physical function, mental/emotional state, social, vitality, and lifestyle choices. Mooventhan and Nivethitha contended that yoga might be useful as a health promotion strategy for the prevention and management of chronic disease in older adults. This view is supported by Ni et al. (2016), whose study on the effect

of power training and high-speed yoga on motor function in older people with PD found, using a number of specific motor, balance, walking and power measures, a significant improvement in physical performance in elderly individuals with PD after 12 weeks (twice a week) of yoga practice compared to a non-exercise control group.

### **2.9.3 Physiotherapy**

This millennium has seen a significant increase in research and clinical interest in using exercise as a treatment for mobility problems in people with PD with advances in research that suggests neurochemical and neuroplastic changes after exercise (Kolk & King, 2013). Poor responses of postural stability to drug and surgical interventions has led to exercise interventions and rehabilitation programmes that have been evaluated with respect to effectiveness on clinical outcomes such as balance, strength, gait, walking speed, and physical function (Goodwin, Richards, Taylor, Taylor, & Campbell, 2008; Xia & Mao, 2012). A number of studies report particular aspects of mobility improving after exercise with the potential to help both gait, balance, strength (motor), non-motor (depression, apathy, fatigue, constipation) aspects of PD and secondary potential cardiovascular and osteoporosis complications of immobility (Kolk & King, 2013).

Clinical studies have shown the beneficial effect of regular physical activity and programmes such as aerobic exercise, resistance training and home based exercise intervention on improving functional mobility in patients with PD and with it a significant lower caregiver burden (Nieuwboer et al., 2007). The investigators in this small sample of published literature included references to quality of life and wellbeing in their respective discussions, however the effects of the interventions on either have not been measured or analysed. A Systematic Review and Meta-Analysis on the effectiveness of exercise interventions for people with PD (Goodwin et al., 2008) included four studies ( $N = 292$ ) with findings across three quality of life outcomes. Of these, only one reported a statistically

significant benefit in favour of the exercise intervention group. Although refining their scope to one aspect of physiotherapy (i.e., exercise-based interventions), they were able to extract relevant data from the four studies relating to health related quality of life to suggest that exercise interventions are likely to result in improvements in health related quality of life.

#### **2.9.4 Acupuncture**

Lee and Lim's (2017) large systematic review and meta-analysis evaluating the use of acupuncture for the relief of PD symptoms showed evidence for its effectiveness.

Acupuncture was more effective in relieving PD symptoms than no treatment or conventional treatment alone. In addition, they found acupuncture plus conventional treatment had a significant effect compared to conventional treatment alone suggesting acupuncture should be considered as a combination treatment for patients with PD. In a different study, de Amorim Aroxa, Fábio Henrique et al. (2017) evaluated the effects of acupuncture on sleep disorders in patients with PD, using a specific instrument for sleep evaluation. They found that acupuncture significantly improved the quality of nocturnal sleep, nocturnal psychosis, and nocturnal motor symptoms. These findings are important, they say, because sleep disturbance is one of the most common NMS in PD, compromising the quality of life.

Therapies such as Tai Chi and yoga have the added dimension of social interaction, which has been identified as crucially important in supporting the wellbeing for people living directly with PD and their carers as the condition progresses (O'Reilly et al., 1996). There is a growing interest in treatments other than those listed above, such as music therapy (MT), which also has the added dimension of social interaction and voice treatments such as the Lee Silverman Voice Treatment (LSVT<sup>®</sup>) (Ramig et al., 2001) and the subject of this study; Voice and Choral Singing Therapy (VCST) (Di Benedetto et al., 2009), which will be the subject of further exploration in Chapters four and five.

### **2.9.5 Music Therapy**

In clinical and non-clinical environments, music therapists use a broad range of approaches in their practice from singing (sound, rhythm, melody and harmony), vocal exercises, to listening to music, playing instruments, rhythmic dancing, music-based movement and free dancing (Ghaffari & Kluger, 2014). Several small studies using a combination of these approaches have found a positive effect of music therapy on PD (Raglio, 2015; Grahn & Brett 2009). Among the studies included is a meta-analysis of several small music-based movement trials that found consistent effects on balance, Bradykinesia and significant improvements in participant's emotional wellbeing (De Dreu, Van Der Wilk, Poppe, Kwakkel, & Van Wegen, 2012; Pacchetti et al., 2000).

Discussed further in Chapter four, music activates a reward system pathway, (Blood & Zatorre, 2001), which is known to release dopamine that temporarily ameliorates the motor symptoms experienced by people with PD (De Dreu et al., 2012). Rhythmic cueing is a tool that uses temporal auditory or visual stimulation to train specific activities and has been shown to be effective in increasing gait speed, step length and reducing freezing in people with PD (Bega et al., 2017; Ghaffari & Kluger, 2014).

Research suggests that music therapy may have the potential to affect social function, cognition, psychological function (such as anxiety, apathy, and depression), and mobility (including gait and dexterity) by inducing unique chemical, physiological, and anatomic changes that may have particular relevance to neurodegenerative diseases like PD (Bega et al., 2014, 2017; Thaut, 2010).

### **2.9.6 LSVT®**

Speaking louder, with more intensity, characterises a longstanding practice (sometimes referred to as recalibration) that is employed, usually by speech and language therapists, to manage voice changes in people with PD. This technique has been formalised

into a treatment approach and the subsequent commercial programme known as the LSVT<sup>®</sup> programme has been marketed by a for profit organisation from the late 1980s onwards (C. Fox et al., 2005; C. M. Fox et al., 2006; Ramig et al., 2001; Spielman, Gilley, Halpern, & Ramig, 2010). More recently an extended form known as LSVT-X<sup>®</sup> has been developed (Spielman et al., 2011).

LSVT is a high effort intensive treatment that aims to increase vocal loudness through increasing vocal adduction, 'thinking loud' and increasing respiratory effort; it is sometimes referred to as LSVT-LOUD (Herd et al., 2012). LSVT treatment consists of exercises requiring intensive phonatory effort over a duration of four 1-hour sessions a week for four consecutive weeks (16 hours) and two 1-hour sessions per week for eight consecutive weeks (16 hours) for LSVT-X. Included in both programmes is a further 5-10 minutes of homework on treatment days and 20-30 minutes per day on non-treatment days. Given the extended duration of LSVT-X, participants have to undertake significantly more home practice than those who have completed traditional LSVT. Participants are encouraged to perform at maximum effort throughout every session with repeated exercises for the first half of each session and speech tasks for the second half of each session (Ramig et al., 2001).

For the past 25 years, LSVT has established itself globally as the most efficacious behavioural treatment for voice and speech disorders in PD (Spielman et al., 2011). However, Herd et al. (2012) state that, because the small number of people examined and the methodological flaws found in an extensive Cochran review of speech and language therapy techniques for speech problems in PD, which included LSVT. Herd et al. (2012) suggest that it is unsafe to draw any conclusions regarding the efficacy of one form of speech and language therapy in preference over another for the treatment of speech problems in PD.

Evidence for LSVT<sup>®</sup>'s efficacy have been published, in the main, from studies dominated by research facility reports from the original LSVT<sup>®</sup> group or closely associated

groups; there have been calls for studies to provide further evidence for its efficacy in routine clinical settings (Wight & Miller, 2015).

LSVT® is a selective and elective therapeutic model with exclusion criteria applied. Those who meet inclusion criteria may self-exclude before treatment for a variety of personal and practical reasons or variety of motives (Wight & Miller, 2015). Thus, those counted for end of treatment and follow-up analyses already represent a select group (Wight & Miller, 2015).

A recent clinical audit was undertaken by Wight et al (2015) on the outcomes of consecutive people with PD (n=33), who were offered and completed LSVT® in a routine hospital outpatient setting. They found that it is possible for an LSVT® certified clinician working in a routine clinic to achieve improvements at the end of treatment that compare with gains reported from studies conducted in research centres with improvements extended to patient perceived voice handicap measures as well as carer perceptions (Wight & Miller, 2015). However, the data required to address the issue of self-exclusion are not available and have been largely absent from other investigations. A definitive trial of LSVT® Wight and Miller contend should include data on reasons for not recommending or accepting LSVT® or leaving prior to completion in order to arrive at a realistic estimate of the number of people with Parkinson's for whom LSVT® may be appropriate and effective.

At an individual level approximately 25% of cases in the audit by Wight and Miller did not show an improvement by the end of treatment. For those who did improve significantly, gains were not maintained to 12 and 24 months with the exception of intensity on prolonged /a:/. Based on this finding that the one variable demonstrating good longer term success was sustained /a:/, Wight and Miller (2015) contend that LSVT® teaches a way for individuals to monitor and increase voice intensity, but not all patients are able to benefit from this. Those who improve on a sustained /a:/ may find it difficult to generalise or transfer

gains to reading and monologue tasks. A complicating factor is the contention that people selected for LSVT® are already chosen on the basis of being able to increase voice intensity to command, therefore Wight and Miller (2015) contend that a more stringent test of success for any treatment programme could be success in converting individuals from being unable to increase intensity to command to being able to normalise it. Wight and Miller (2015) conclude that given the variability outcomes across studies, which include factors such as how sound pressure levels (SPL) have been measured (e.g., varying mouth to microphone distance and whether readings were taken from acoustic analyses or hand-held devices) and other factors relating to therapist variables, it is prudent in a definitive trial to plan randomisation of clinicians as well as patients.

With a focus on increased respiratory phonatory effort used in LSVT®, a concern is that it has the potential to adversely affect the voice because it raises vocal pitch and laryngeal muscle tension (de Swart, Willemse, Maassen, & Horstink, 2003). A comparison of two therapy approaches, LSVT® and Pitch Limiting Voice Treatment (PLVT) a therapy approach developed by de Swart et al. (2003), was undertaken by de Swat et al. From this study they contended that a focus on an increase in respiratory phonatory effort has an adverse effect, because it raises vocal pitch and laryngeal muscle tension. PVLV increases loudness as LSVT® but, by setting vocal pitch at a lower level, limits the increase in vocal pitch and prevents strained or pressed voicing (de Swart et al., 2003).

Skodda et al. (2013) states the therapeutic approaches for an amelioration of speech performance in PD remain disappointing, and the LSVT® which is considered as the most effective speech and therapy, so far, has its limitations mostly based on insufficient availability. LSVT® has high administration cost because of the intensity of the client contact time required. Access to speech and language therapy (SLT) services alongside the limitations for some people with PD in the extent to which they can take part in such an

intensive activity, because of physical impairments, can result in significant numbers of participants dropping out (Allen et al., 2012; Johnston & Chu, 2010).

Despite the existence of voice and speech treatment programmes such as LSVT®, it has been reported in USA that perhaps as few as 3-4% of people with PD with voice and speech complaints actually participate in treatment (Shih et al., 2012). There are no references in the literature to qualitative studies examining participant acceptability of LSVT. Shih et al. (2012) suggest that common barriers to participation may relate to perceptions that the programmes are too intensive or not engaging enough to sustain long long-term commitment to practice as well as limited clinician availability to deliver individual therapy.

### **2.9.7 Group Singing**

The effect of group singing on QoL has been examined in both healthy and clinical populations, including chronic mental health, physical and intellectual disabilities, respiratory, gastrointestinal and neurological conditions such as PD (Abell, Baird, & Chalmers, 2017; Clift, Manship, & Stephens, 2017; Clift & Hancox, 2010; Grape, Sandgren, Hansson, Ericson, & Theorell, 2003; Thaut, 2010).

Clift et al.'s (2010) multinational qualitative study of 1124 choral singers concluded, in line with a number of similar qualitative studies, that the group singing experience exerts a counteractive influence on factors potentially detrimental to health and wellbeing. The study was robust, but interpretation of the data is open to bias. A questionnaire based on the 26 item WHOQOL-BREF developed by the World Health Organisation Quality of Life Group was administered in three countries and measured physical, psychological, social and environmental wellbeing, and a 12 item 'effects of choral singing scale'. However, it asked questions of an aging healthy (87% described their health as good) population of choristers with a significant gender imbalance, who have a particular love of singing and choir membership and, of relevance to this present study, no one with a degenerative neurological

condition such as PD. That notwithstanding, the study identified a strong emphasis on improved mood, enhanced quality of life, greater happiness, less stress and emotional wellbeing.

Voice and respiration impairment affect the quality of life in people with PD. Voice disorders are present in as many as 60–80% of patients with PD, but there is little correlation between motor and voice symptoms; current treatment that targets motor impairment does not effectively target voice impairment (Silbergleit et al., 2015). Therapeutic approaches for people with PD focus predominately on the prosodic aspect of speech, vocal intensity (LSVT) or expiratory muscle strength. Although demonstrated to effectively treat impairment in PD, these approaches tend to be impairment focused often overlooking the impact on QoL (Collis & Bloch, 2012). With ‘progressive’ voice and respiratory impairment negatively influencing QoL, it can contribute to poor adherence to voice and respiratory therapy exercises following treatment (Stegemöller et al., 2016).

As singing has the potential to treat speech abnormalities by directly stimulating the musculature control systems associated with respiration, phonation and articulation (Natke, Donath, & Kalveram, 2003) and, as a more engaging vehicle for treatment with the potential to improve both voice and influence QoL positively, there are compelling reasons to believe that it has the potential to be an effective therapeutic model (Stegemöller et al., 2016). There are a growing number of studies investigating group singing, but to date very few investigate group singing on voice with PD (Buetow, Talmage, McCann, Fogg, & Purdy, 2014; Di Benedetto et al., 2009; Elefant et al., 2012; Haneishi, 2001; Harris, Leenders, & de Jong, 2016; Shih et al., 2012; Stegemöller et al., 2016).

An experienced choir leader with a knowledge of phonation and respiration strengthening exercises and charisma to enthuse the singers would usually lead the choir or singing group, but music therapists alongside speech and language therapists are well placed

for this function (Talmage, Ludlam, Leao, Fogg-Rogers, & Purdy, 2013; Vella-Burrows & Hancox, 2012).

Delivered to a group, VCST also has the benefit for its members of an activity that can provide and stimulate a mutually supportive social environment. Where practiced, VCST is considered an enjoyable and cost effective means of providing speech and voice therapy compared to established treatments (Davidson et al., 2014; Buetow et al., 2014).

Di Benedetto et al.'s (2009) preliminary study stated that VCST was an amusing and agreeable approach for the treatment of speech and voice abnormalities in PD patients but, with only a small number of participants, they were unable to draw any conclusions. They did suggest however, that first findings showed an improvement in phonation time, prosody and fatigue, to find evidence of efficacy they called for a RCT and suggested comparing VCST with LSVT®.

To better understand the treatment effects of VCST on people with PD, the purpose of this thesis is to examine if singing is a viable means of improving vocal intensity, prosody, respiration and QoL in people with PD. A treatment dosage of 16 hours enables effect size comparison with published LSVT-X® data. Group singing using voice and choral singing therapy is discussed further in Chapters four and five.

## Chapter 3: Study One

### Stability Over a One Month Period of Self-Rating Measures of Disease Severity and Impact in a Clinical Sample of Adults with Parkinson's Disease

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#### 3.1 Abstract

**Background:** PD has a range of motor and non-motor effects that vary in severity across people and can be associated with cognitive impairment and voice problems that impact on quality of life (QoL) and can have negative effects on wellbeing including depression, anxiety and stress. How participants perceive symptom change, symptom severity and quality of life are other outcomes are important factors in a clinical study. Accurate information on how medications and therapy affect symptomatology are also important when deciding on clinical management. Therefore, reliable measures with which to assess participant perceptions are needed. There are published measures with established reliability that have been used for people with PD, but none of these studies were conducted in New Zealand. Also, none of these studies looked at the reliability and acceptability of performing all of these measures together as part of a 45 minute test battery.

**Objectives:** To determine if the measures are internally reliable, acceptable and feasible, reliable across participants, sensitive to the effects of PD and show stability over time. To investigate the association between self-report measures of the participant's motor and non-motor effects on general function (activities of daily living, ADLs), cognition, the participant's (and their partner's) perception of the impact of voice difficulties and the association between the severity of motor and non-motor severity and wellbeing (depression, anxiety, stress) and QoL.

**Methods:** Participants with PD ( $N = 36$ ) receiving usual PD care completed four self-report measures on two test occasions separated by an interval of one month. Cognition and partner perceptions of voice handicap were also assessed. Measures used were the Movement

Disorder Society-Revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS) Part I (non-motor Experiences of Daily living) and Part 2 (Motor Experiences of Daily Living); Voice Handicap Index-10 (VHI-10) and VHI-10 Partner version (n = 32) (VHI-10P) to obtain information on the person's and their partner's perception of the person's voice; the Depression, Anxiety and Stress Scale (DASS-21); the Parkinson's disease Questionnaire-8 (PDQ-8) to measure PD related QoL, Cognition was assessed by the researcher using the Addenbrookes Cognitive Assessment-III, NZ Version A (ACE-III). A semi structured qualitative interview was conducted on the second test occasion to obtain the participants' perception of symptom change, the measures used and acceptability of the study process.

**Results:** Cronbach's alpha measures of internal reliability were good to excellent for all measures. Analysis of intra subject reliability showed significant changes between the first and second test occasions for a few measures; ACE-III scores increased (better cognitive score) and PDQ-8 and VHI-10 scores reduced (less self-reported difficulty). VHI-10 ratings were correlated with the VHI-10P partner ratings. There were no statistically significant differences in self-report questionnaire outcomes between participants who were above (n = 10 'healthy'; ACE-III scores 89 to 100) versus below (n = 26 'risk', ACE-III scores 88 and lower) the SACE-III cutoff for 'cognitive risk'. Qualitative data showed that participants were happy with what they perceived as a natural, relaxed experience; they noted the comfort, timing and convenience of the assessment process and reported the process and measures were acceptable and relevant to people with PD.

**Conclusion:** Internal reliability of the self-report measures largely reflect published findings for the measures, i.e.  $\alpha > .9$  and  $.8$  (optimal). There was no statistically significant difference in self-reported measures outcomes between the 'healthy' and 'cognitive risk' groups, suggesting that ACE-III cognition scores need not be an exclusion criterion for further studies using the MDS-UPDRS, DASS-21, VHI-10/VHI-10P or DPQ-8 as outcome measures

for participants with PD. Qualitative data showed that 31% (n = 12) of participants reported concern with regard to health professionals adjusting the dosage or timings of their anti-PD medications during the test period. Overall, the participants reported satisfaction with the relaxed experience and comfort of completing the questionnaires in their homes. Participants rated the timing and convenience of the process as manageable and not tiring and thought the process and the measures used were acceptable and relevant to PD.

**Keywords:** Parkinson's disease, self-report, reliability, quality of life, depression, anxiety, stress, voice, cognition

### **3.2 Background**

Current research is recognising and building our understanding of the 'alterations' caused by PD and how they can impact upon social communication skills and quality of life (QoL) (Uitti, 2012). There are four cardinal features (system complex) of PD often grouped under the acronym TRAP: Tremor at rest, Rigidity, Akinesia (or bradykinesia) and Postural instability. In addition, flexed posture and freezing (motor blocks) have been included among classic features of PD (Jankovic, 2008). Equally disabling is the bulbar dysfunction manifested by hypokinetic dysarthria, hypophonia, dysphagia and sialorrhoea; symptoms that are thought to be related to orofacial–laryngeal bradykinesia and rigidity that are frequently observed in people with PD (Martino et al., 2016).

The speech characteristics associated with hypokinetic dysarthria reflect the general pattern of hypokinetic motor disorder characterised by a marked reduction in amplitude of voluntary movements, slowness of movement, movement initiation and rigidity (Murdoch, 2010). Perceptual speech characteristics of hypokinetic dysarthria include mono pitch, mono loudness and reduced stress, all of which represent alterations in the prosodic aspects of speech (Walsh et al., 2001; Allen et al., 2012; Pell et al., 2006).

Most people with PD (70% to 75%) will have such speech difficulties affecting their QoL by restricting the ability and readiness of the person to partake in conversation (Di Benedetto et al., 2009; Skodda et al., 2011). More severe motor symptoms and non-motor symptoms (NMS), which include anxiety and depression, almost inevitably emerge with disease progression (Chaudhuri et al., 2006). NMS tend to dominate the clinical presentation of PD in the later stages of its progression contributing to increased severity of disability and impact on QoL (Buetow et al., 2013; Chaudhuri et al., 2006; Santos-García & de la Fuente-Fernández, 2013). NMS frequently remain unreported unless specifically investigated, with the relative contribution of motor and non-motor symptoms to QoL and wellbeing remaining unclear (Hinnell, Hurt, Landau, Brown, & Samuel, 2012).

Pharmacological treatment to relieve the motor symptoms and improve physical functioning are largely designed to replenish decreased levels of dopamine in the brain (Buetow et al., 2013). However, loss of dopamine alone cannot explain many of the disabling, NMS of PD such as cognitive impairment and low mood (Buetow et al., 2013; Martinez-Martin et al., 2011).

People with PD experience clinically significant anxiety which, although sometimes presenting in isolation, frequently coexist with depression. A study of 1351 people with PD without dementia found that the most frequently observed neuropsychiatric symptoms were depression (70%), anxiety (69%) and apathy (48%), with 87% of subjects having at least one neuropsychiatric symptom (Kulisevsky et al., 2008). A systematic meta-analysis of 36 papers found the prevalence of clinically depressive symptoms to be 35% for the PD population (Reijnders, Ehrt, Weber, Aarsland, & Leentjens, 2008). Prevalence of anxiety and depression “exceeds both the prevalence in the general population and in individuals with chronic medical conditions (Stefanova et al., 2013). Panic disorder, generalised anxiety disorder and

social phobia were the most common anxiety disorders reported”, with females nearly three times more susceptible to anxiety than males with PD (Stefanova et al., 2013).

Motor and cognitive symptoms are diverse in people with PD and it is not clear which have greatest impact on ADLs (Cahn et al., 1998). Mild cognitive impairment (MCI) is now recognised to be a relatively common and heterogeneous disorder in PD, with certain subtypes predicting progression to PD dementia (Yarnall, Rochester, & Burn, 2013). Dementia is a frequent and distressing complication of PD with a cumulative incidence approaching 80% in community-based studies (Hely et al., 2008). People with PD become more dependent upon caregivers as motor and cognitive disabilities increasingly interfere with their ability to carry out activities of daily living (ADLs). Ascertaining subtypes and predicting MCI progression was the aim of the Movement Disorder Society (MDS) who commissioned a task force to evaluate the literature and propose criteria for the diagnosis of MCI in PD (PD-MCI) (Appendix 2). The MDS developed specific diagnostic criteria based on a raft of assessments: the Montreal Cognitive Assessment (MoCA); Scales for Outcomes of Parkinson’s disease Cognition (SCOPA-COG); PD Cognitive Rating Scale (CRS PD); Mattis Dementia Rating Scale (MDRS) (Yarnall, Rochester, & Burn, 2013).

The primary objectives of this study were to determine if self-reported measures of symptom severity, QoL, wellbeing and voice quality are internally reliable, acceptable and feasible, reliable across participant, sensitive to the effects of PD and show stability over time in a clinical sample of people with PD. The agreement between the participant and their partner’s perception of their voice quality was also determined. Motor and non-motor effects on general function (activities of daily living ADLs) were measured using the MDS-UPDRS and the association between participants’ cognitive status and the self-report measures was determined to assess whether ‘cognitive risk’ precludes the use of the self-report measure.

A review of the literature informed the selection of measures that were investigated in

this study. Alongside consideration given to brevity and ease of administration, measures were chosen that have satisfactory published reliability and validity data and sensitivity to the effects of PD (Callow, 2013; Portone, Hapner, McGregor, Otto, & Johns, 2007; Schindler et al., 2010; Verdonck-de Leeuw et al., 2008; Crawford, Whitnall, Robertson, & Evans, 2012; Martinez-Martin et al., 2015). Qualitative data regarding the participants' perceptions of the measures and acceptability of the process was obtained using semi structured interviews and analysed using content analysis (Thomas, 2006). Ethics approval was granted by the Health and Disability Ethics Committees (ref: 15/NTA/80, Appendix 3).

### **3.3 Method**

#### **3.3.1 Participants**

People with idiopathic PD ( $N = 45$ ) diagnosed by a neurologist and receiving usual PD clinical care were identified from a District Health Board (DHB) database. Participant information sheets with consent forms were mailed to potential volunteers (Appendix 4) and their partners (Appendix 5);  $n = 33$  (73% response rate) were signed and returned. Three additional participants were recruited via a Parkinson's Society newsletter giving a total of 36 participants with PD ( $n = 27$  males,  $n = 9$  female). Participants were aged 58-87 years ( $M = 73.8$   $SD = 6.63$ ). Of the 36 participants 19 (53%) were members of an established community Parkinson's disease voice and choral singing group.

#### **3.3.2 Procedure**

Participants were contacted to arrange a convenient and timely home visit to enable completion of the questionnaires. Home visits occurred on two occasions (test - retest) with an interval of one month between. Parkinson's symptoms can vary significantly according to medication levels (Fritsch et al., 2012), so to safeguard against On – Off motor fluctuations and inconsistent data collection, efforts were made to schedule the home visits so that they occurred at the same time of day and no more than one hour after the participant had last

taken their Parkinson's medication. The researcher explained each questionnaire to the participant and how it would be done and in which order.

The DASS-21, VHI-10/VHI-10P, DPQ-8 and MDS-UPDRS were completed with the researcher present and the ACE-III was administered by the researcher. It became apparent after the first two home visits that the participants needed time to rest after completing the cognition, wellbeing and voice questionnaires and required more time to consider their responses for the MDS-UPDRS. After the first two home visits, therefore, all remaining participants completed the DASS-21, VHI-10/VHI-10P, DPQ-8 and ACE-III with the researcher and completed the MDS-UPDRS questionnaire later the same day and returned it to the researcher in a pre-paid addressed envelope. This approach enabled the participants to consider their responses to the detailed MDS-UPDRS questionnaire in a timely manner avoiding stress and fatigue and without feeling pressured.

The 36 participants were randomly allocated into four groups of eight. A random test order was determined for each group of eight by the researcher using a random number generator for all the assessments except the MDS-UPDRS which was self-administered. Each group of eight participants had a different random test order for the two test occasions. Across the four groups and two test occasions the randomised test order was counterbalanced to prevent a test order effect (Lucas, 1992).

A semi structured interview lasting about 30 minutes on the second visit explored the participant's experience of the process and perception of the suitability and relevance of the outcome measures. Interviews were recorded on a Yamaha™ PR7 24 bit 96 kHz digital recorder. The same probe questions were asked to each person and were encouraged to describe their experience. Interviews were recorded and transcribed. A general inductive approach (Thomas, 2006) was used to capture and condense emergent themes. The interview developed six themes: Health, Living with PD, Voice, Communication, Study Process and Study

Experience. Transcribed responses were coded and analysed using QSR NVivo 10 (Johnston, 2006).

### **3.3.3 Measures**

On each test occasion, and in random order, the participant completed three questionnaires (Table 3). DASS-21 (Lovibond & Lovibond, 1995), PDQ-8 (Jenkinson, Fitzpatrick, Peto, Greenhall, & Hyman, 1997) and VHI-10 (Rosen, Lee, Osborne, Zullo, & Murry, 2004). The participant's partner ( $N = 32$ , 4 participants did not have a partner) completed the partner's version of the VHI-10, the VHI-10P (Zraick et al., 2007). The VHI-10P has the same ten questions as the VHI-10; adjusted to read in the third person enabling perceptual rating of the participant's voice by the partner. The VHI-10 is a short form version of the VHI and was validated by Rosen et al. (2004). The 10 most robust VHI items were selected using item analysis and clinical consensus by comparing the individual VHI item responses of 100 patients with dysphonia (study group) and 159 non-dysphonic individuals (control group). Comparison of the VHI item responses between the study group and the control were performed to determine the items exhibiting the largest mean differences between the two groups. Clinical consensus by a laryngologist, two speech-language pathologist voice specialists and a singing voice specialist was then used to select the 10 most "clinically relevant" VHI items from the items with large group differences, for both the assessment of initial voice handicap and the measurement of responsiveness to treatment (Rosen et al., 2004). Irrespective of diagnosis, Rosen et al. found there was a high correlation between the VHI and VHI-10. Some reports suggested that the VHI-10 was a more robust assessment than the VHI (Morzaria & Damrose, 2012).

When the participants had completed the DASS-21, PDQ-8 and VHI-10 and ACE-III questionnaires they were given the MDS-UPDRS and information on how to complete it. The participants completed the MDS-UPDRS Part I: Non-Motor Aspects of Experiences of Daily

Living (nM-EDL) and Part II: Motor Aspects of Experiences of Daily Living (M-EDL) (Goetz et al., 2008), in their own time later the same day and, when completed, returned it to the researcher by pre-paid post. Participants were asked to complete this questionnaire no more than one hour after taking their Parkinson's medication.

The cognitive screening measure ACE-III (Hsieh, Schubert, Hoon, Mioshi, & Hodges, 2013) has a total scale from 0-100 and assesses five cognitive domains: Attention (18 points), Memory (26 points), Verbal Fluency (14 points), Language (26 points) and Visual-spatial (16 points) and was administered by the researcher in accordance with the ACE-III administration manual in a different test order according to how the tests were randomly assigned. Cut-off scores (88 and 82 out of 100) are reported to have good sensitivity and specificity for identifying dementia (Hodges & Larner, 2017).

The two cut-off values for the ACE-III composite score (88 and 82) are reported to be of optimal utility for identifying cognitive risk, depending on the target population. The ACE-III has high internal reliability, measured by Cronbach's  $\alpha$  coefficient  $\alpha = 0.88$  (Velayudhan et al., 2014), good construct validity, and high sensitivity and specificity at cut-offs of 88 (sensitivity = 1.0; specificity = 0.96) and 82 (sensitivity = 0.93; specificity = 1.0) for cognitive impairment, based results for patients with dementia (Hsieh et al., 2013; Elamin, Holloway, Khan, and Bak, 2015; Velayudhan et al., 2014). Using the lower cut-off of 88, the ACE-III has a higher specificity and predictive value than other similar assessments (Mathuranath et al., 2000).

**Table 3**  
*Summary of Questionnaires and Cognition Assessment*

<b>Measure</b>	<b>Questionnaire</b>	<b>Domains, Elements &amp; Questions</b>
Voice	VHI-10 Voice Handicap Index	Total score 10 Questions
	VHI-10P Voice Handicap Index (Partner)	Total score 10 Questions
Quality of life	PDQ-8 Parkinson's disease quality of life scale	Total score 8 Questions
Depression Anxiety Stress	DASS-21- Depression Anxiety Stress Scales	1. Depression 2. Anxiety 3. Stress
Symptom Severity	UPDRS: Part 1 Non-Motor Aspects of Experiences of Daily Living (nM-EDL) <i>sleep, daytime sleepiness, pain and other sensation, urinary &amp; constipation problems, lightheadedness on standing and fatigue</i>	Total Score + 7 questions
	UPDRS: Part 2 Motor Aspects of Experiences of Daily Living (M-EDL) <i>speech, swallow, handwriting, dressing, hygiene, falling, salivating, turning in bed, walking, transfers</i>	Total Score + 12 Questions
Cognitive	ACE-III - (NZed A&B) Addenbrookes Cognitive Examination <i>memory/organisation/spatial awareness</i>	1. Attention 2. Memory 3. Fluency 4. Language 5. Visuospatial
Participant interview (Post treatment only)	To determine participant view on the process, the experience of their participation in the research.	23 questions

### 3.4 Results

All 36 participants completed both test occasions. Data were analysed using IBM SPSS statistics® (version 23). Scores from the six measures were compared over two test occasions – test and retest, using the Wilcoxon Signed Rank Test for matched samples.

Cronbach’s alpha ( $\alpha$ ) (Cronbach, 1951) was calculated to assess internal reliability. In addition to the test / re-test paired comparisons, associations between variables were assessed non-parametrically using Spearman correlations.

#### 3.4.1 Internal Reliability

Means and standard deviations (SDs) for each of the measures and internal reliability - Cronbach’s  $\alpha$  (Cronbach, 1951) are displayed in Table 4. Internal reliability ranged from Excellent to Good for all the measures. There were exceptions for the ACE-III and elements of the DASS-21, but these still had acceptable internal reliability.

**Table 4**  
*Means of Total and Sub-Total Scores of Test and Re-Test with Cronbach’s Alpha*

Measure	Score/Sub Score	test		$\alpha$	retest		$\alpha$
		Mean	(SD)		Mean	(SD)	
UPDRS	Part 1: Non Motor	9.92	(4.05)	.85	6.69	(4.59)	.88
	Part 2: Motor	17.39	(8.40)	.89	16.75	(8.79)	.91
ACE-III	Total	80.08	(13.73)	.93	83.33	(12.30)	.94
	Attention	16.22	(2.42)	.71	16.14	(2.61)	.70
	Memory	17.89	(5.11)	.89	19.86	(4.60)	.89
	Fluency	8.61	(3.24)	.90	8.97	(3.15)	.89
	Language	24.08	(2.21)	.75	24.56	(2.02)	.77
	Visuospatial	13.78	(2.55)	.90	13.75	(2.50)	.90
VHI-10		15.67	(8.37)	.91	13.89	(7.83)	.89
VHI-10P		16.94	(7.03)	.92	16.03	(8.56)	.90
DASS-21	Total	3.87	(0.57)	.84	4.08	(0.42)	.84
	Depression	3.22	(2.87)	.87	3.61	(3.58)	.88
	Anxiety	4.11	(2.65)	.77	4.42	(3.07)	.79
	Stress	4.28	(3.26)	.84	4.22	(3.01)	.83
PDQ-8		16.25	(5.56)	.89	14.95	(5.15)	.89

Notes. Cronbach’s  $\alpha$  -> .9 – Excellent, > .8 – Good, > .7 – Acceptable (Gliem & Gliem, 2003).  
ns = not significant

### 3.4.2 Effects of Cognition

Statistical analysis of the ACE-III data using Mann-Whitney U tests was undertaken to compare the 'healthy' cognition group scores (scores 89 to 100) to the 'cognitive risk' group. Cognitive risk was based on two criteria described by Hsieh and colleagues (Hsieh et al., 2013) which have slightly different sensitivity and specificity (88 and lower scores; sensitivity = 1.0; specificity = 0.96 *versus* 82 and lower scores; sensitivity = 0.93; specificity = 1.0). Across the four self-report measures there were no statistically significant group differences, when the 'healthy' cognition ( $n = 10$ ) group was compared to the 'cognitive risk' group for either the 88 ACE-III cutoff score ( $n = 6$ ) or the 82 cutoff score ( $n = 20$ ).

### 3.4.3 Intra-Subject (Test-Retest) Reliability

Intra-subject reliability analysed using Wilcoxon pair wise comparisons (Table 5) showed significant findings for the ACE-III total and memory scores and for the PDQ-8. The ACE-III total score was significantly higher at retest ( $Mdn = 84.00$ ,  $IQR 18$ ) compared to the baseline assessment ( $Mdn = 82.00$ ,  $IQR 16$ ). Closer inspection of the significant changes in scores between test and retest by domain for the ACE-III showed this difference was related to memory items. The ACE-III memory domain score was significantly higher at retest ( $Mdn = 19.00$ ,  $IQR 8$ ) compared to baseline ( $Mdn = 18.5$ ,  $IQR 6$ ).

The PDQ-8 total score was also significantly lower (i.e., better) at retest ( $Mdn = 14.00$ ,  $IQR 5$ ) compared to baseline ( $Mdn = 16.00$ ,  $IQR 6$ ) Effect size ( $r$ ) calculated from Cohen's  $d$  values fell within the small to medium range.

**Table 5***Intra Subject Reliability and Effect Sizes (r) Based on Wilcoxon Pair Wise Comparisons*

Measure	Sub/Total	test		retest		Z	p	r
		Median (IQR)		Median (IQR)				
UPDRS	Part 1	9.50	(6)	10.00	(7)	-1.147	.600	0.191
	Part 2	17.50	(14)	17.00	(10)	-.881	.378	0.146
ACE-III	Total	82.00	(16)	84.00	(18)	-2.735	<b>.006</b>	<b>0.456</b>
	Attention	18.00	(4)	17.50	(5)	-.082	.935	0.014
	Memory	18.50	(6)	19.00	(8)	-3.599	<b>&lt;.001</b>	<b>0.599</b>
	Fluency	8.50	(5)	9.00	(6)	-1.168	.243	0.195
	Language	25.00	(3)	25.00	(2)	-1.310	.190	0.218
	Visuospatial	14.00	(4)	14.00	(4)	-.155	.877	0.026
VHI-10	Total	18.00	(13)	14.00	(10)	-2.102	.036	0.350
VHI-10P	Total	17.50	(9)	19.00	(14)	-.442	.659	0.074
DAS-21	Depression	2.00	(5)	3.50	(4)	-.552	.581	0.092
	Anxiety	4.00	(4)	4.00	(4)	-.253	.800	0.042
	Stress	3.50	(6)	4.00	(6)	-.012	.991	0.002
PDQ-8	Total	16.00	(6)	14.00	(5)	-2.328	<b>.020</b>	<b>0.388</b>

Note. Statistically significant findings ( $p < .05$ ) in **bold** (not corrected for multiple comparisons)

Responses to individual questions were also compared using Wilcoxon tests (Table 6).

The responses to VHI-10 question 2: *I run out of air when I talk* were higher at test than retest. Responses to VHI-10 question 4: *The sound of my voice varies throughout the day* were also higher at test than retest. For the VHI-10 a lower score is better. If a Bonferroni correction is made for multiple comparisons (10 questions, hence  $p < .005$  is considered significant), then only the change in responses to VHI-10 question 2 are statistically significant.

Responses to DASS-21 Stress question 18: *I felt that I was rather touchy* were lower (i.e., better) at test than retest. For the DASS-21 a higher score is worse. Because there are 21 items in the DASS-21, this difference is not significant after adjusting the critical  $p$  value for multiple comparisons ( $p = .05/21 = .00238$ ).

PDQ-8 question 6: *Felt unable to communicate with people properly*, responses were higher (i.e., worse) at baseline than retest. The mean for test of PDQ-8 question 7: *Had painful muscle cramps or spasms* was higher than retest. For the PDQ-8 a lower score is

better. Neither change was significant after correcting for multiple comparisons ( $p = <.05/8 = .00625$ )

**Table 6**  
*Medians (IQR) of Significant Individual Question Scores at Test and Re-Tests*

Measures		test Median (IQR)	retest Median (IQR)	<i>p</i>
DASS-21 Stress	DASS q18 <i>I felt that I was rather touchy</i>	0.47 (1)	0.72 (1)	.029
PDQ-8	PDQ8 q6 <i>Felt unable to communicate with people properly</i>	2.39 (2)	2.00 (2)	.041
	PDQ8 q7 <i>Had painful muscle cramps or spasms</i>	2.58 (2)	2.06 (2)	.007
VHI-10	VHI10 q2 <i>I run out of air when I talk</i>	1.50 (2)	0.81 (2)	<b>&lt;.001</b>
	VHI10 q4 <i>The sound of my voice varies throughout the day</i>	2.36 (1)	0.92 (2)	.031

Note. *p* values are from using Wilcoxon pair wise comparisons (bold indicates statistical significance after adjustment for multiple comparisons)

### 3.4.4 Associations Between Variables - Correlations with Demographic Factors and Between Measures

Nonparametric Spearman's rank correlation ( $r_s$ ) coefficient were used to measure the strength and direction of association between the ACE-III and self-report measures and demographic information (participant's age and years with PD). Data showing positive correlations between demographic and the measures are shown in Table 7. There was, as expected, a significant positive correlation between the participant's age and years with PD. The main association with age and years with PD is seen in the total ACE-III cognition score and domains of memory, fluency, language and visuospatial. Wellbeing, quality of life and perception of the impact of voice difficulties were not correlated with participant age or the number of years with PD.

**Table 7**

*Spearman's Correlations - Statistical Results (<sup>r</sup>s, *p* values) for Associations Between Demographics and Measures*

	Age	Yrs PD	ACE-III					DASS-21			UPDRS				
			Total	Attention	Memory	Fluency	Language	Visuospatial	Dep	Anxiety	Stress	PDQ-8	VHI-10	VHI-10P	Part 1
Age		.674	-.561	-.425	-.581	-.542	-.629								.343
		<b>&lt;.001</b>	<b>&lt;.001</b>	ns	<b>&lt;.001</b>	<b>&lt;.001</b>	<b>&lt;.001</b>	<b>&lt;.001</b>	ns	ns	ns	ns	ns	ns	<b>.040</b>
Yrs PD			-.527	-.386	-.561	-.535	-.509								
			<b>&lt;.001</b>	ns	<b>&lt;.020</b>	<b>&lt;.001</b>	<b>&lt;.001</b>	<b>&lt;.002</b>	ns	ns	ns	ns	ns	ns	ns

Note. Statistically significant findings in **bold** base on Bonferroni adjusted *p* value of *p*<.001.  
ns = not significant

There was a significant correlation (Table 8) between the DASS-21 element of Stress with Part 1: Non-Motor Aspects of Experiences of Daily Living (nM-EDL), Part 2: Motor Aspects of Experiences of Daily Living (M-EDL) of the MDS UPDRS and VHI-10. There was a significant correlation between the DASS-21 element of Depression and the PDQ-8, VHI-10, VHI-10P; UPDRS Part 1 and Part 2. DASS-21 anxiety element correlated with Part I (nM-EDL) only.

There was a significant positive correlation between the UPDRS Part1 and the PDQ-8 and VHI-10 and a significant positive correlation between the UPDRS Part2 and the PDQ-8, VHI-10 and VHI-10P.

**Table 8***Spearman's Correlation's - Statistical Results (p values) Associations between Measures*

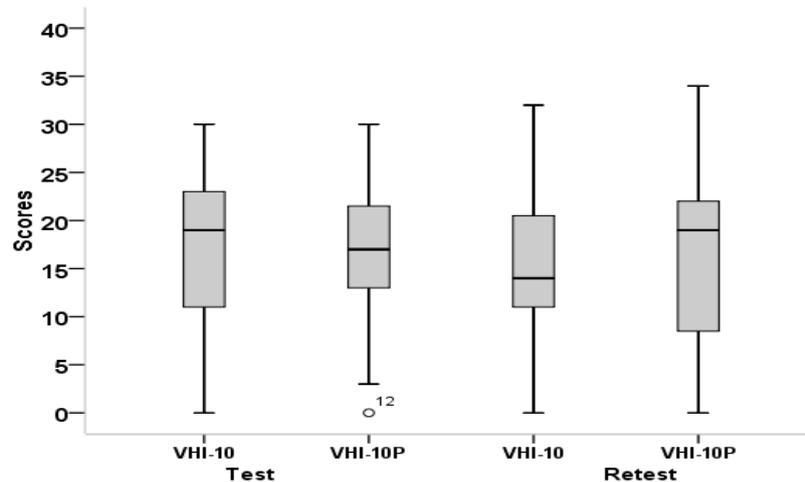
	DASS-21				VHI-10	VHI-10P	UPDRS	
	Dep	Anx	Str	PDQ-8			Part 1	Part 2
ACE Total	ns	ns	ns	ns	-.333 <.047	ns	ns	ns
ACE Attention	ns	ns	ns	ns	ns	ns	ns	ns
ACE Memory	ns	ns	ns	-.374 <.025	-.457 <.005	ns	ns	-.369 <.027
ACE Fluency	ns	ns	ns	ns	ns	ns	ns	ns
ACE Language	ns	ns	ns	ns	ns	ns	ns	ns
ACE Visuospatial	ns	ns	ns	ns	-.346 <.039	ns	ns	-.331 <.049
DASS Depression	ns	ns	.473 <.004	.600 <.001	.540 <.001	.414 <.018	.563 <.001	.555 <.001
DASS Anxiety	ns	ns	.579 <.001	ns	ns	ns	.387 <.020	ns
DASS Stress	ns	ns	ns	ns	.417 <.011	ns	.639 <.001	.565 <.001
PDQ-8	ns	ns	ns	ns	.718 <.001	.556 <.001	.504 <.002	.638 <.001
VHI-10	ns	ns	ns	ns	ns	.589 <.001	.397 <.016	.568 <.001
VHI-10P	ns	ns	ns	ns	ns	ns	ns	.429 <.014
UPDRS Part1	ns	ns	ns	ns	ns	ns	ns	.659 <.001
UPDRS Part2	ns	ns	ns	ns	ns	ns	ns	ns

Note. Statistically significant findings in **bold**. ns = not significant

### 3.4.5 VHI-10 Participant vs Partner

The relationship between variables VHI-10 and VHI-10P are seen in a side by side box plot (Figure 1). The partner's mean scores VHI-10P test ( $M = 16.81$ ,  $SE = 1.28$ ) and retest ( $M = 16.03$ ,  $SE = 1.54$ ) are consistent on both occasions. Participants viewed themselves as moderately handicapped and that their partners were generally in close agreement. A repeated measures ANOVA with time (test, retest) and person (participant, partner) as within-subject variables showed no difference in ratings between the participant and their partner,  $F(1,30) = .164$ ,  $p = .068$ . There was a significant main effect of time on VHI-10 ratings, with lower ratings at retest,  $F(1,30) = 169.71$ ,  $p = .001$ .

The VHI-10P correlated ( $p = <.001$ ,  $r_s=.589$ ) with the VHI-10 agreeing with published data, which also showed a statistically significant correlation ( $p<0.01$ ) for the VHI-10 participant and partner versions (Zraick et al., 2007).



*Figure 1.* Box plots showing scores of Participant - VHI-10 and Partners - VHI-10P questionnaire at test and retest.

### 3.4.6 Qualitative Interview

Semi-structured interviews were conducted in the participants' home to explore their subjective experience of the data capture process and their perception of the suitability and relevance of the outcome measures used. Probe questions (Appendix 6) were used to generate discussion around participants' experience of the study process, health, living with PD and communication. Interviews lasted for about 30 minutes with care taken to ensure participants were comfortable. The participants regarded environmental familiarity and home comfort as very important to the success of both the questionnaire and interview process.

Six topics derived from the interview are set out along with the codes and supported with samples of verbatim quotes from the participants.

**Health:** 69% of the participants reported that their health had been stable over that period.

31% reported changes to their health had been a cause for concern with health professionals adjusting the dosage or the timings of their anti PD medications.

**1130** *Well it's been very good. As long as I take my pills and obey all the rules. My diets been good and um my general health overall has been very good.*

**1010** *I don't think doctors have given me any advice specifically about voice.*

**1100** *My GP has help with medication timings and things like that.*

**Living with PD:** Participants described how the PD condition affects their lives with an emphasis on changes to mobility and cognition.

**1170** *Well I've noticed that cognitively I am not a patch on what I used to be. Especially when I'm tired or when the medications is running out.*

**1130** *Life's in the slow lane. You just have to adjust to doing things a little bit differently. Thinking ahead as you know your reactions are marginally slower.*

**Voice:** When describing the effect that PD has had on voice it was apparent that there was better than expected insight into the changes in voice and what might be required to improve voice.

**1030** *Depends on the circumstances I use the voice. I try to create situations I can use my voice. I go to exercise. I like to go to the shopping mall and talk to the staff. It gives me a short simple task. Raise my voice in a noisy environment. I find a lot of benefit in that.*

**1350** *I'm concerned that I'm not being heard. I try to speak out more*

**Communication:** Many of the participants described having difficulty with communicating with others and was perceived by them as a significant problem.

**1070** *Yes. it's embarrassing for other people as well. I feel it is. Because they can't hear my voice very well.*

**1170** *Unless I can dominate the conversation and therefore I got the subject always on hand and I can guess what people are saying and lip read, but if it's talking around the group I just stand there.*

### **3.4.7 Pilot Process and Experience**

Being able to complete the questionnaires in the participants' home was perceived as positive. It addressed the difficulties that many of the participants have with mobility, accessing the hospital and "daunting" and unfriendly clinical atmosphere. Participants commented on the natural, relaxed experience and comfort of their home environment. Participants were happy with the timing of the home sessions in terms of negotiated convenience and said 45 minutes was manageable and not tiring. Participants described the process and the measures as both acceptable and relevant to PD and were very happy to take part in the study.

**1180** *Oh this is better than going into clinic; a lot less daunting. Sitting in the waiting room for an hour trouble parking etc. This is more convenient and less tiring.*

**1310** *It was certainly good doing it home. Much more relaxing and I think gives a better result. Yes, they (questionnaires) were very acceptable and appropriate for PD and it was better to do them with you so that I could communicate with you.*

**Table 9**

*Topics and Codes Developed from the Qualitative Interviews with the Number of Participants Contributing to the Codes and the Frequency with which they were Referenced by participants*

<b>Topics</b>	<b>Codes</b>	<b>Participants</b>	<b>References</b>
<b>Health</b>	Health Professionals	25	26
	Changes to Medications	17	20
	Changes to health	25	30
	Influence change	26	29
<b>Living with PD</b>	Mobility	26	38
	Sleep	22	22
	Wellbeing	15	19
	Mood	23	33
<b>Voice</b>	Voice now	23	29
	Changes to voice	22	37
	Influence change	2	4
<b>Communication</b>	With others	21	24
	Influence change	2	4
<b>Study Process</b>	Time of session	24	61
	Time to complete	24	59
	Acceptability	24	43
	Relevance	19	37
	Location	26	36
	Improvement	6	6
	Surprises	23	24
<b>Study Experience</b>	Fatigue	17	34
	Motivation	23	23
	Learning hopes	8	8
	Comfort	23	29

### **3.5 Discussion**

An interval of one month was chosen between test and retest points for this study based on pragmatic considerations such as the time needed to complete the study and evidence that a minimum period of one month between test administrations was an acceptable time gap before retesting for the DASS-21 (Lovibond & Lovibond, 1995), PDQ-8 (Tan et al., 2004) and VHI-10 (Núñez-Batalla et al., 2007). Unfortunately, this one month gap was not appropriate for the ACE-III.

For the ACE-III memory domain scores were higher on the second test occasion, which indicates that the participants may have remembered items in the memory domain

assessment. Future studies intending to assess cognition on multiple occasions with less than six months between test administrations could reduce the memory domain issue by using alternate test forms. The ACE-III has alternate test forms, which are based on the different regions within the country. The relevant region was selected for this study, but in hindsight we could have used a different region for the retest. Future studies wanting to use the ACE-III as an outcome measure should use an alternate test forms to evaluate test-retest reliability over time, prior to using the ACE-III as an outcome measure.

There were no statistically significant differences in the self-report measures between participants with a 'healthy' ACE-III score and those of the 'cognitive risk' group suggesting that cognition scores need not be an exclusion criterion for future studies.

As expected, there were significant positive correlations between the participant's age and years with PD and cognition (Wood et al 2016; Dalrymple-Alford et al 2011). These data suggests that cognitive function is related to age and reflects the expected decline that is reported in the literature (Jankovic, 2008; Fritsch et al., 2012; Hoehn & Yahr, 1967). The data also suggests that, for these participants, the PD symptoms are medically well managed. Wellbeing, quality of life and perception of the impact of voice difficulties were not affected by the age of the participants or the number of years that they have had PD.

All measures had good internal reliability as estimated by Cronbach's  $\alpha$ . This is consistent with the published results for the ACE-III (Velayudhan et al., 2014; Hsiesh et al., 2013), DASS-21 (Henry & Crawford, 2005; Lovibond & Lovibond, 1995), PDQ-8 (Jenkinson & Fitzpatrick, 2006; Tan et al., 2004), VHI-10 (Rosen et al., 2004; Verdonck-de Leeuw et al., 2008) and UPDRS Part 1 and Part 2 (Martinez-Martin et al., 2012; Goetz et al., 2008). There were exceptions in this study, for example, the internal reliability results for the Attention and Language domains scores of the ACE-III and Anxiety element score in the DASS-21 were below optimal, but were within the acceptable range. (Cronbach's  $\alpha > .7$ ; Gliem & Gliem,

2003). Cronbach's  $\alpha$  for the VHI-10 and the VHI-10P were the same, which reflects the published data showing that both have an excellent internal reliability.

Generally, stability was observed over the test-retest period for all the self-rating measures. Test-retest differences could be explained by the variability in PD symptoms over time (Moore & Barker, 2014; Fritsch et al., 2012). PD symptom severity can vary considerably from day to day (Benamer et al., 2000). Disease severity, potential for medication timing errors, dehydration and other personal and environmental factors can impact significantly on participant wellbeing and perception of function and could explain the disparity in test and re-test data for some of the measures.

There were interesting and significant correlations between the DASS-21 Stress and UPDRS Part I and Part II and significant correlations between DASS-21 Depression and the PDQ-8 and UPDRS Part1. These findings reflect the published literature where anxiety related stress and associated depression are widely reported as significant non-motor neuropsychiatric symptoms of PD (Chaudhuri et al., 2006). UPDRS Part I, UPDRS Part1 and Part2 correlated with each other and with the PDQ-8, VHI-10 and VHI-10P.

There is a paucity of literature reporting partner agreement on the effects of dysphonia on wellbeing and quality of life. The VHI-10P was a pilot instrument developed from the VHI by Zraick et al. (2007). Zraick et al.'s study examined whether people with a range of voice disorders agreed with their partners about the degree of perceived voice handicap and showed that VHI participant scores and VHI-P partner scores were positively correlated, indicating agreement on the handicapping effect of dysphonia (Zraick et al., 2007). The results of the current study are consistent with previous studies (Zraick et al., 2007; Zraick & Risner, 2008) examining patient-partner agreement. The VHI-10P provides insight into the partner's perception of changes in voice (improvement or worsening). Zraick et al. (2006) consider proxy ratings to be a useful collaborative source of patient's self-perception

providing a helpful comparison with instrumental assessments of voice and additional information about the handicapping effect of dysphonia.

Qualitative data from participant interviews indicated the self-reported health of the participants remained generally stable over the month between the test occasions with the exception of three participants who were concerned about serious medical changes outside that of PD. Noticeable participant concerns centred on issues of mobility and communication, with speech volume the focal concern. Awareness of voice problems and ways to help improve voice however, were not translated into a perceived need for therapy for some of the participants who were not members of the community PD voice and choral singing group. A possible explanation for this might be explained by findings of a large scale study by Kulisevsky et al. (2008), which found apathy (54%) and anxiety (49%) as common symptoms of non-demented PD. Anxiety and apathy together with daily variability of symptom severity are cited as reasons for poor participation in group therapy (Allen et al., 2012; Johnston & Chu, 2010).

Participants referred positively to the timing and duration of the two test occasions confirming the importance of brevity and ease of administration. Being able to negotiate the time of the test occasion as well as being seen in their homes rather than in clinic were regarded as very positive and helped reduce the potential negative effects of fatigue and difficulties related to medication timings.

### **3.6 Limitations**

A test-retest design to establish reliability and stability of measures by observing correlations between two test occasions is an obvious method to test people twice and compare their scores, but there is also an obvious problem (Pring, 2005). Deciding on the interval between the two test occasions is important; too short and the reliability may be

overestimated because the participants remember the elements of the measures and too long and the participants' condition may change and reliability may then be underestimated.

The test re-test interval of one month in this study was insufficient for the ACE-III. The ACE-III memory domain scores were significantly better on the second test occasion as participants were able to remember test items. This assessment should not be repeated within a four week interval unless an alternate test form is used. Although there are no current data to base this on, the suggested minimum time for retesting using the ACE-III is 6 months with 12 months advised (Neuroscience Research Australia, NeuRA, email - Prof John Hodges October 12, 2015)

### **3.7 Conclusions**

Internal reliability data of the measures was good and in line with published findings. Test-retest differences were minimal for the self-report measures.

There were no statistically significant differences in self-report measure outcomes between participants of with a 'healthy' ACE-III cognitive score and those of the cognitive risk group, which suggests that cognition scores need not be a parameter of exclusion criteria for future studies.

There was a significant correlation between participant's age and years with PD and cognition. Wellbeing, quality of life and perception of the impact of voice difficulties were not affected by their age or the number of years that they have had PD and also suggests that, for these participants, the PD symptoms were medically well managed.

Participants were happy with the natural, relaxed experience and comfort of completing the questionnaires in their home and were happy with the timing and convenience, meaning the process was manageable and not tiring. Participants referred positively to the timing and duration of the two test occasions confirming the importance of

brevity and ease of administration. Participants also described the process and the measures to be acceptable and relevant to PD.

## Chapter 4: Group Singing

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This chapter investigates how the volume and quality of voice, QoL and wellbeing might improve in people with PD using a creative group singing approach to therapeutic and ongoing self-management. Against a backdrop of the International Classification of Functioning, Disability and Health's definition of a person's function using the three levels – impairment, activity and participation (ICF; WHO, 2001), the literature review in this chapter examines the benefits of group singing on voice, respiration and wellbeing for healthy participants, people with PD and other clinical populations.

PD is a chronic neurological condition of insidious onset involving gradual degeneration. Previous chapters have described how this chronic condition (PD) has a significant multifactorial impact on motor (mobility, voice, activities of daily living - ADLs) and the NMS effects on psychological and psychosocial wellbeing. This chapter sets out to explain how group singing might have an ability to ameliorate the debilitating effects of the motor and NMS in people with PD described in Chapter two.

### **4.1 Group Singing and the Collaborative Community**

An editorial by Haslam, Jetten, Postmes and Haslam (2008) on advancing the social identity approach (Social Identity Theory) to health and wellbeing state that, as social beings, the most important expression of human sociality is that we live, and have evolved to live, in social groups. This basic fact, they say, has shaped not only what we do, but also how our minds have evolved to enable us to do it.

The health of body and mind is conditioned by social factors that affect our social identity. Interest is growing in the way that belonging to a group, and the social identity derived from belonging to a group, affects health and wellbeing (Jetten et al., 2017). Group membership can provide meaning, support, and positive sense of social identity; health is positively

impacted, constituting a “social cure” (Jetten et al., 2017). This research suggests that the processes that underpin the Choir group’s willingness to attend each week are associated with the ongoing developing social interaction of a social identity defined in terms of membership to the group and not defined by their impairment.

Bonilha, Onofre, Vieira, Prado and Martinez (2009) posited the notion that producing musical sounds with one’s voice - singing - is so basic to human beings that its origins are lost in antiquity and predates spoken language. Singing in community groups, choirs and choral societies is one of the most wide-spread forms of active musical participation in many western societies and enormous numbers of people regularly come together to sing, motivated primarily by a love of music and the expressive activity of singing itself (Clift, Nicol, Raisbeck, Whitmore, & Morrison, 2010).

Singing together is a socially acceptable and creative activity, having intrinsic value and reward for those who participate, but beyond the intrinsic value and pleasure attached to singing, is there evidence for real and measureable impact on the health and wellbeing of those participating (Clift et al., 2010)? Herein lies the inherent difficulty, as Cohen, Statham, Rosen, and Zullo (2009) state, wellbeing is a complex construct and as such is extremely difficult to measure quantitatively. That notwithstanding, the health benefits associated with singing, and the related idea that singing in groups could be used as a form of therapy for people with compromised health, has attracted increasing attention (Sandgren, 2009).

There is growing evidence that singing presents as a promising, creative and viable therapeutic tool in a variety of neurological disorders (Wan, Rüber, Hohmann, & Schlaug, 2010). A search of the literature reveals ongoing research evaluating the efficacy of group singing as a means of improving motor speech difficulties (Di Benedetto et al., 2009; Shih et al., 2012; Yinger & Lapoint, 2012; Fogg-Rogers et al., 2015; Tanner et al., 2015; Stegemoller et al., 2016; Abel et al., 2017) as well as providing evidence of the value for such activities in

relation to psychological wellbeing (Sandgren, 2009), enhancing cognitive abilities (Schellenberg & Peretz, 2008) and quality of life (Clift & Hancox, 2010).

A systematic review by Clark and Harding (2012) on the psychosocial outcome of active singing interventions provides additional evidence that active singing can create opportunities for physical, emotional, cognitive and social engagement. A recent study that examined the immediate emotional effects of how song familiarity and individual differences in music reward might impact on the relationship between group singing and emotion in people with PD found that group singing significantly increased positive affect after singing compared with no singing (Baird et al., 2018). The opportunities created by active singing were also evidenced in a Masters thesis by Matthews (2013), where it was found that group singing facilitated self-expression, emotional release and a sense of belonging. The result was a flourishing ‘collaborative community’ with a sense of purpose developed by the members who, by their own admission, were experiencing deterioration in wellbeing, confidence and social networks.

#### **4.2 Group Singing as an Intervention to Improve Wellbeing**

The World Health Organisation (WHO) refers to mental health as a state of wellbeing in which every individual realises his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to contribute to his or her community (World Health Organization, 2001). WHO proposed a model that integrates the concepts of health and functioning into the International Classification of Functioning, Disability and Health (ICF; WHO, 2001). The ICF defines a person's functioning and disability in relation to health condition and contextual factors. Using three levels: (a) “Body Functions and Structures” (impairments), which include the physiological functions of body systems or anatomical elements such as organs, limbs, and their components; (b) “Activities,” which are

the execution of specific actions; and (c) “Participation,” which encompasses involvement in life situations (World Health Organization, 2001).

Despite widespread popular interest and participation, relatively little research has investigated the extent of the supposed positive effects of choral singing on well-being, or the possible mechanisms responsible for these effects (Stewart & Lonsdale, 2016). Research in this area, thus far, has included survey studies of varying size and focus undertaken to measure the effects of choral singing on wellbeing, quality of life and physical health. One such study, a large-scale questionnaire study conducted by Clift et al. (2007), which included the WHOQOL-BREF (a short form of the World Health Organisation Quality of Life Questionnaire) was distributed to 633 choral singers in the South East and North East of England. The findings from this large scale and rigorous cross national study confirmed data from previous studies, including Grape et al. (2003), that a large majority of singers perceive singing as beneficial to their wellbeing. Analysis of the choral singing items identified a strong emphasis on improved mood, enhanced quality of life, greater happiness, less stress and emotional wellbeing.

One study on how group singing may enhance the QoL of people with PD described how connectedness reaffirmed to choir members their capacity to exercise some control over how they might interact with their environment (Buetow et al., 2013). Connectedness within a collaborative community is a very important component of group singing in which the shared experience and participation may stimulate perceptual and emotional processing and, in the context of social support, facilitate expression, increase confidence, provide a distraction and, as stated by Buetow et al. (2013), in doing so help individual participants find their voice (literally and metaphorically) by coordinating and connecting with themselves and others in and beyond the singing group.

Buetow et al.'s (2013) theory of connectedness is supported by Antonovsky's (1987) 'salutogenic' sense of coherence (SOC) model, which argues that individuals can achieve health if they have the necessary resources and strategies to cope with the demands of life (Eriksson & Lindstrom, 2005). Choral singing may contribute to health through strengthening some of these components in singers by improving social and individual resources, reducing stress and meeting spiritual needs (Livesey, Morrison, Clift, & Camic, 2012). Focusing on the concept of the person and paying attention to personality, coping strategies and self-regulation under stressful conditions should allow PD patients to receive more holistic and beneficial care (Gison, Dall'Armi, Donati, Rizza, & Giaquinto, 2014).

Nonetheless, despite widespread popular interest and participation, relatively little research has investigated the extent of the supposed positive effects of choral singing on wellbeing, or the possible mechanisms responsible for these effects (Stewart & Lonsdale, 2016). A systematic review of research concerned with choral singing and wellbeing found that investigations varied widely in terms of method, the participant samples studied, the kind of data gathered and their approach to data analysis (Clift et al., 2010).

In a study aimed at investigating the wellbeing effects of choral singing on a healthy population, Stewart and Lonsdale (2016) compared choral singing with solo singing and playing a team sport. Using a theoretical framework that consisted of two elements: (1) entitativity (pure entity) designed to provide a means of understanding the group processes involved; and (2) self-determination theory (SDT) to provide a means of understanding the processes affecting participants as individuals, they found that choral singers and team sport players reported significantly higher psychological wellbeing than solo singers.

SDT describes the conditions thought to be necessary for an individual to be motivated and psychologically healthy. When people are motivated to undertake a task or activity for intrinsic, rather than extrinsic reasons, it is known to have a number of positive

consequences, including improved performance, increased persistence and enhanced subjective wellbeing (Ryan & Deci, 2000). Stewart and Lonsdale (2016) used SDT to provide a model of the social and psychological conditions under which self-determined and intrinsic forms of motivation are most likely. They identified three basic psychological needs: (1) autonomy; (2) competence (confidence to act); and (3) relatedness (belonging or connectedness). Their questionnaire data from 375 participants indicated that choral singers reported that they considered their choirs to be a more coherent or 'meaningful' social group than team sport players considered their teams. Together these findings might suggest that membership of a group may be a more important influence on the psychological wellbeing experienced by choral singers than singing. Individuals who sing in choirs usually do so voluntarily, with little apparent regard for extrinsic rewards. Intrinsic motivation may be what is responsible for the supposed psychological benefits of choral singing (Stewart & Lonsdale, 2016).

#### **4.3 Entrainment of Behaviour**

Choral singing is an example of an activity that involves joint action, the ability of individuals to coordinate their actions with those of others. Understanding the cognitive and neural processes involved in joint action has been slow and sparse, because cognitive neuroscientists have predominantly studied individual minds and brains in isolation (Sebanz, Bekkering, & Knoblich, 2006).

Entrainment has been studied in a variety of contexts including music perception, dance, verbal communication and motor coordination. Social entrainment is a special category of entrainment characterised by Phillips-Silver, Aktipis and Bryant (2010) as responsiveness to rhythmic information generated by others. They describe three critical building blocks – detection, production and integration of rhythmic signals, which is of interest to the present study as it may explain the observation of popularity and success of

songs sung in  $\frac{3}{4}$  time described further in Chapter 5, where it is suggested that choir members appear to find  $\frac{3}{4}$  time easier, collectively, to feel the beat (Phillips-Silver & Trainor, 2005).

Rhythmic entrainment (coordination) of behaviour during human interaction is a powerful phenomenon and considered essential for successful communication, supporting social and emotional connection, and facilitating sense-making and information exchange (Borrie & Liss, 2014). Disruption in entrainment, Borrie and Liss suggest, is likely to occur in conversations involving those with speech and language impairment, but its contribution to communication disorders has not been defined.

A study by Borrie and Liss (2014) explored the entrainment phenomenon in clinical populations to examine the influence of disordered speech on speech production of neurologically healthy participants ( $N = 29$ ) in a quasi-conversational paradigm, in which sentences were read in response to hearing pre-recorded sentences from four speakers with dysarthria and four healthy controls. Their findings revealed that the participants modified their speaking rate and pitch variation to align more closely with the disordered speech, but that shifts in these rhythmic properties, however, remained significantly different from corresponding properties in dysarthric speech. It was concluded that entrainment offers a new avenue for exploring speech and language impairment, addressing a communication process not currently explained by existing frameworks.

Phillips-Silver, Aktipis and Bryant's (2010) proposal that the capacity to entrain is dependent on three critical components: (a) rhythmic detection; (b) rhythmic action; and (c) rhythmic integration is very relevant to the present study. Entrainment facilitated by way of a group activity such as singing may help singers to perceive rhythmic information, produce rhythmic information, and to integrate rhythmic information to adjust one's motor output in response to sensory input.

#### **4.4 Gender Related Patterns of Wellbeing**

Sandgren (2009) investigated two groups - 152 female and 60 male choral singers from eleven choirs of which six were amateur and five were advanced. The objective of the study was to investigate how emotional states vary on pre and post measurements of a regular choral rehearsal between the two groups. Dr Maria Sandgren's results showed, that in accordance with the literature (Laukka & Juslin, 2007; Schellenberg & Peretz, 2008) on emotions and gender, women reported significantly more positive emotional states than men relating to participating in a regular choral rehearsal. However, Sandgren found relatively few significant gender differences for positive emotional states and no gender differences for negative emotional states. Women and men reported similar levels of negative emotions, but seemed to vary more in ratings of positive emotional states. Sandgren suggests that one possible reason for this outcome could be that the choir members in the study were committed to choral singing and had been in the choir for a number of years. Therefore long term sharing of the experience of choral singing could create similar singing experiences and expectations.

These findings are reflected in a study by Clift et al. (2010) where individual items taken from a 12 item 'effects of choral singing scale' showed that women were more likely than men to strongly agree that singing made them feel happier, made their mood more positive, helped improve wellbeing and health, and helped them relax and deal with stress. Similarly, they were more likely to strongly disagree that singing doesn't help to release negative feelings. The findings of Clift et al. (2010) and Clift and Hancox (2010) may reflect a broader gender difference in emotional sensitivity and expressiveness with women and men experiencing similar gains, but with women expressing themselves more strongly in this respect. Clift et al. (2010) and Clift and Hancox (2010) suggest that these differences may also help to explain why choral singing should be an activity which tends to attract more

women than men. The study showed that the men in the sample are indeed actively involved in choral singing, and while they endorse the wellbeing benefits of the activity, they suggest it may be that other factors, such as the value placed on music or the opportunity to socialise, are stronger motivators for their involvement.

A number of qualitative studies on the benefits of community singing have been undertaken with diverse samples of singers, providing evidence from subjective reports on a range of social, psychological, and health benefits associated with singing (Clift et al., 2017). One such report, and of particular interest and relevance in relation to the male members of a singing group is the work of Bailey and Davidson (2005), who interviewed members of a small choir for homeless men in Montreal. A common theme emerged in the men's accounts who felt that group singing alleviated depression and enhanced emotional and physical wellbeing and provided a supportive context for the men in which they could develop their social skills and achieve collective goals. They also reported that performing to an audience encouraged a sense of personal worth and provided a means of re-engaging with wider social networks.

Sandgren (2009) queries how much of the wellbeing effect depends on the singing activity itself or aspects of the setting or individual characteristics. What is known is that individuals react differently to singing activities; singers with professional ambitions appear to experience more stress and less joy compared to amateurs, women enjoy singing more than men, individuals with lower health status gain more wellbeing than those with higher health status (Grape et al., 2003; Cohen et al., 2009); Sandgren, 2009; Clift & Hancox, 2010; Cohen, 2006).

#### **4.5 Group Singing and the NMS Associated with PD**

From the salutogenic point of view, the condition of PD is associated with profound and prolonged adjustment for those living with the condition and for those closest to them as

they adjust to changes in wellbeing, physical abilities and communication. It is suggested that engagement in creative activities, such as singing, can help build resistance to stressful situations that prevent people dealing with health changes thus, for people who face significant PD related adjustments, the opportunity to engage in creative activities is highly desirable (Davidson et al., 2014). There is a potential to explore a range of stressful situations when someone with PD engaged in a creative activity like singing also involves their significant other. These observations support the view that, as a creative and social activity, singing regularly in a social environment can help people living with PD and those closest to them explore ways in which to deal with the inevitable life changes (Vella-Burrows & Hancox, 2012).

Given the early stage of development of research on singing and wellbeing, there is currently no comprehensive model which might explain how singing might lead to benefits for health. Social and psychological theories like SDT, which are useful in suggesting potential mechanisms linking singing to possible health benefits, provide a theoretical framework that could prove invaluable for much needed future research on choirs, and in particular, on choirs for people with PD (Stewart & Lonsdale, 2016).

#### **4.6 Quality of Life**

Abell et al. (2017) hypothesised that group singing could enhance QoL. The aim of their small study was to investigate the effects of group singing on health related quality of life (HRQoL) for people diagnosed with PD. Using a semi-structured choir participant interview to capture their perception of the effect of group singing on quality of life they found benefits from participation in group singing across four of six themes: physical, mood, cognitive functioning, social connection, flow-on effects, and sense-of-self. The study findings, they suggest, show that weekly engagement in group singing resulted in multiple benefits including improved HRQoL and were consistent with previous research showing that

the presence of multiple NMS of PD is a better predictor of low HRQoL when compared to motor symptoms. All participants reported positive effects regardless of PD stage or symptom severity. Although not specifically addressed in the current research, it would be useful in future research to determine whether motor symptoms or NMS contributing to reduced QoL have greater impact on initial engagement in and continued participation in non-medical therapies such as choral singing.

Further discussion on the potential positive effects of group singing is provided by a study by Buetow et al. (2014) who postulated how group singing could produce states of connectedness and flow that might encourage ongoing 'internal rhythms' in people with PD. Buetow and colleagues concluded that QoL could be improved (entrained) through group singing by way of the social relationships and community to produce an environment for pleasure. A group singing environment, they contend, can provide motor and NMS health benefits that include reduced deficits in motor initiation, timing, emotional processing and expression.

A pilot study by Stegemöller et al. (2016) measured the effects of an 8-week singing, vocal and articulation exercise intervention in 27 participants with PD, who were assigned to a high (twice weekly) or low (once weekly) dosage group. Measures of voice, respiratory and QoL were recorded before and after the intervention. Stegemöller and colleagues used both Voice QoL and World Health WHQoL measures and found significant improvements, which they contended may have resulted from subjective feelings of increased support and understanding through social interaction with others also affected by similar impairments and life stresses. This is another example of how singing groups may provide an additional treatment strategy that complements traditional speech therapy treatment while enhancing the QoL for persons with PD.

#### **4.7 Anxiety and Depression**

A search of the literature exposes an abundance of material containing research into depression and anxiety within the PD population, and of group singing and the benefit to participant's psychological wellbeing and QoL within the non-PD population (Clark & Harding, 2012; Clift & Hancox, 2010; Bonilha et al., 2009; Grape, Wikstrom, Ekman, Hasson, & Theorell, 2010). These studies suggest a strong association between wellbeing, QoL and group singing; none however have included measures for the effect on depression. Research examining group singing to determine whether there are positive effects on psychological wellbeing and QoL suggests that anxiety and depression could be affected positively using 'behavioural' or group singing therapies (Di Benedetto et al., 2009; Uitti, 2012).

Further evidence of group singing helping to alleviate some of the emotional difficulties associated with Parkinson's is provided by Pacchetti et al. (2000) whose research on one intervention; a single-blinded randomised control study of 32 people with PD randomly assigned to two groups of 16 for weekly sessions of MT and physiotherapy showed significant improvements in participants' emotional wellbeing. The MT sessions consisted of choral singing, voice exercise, rhythmic and free body movements and active music involving collective invention. The physical therapy sessions included a series of passive stretching exercises, specific motor tasks, and strategies to improve balance and gait. Pacchetti and colleagues measured emotional wellbeing using a short, self-administered Happiness Measure questionnaire and the Parkinson's Disease Quality of Life Questionnaire and found significant improvements in participants' emotional wellbeing. MT also had a significant overall effect on bradykinesia (measured using the UPDRS) as well as activities of daily living and quality of life suggesting a connection between emotions and the facilitation of movement. Pacchetti et al. (2000) state that the beneficial effect on emotion measured in

the MT group could be explained by the emotional impact that MT had on the participants, which is related to its high level of sensory stimulation and high degree of personal interaction. Emotional wellbeing has been investigated by measuring the impact on cortisol, oxytocin, and Immunoglobulin A, of group and solo singing (Grape et al., 2003; Kreutz, Bongard, Rohrmann, Hodapp, & Grebe, 2004); this research is discussed later in this chapter.

Group singing could become an effective complementary intervention for improving factors that contribute to QoL and enabling people with PD to experience reprieve from some disease symptoms that might include anxiety and depression (Abell et al., 2017). Successful treatment of depression is associated with improvements in quality of life (Uitti, 2012), but no study has systematically investigated group singing as a treatment specifically for depression in people with PD.

Speech therapy approaches to clinical management have traditionally been impairment focused, sometimes neglecting impact beyond that of the impairment (Stegemöller et al., 2016). Greater attention, therefore, on quality of life factors affecting people with PD with regard to depression and wellbeing combined with activities and participation is desirable, rather than solely examining changes in impairment (e.g. disordered voice) after treatment. In disorders of communication, impairment is the most studied outcome with ‘mechanical’ measures of speech, language, voice, and fluency, (articulatory accuracy and physiological functioning of the vocal folds) well documented. It is easier to measure the regularity of vocal fold movement or the percentage of words understood by a listener than it is to measure an individual’s ability to participate in valued activities (Eadie et al., 2006), but such research is needed.

#### **4.8 Meaningful Pursuits and Personal Fulfilment**

A comprehensive study measuring physical, psychological, social and environmental wellbeing of a large sample of choral singers, who did not have PD found a significant degree

of consensus on the positive benefits of choral singing (Clift & Hancox, 2010). Clift and Hancock also review a number of qualitative studies on the benefits of community singing which provide evidence from subjective reports on a range of social, psychological, and health benefits associated with singing. More research is needed to determine whether such benefits occur for people with PD.

Paying attention to personality, coping strategies and self-regulation under stressful conditions should allow people with PD to receive more holistic and beneficial care (Gison et al., 2014). A study exploring the effect on wellbeing of group singing, listening to music and expressive music production using measures that included analysis of endocrine/cortisol levels, showed that singing in a group links to long term measures of wellbeing, particularly those related to social and eudaimonic or 'contented' state confirming that group singing consistently relates to correlates of wellbeing (Bento-Allpress, 2013). Eudaimonic wellbeing is typically defined as fulfilling one's potential and identifying meaningful life pursuits with an emphasis on an individual's evaluations of functioning in life, whereas hedonic wellbeing emphasises an individual's evaluations of feelings regarding life and the pursuit of pleasure and happiness (Boehm & Kubzansky, 2012; Waterman, 2008).

Research findings into music intervention as one of a range of applications in dementia care found that, although the process by which singing reduces problem behaviours remains unclear, music has the potential to reduce problem behaviours possibly averting the need for pharmacological or physical intervention and providing engagement in meaningful activity (Sherratt, Thornton, & Hatton, 2004).

The findings of Dr Rita Bento-Allpress (Bento-Allpress, 2013) support those of others (Beck et al., 2000; Grape et al., 2003; Kreutz et al., 2004) who have found that the release of hormones such as cortisol and oxytocin and first line immune system support such as Immunoglobulin (A) are known to occur during group and solo singing. These hormones are

collectively associated with life-factors that are often negatively affected by Parkinson's, which include mood regulation, a sense of self-esteem and self-confidence, sleep patterns, memory and new learning, social bonding and trust, and anxiety (Parkinson's UK, undated). A study by (Grape et al., 2003) comparing the possible beneficial effects of singing on wellbeing between one group of eight professional singers and one group of eight amateur singers found that, although the professional group focused on areas like technique and vocal apparatus, the amateurs used the singing as a means of self-actualisation and self-expression as a means of releasing emotional tensions. This evidence supports a theory developed by (Ridderinkhof et al., 2012) who investigated reward based decision learning. Reward related behaviours, they state, refers to the process of learning to select those actions that lead to rewards while avoiding actions that lead to punishments. This process, known to rely on dopaminergic activity in striatal brain regions, is compromised in PD. However, Ridderinkhof et al. (2012) found that pre-and post-test Likert scale results showed that participants in the positive affect condition confirmed that they felt more positive and amused (in this case viewing comedy clips) and showed improved performance in a variety of tasks that rely on frontostriatal dopaminergic interactions suggesting that any intervention (including group singing) that enhances dopaminergic functionality may serve to remedy the learning deficit.

#### **4.9 Neuro-Rehabilitation**

Rehabilitation using music is not only more enjoyable, it can also provide an alternative entry point into a "broken" brain system that can remediate impaired neural processes or neural connections (Schlaug, Marchina, & Norton, 2009). Thaut (2010) stated that neurological music therapy last came into research and clinical focus via cognitive rehabilitation. Higher cognitive function in the human brain 'in vivo' and theoretical advancements in music and brain function have been enabled with the development of new

imaging techniques (Thaut, 2010). Neuroimaging studies show there are shared cognitive and perceptual mechanisms and shared neural systems between musical cognition and parallel non-musical cognitive functions that provide access for music to affect general non-musical functions, such as memory, attention, and executive function. The emerging clinical literature shows substantial support for these effects in rehabilitative retraining of the injured brain' (Thaut, 2010 pg 281). More recently, neuroimaging studies by investigators such as (Vuilleumier & Trost, 2015; Hsieh, Hornberger, Piguet, & Hodges, 2011) enable review and better understanding of the similarities and differences in the neural substrates underlying complex (transcendence or nostalgia) music evoked emotions relative to other more basic (joy or sadness) emotional experiences suggesting that these emotions emerge through a combination of activation in emotional and motivational brain systems (e.g., including reward pathways) that confer its valence to music. This occurs with activation in several other areas outside emotional systems, including motor, attention, or memory-related regions. Interestingly, neuroimaging has shown that there is significant correlation between the recognition of famous tunes and faces but not with the comprehension of everyday sounds with further analysis that recognition was modulated with right-sided atrophy of medial temporal structures (e.g. amygdala).

#### **4.10 Motor Speech Difficulties and Group Singing**

##### **4.10.1 Respiration and Maximum Sustained Phonation**

Singing is a multimodal activity involving the integration of auditory and sensorimotor processes not dependent on formal vocal training although, with training, it can be enhanced (Wan et al., 2010). Given the behavioural similarities between singing and speaking, as well as the shared and distinct neural associations of both, research is now examining how singing can be used to treat some of the motor speech abnormalities associated with PD (Wan et al., 2010).

Studies of the therapeutic effects of singing, and how it can potentially ameliorate some of the speech deficits associated with conditions such as PD have found that intensive singing practice can lead to long lasting changes in both the cardiovascular and pulmonary systems (Di Benedetto et al., 2009; Stegemoller et al., 2016; Goldberg 2017).

A longitudinal study by Sabol, Lee, and Stemple, (1995) examined whether vocal function exercises would improve physiological parameters of vocal production in singers. The exercises, over a four week duration, combined muscle action (isotonic) and tone (isometric) elements and were designed to strengthen the laryngeal musculature and to facilitate efficient vocal fold vibration. The primary physiological effects that Sabol, Lee, and Stemple observed were higher phonation volumes and phonation times, as well as a reduction in airflow, which they took to reflect improved coordination of laryngeal function and vocal fold vibration.

Singing, therefore, has the potential to treat speech abnormalities because it directly stimulates the musculature associated with respiration, phonation, articulation and resonance. It has the potential to ameliorate some of the associated speech-motor difficulties as a result of features such as continuous voicing, decreased production rate, and increased awareness of individual phonemes (Natke et al., 2003; Vella-Burrows & Hancox, 2012; Bonilha et al., 2009) and with an ability to generate greater vocal intensity and awareness of vocal control than speaking, singing can increase respiratory muscle strength (Wiens, Reimer, & Guyn, 1999).

Respiration is key in generating voice and is thus an essential factor when singing (Elefant, 2012). Singing involves strong and fast respirations followed by extended regulated expirations requiring well-coordinated control regulated to sustain notes of differing lengths, which might include glissando and staccato (Wan et al., 2010). People who sing are practicing a particular type of respiratory exercise that repeatedly demands diaphragm

contractions for full inspirations followed by sustained contractions of expiratory muscles with semi closed vocal folds during expirations (Pettersen, 2005). Singing, therefore, has the potential to help people with PD as the physical act of singing reproduces the well-established principles of the Lee Silverman Voice Treatment (LSVT<sup>®</sup>) (Vella-Burrows & Hancox, 2012).

A kinematic and spirometric analysis of respiratory function in Parkinson's subjects gives support to the contention that respiratory exercise might improve respiratory function and voice in someone with PD (Murdoch, 2010). Murdoch assessed the respiratory abilities of a group of nineteen people with PD exhibiting a perceptible speech deficit using both spirometric and kinematic techniques and compared to those of a group of 19 non-neurologically impaired controls matched for age and sex. Results of the spirometric assessment showed that only a minority of the Parkinson's subjects had lung volumes and capacities outside normal limits. Consequently in the majority of cases, the speech disorder could not be related to any abnormality in lung function determined spirometrically. Chest wall dynamics during both conversation and reading were essentially normal in all cases. Approximately half of the Parkinson's subjects, however, exhibited irregularities in their chest wall movements while performing vowel prolongation and syllable repetition tasks. The same irregularities were not present in the chest wall movements exhibited by the control subjects, suggesting that their presence was in some way related to neuromuscular function in those subjects with Parkinson's disease (Murdoch, 2010).

#### **4.11 Literature Review on PD Group Singing**

The notion that group singing can be used as an effective non-pharmacological intervention for voice in people with PD has attracted increasing attention. Nevertheless a review of the literature indicates that it has been slow to develop with only a small number of studies completed in the past decade. Twelve studies investigating group singing on speech

for people with PD were identified and compared (Table 10). Of the studies completed thus far none were RCTs, there are methodological differences between them with regard to the intervention design, be it dosage, frequency and duration of intervention. Intervention design has differed across the studies with the majority employing just singing (Yinger & Lapointe, 2012; Abel et al., 2017), whilst others have combined group singing and playing musical instruments (Pacchetti et al., 2000) or combined group singing with a standard speech and language therapy intervention applied before starting the group singing intervention (Di Benedetto et al., 2009).

A review by Barnish, Atkinson, Barran and Barnish (2016) of nine studies found that all were considered at risk of bias – six with high risk, of which four (Evans, Canavan, Foy, Langford, & Proctor, 2012; Haneishi, 2001; Tanner, Rammage, & Liu, 2016; Yinger & Lapointe, 2012) indicated benefit, with two others at high risk (Elefant et al., 2012; Shih et al., 2012) showing no benefit of treatment. One study was considered at low risk (Di Benedetto et al., 2009). Results of these studies with the addition of three further studies (Fogg-Rogers et al., 2016; Stegemöller et al., 2016); Abell, Baird, & Chalmers, 2017) are summarised in Table 10.

Speech parameters that are shown to benefit from the group singing studies include respiration, maximum phonation time,  $F_0$ , intensity, intelligibility, prosody, fatigue and in one study by (Evans et al., 2012) laryngeal speech and volume measured using the Frenchay Dysarthria Assessment (FDA) (Enderby, 1980).

Only two studies assessed effects of intervention on functional communication, finding no significant changes. None of the studies included assessment on the benefit of singing on cognition or motor function. Only three studies assessed the impact of group singing on QoL, one (Evans et al., 2012) found no significant improvement, but two (Fogg-

Rogers et al., 2016; Stegemöller et al., 2016) assessed WHQoL and Voice QoL and found significant results for choir participation overall and pre and post differences across groups.

The thematic analysis by Fogg-Rogers et al. (2016) explored the experiences and factors influencing participation in choral singing by people with PD and people who have had a stroke. Their qualitative results were separated by neurological condition, however the themes generated in their analysis are derived from the combined PD and stroke sample which made it difficult to conclude which specific activity underpinned the positive outcomes for the people with PD (Abell et al., 2017).

**Table 10***Summary of Previous Studies Reporting on the Benefits of Group Singing for People with PD*

First Author	Part's	Design	Symptom	Freq, Period & Duration	Intervention(s)	Results
Pacchetti	16 PD	Quantitative prospective, single-blinded prospective, single-blinded	Motor symptoms emotional & behavioural functioning	Weekly 2 hr 12 wks	Group singing. Playing musical instruments	Improved bradykinesia Improved ADLs Improved QoL
Di Benedetto	20 PD	Single group repeated measures Quantitative	Voice	Weekly 2x1hr 10 wks Weekly 1x2hr 13 wks	Speech therapy (propedeutic) Choral singing	Improved speech and voice parameters: functional residual capacity, maximum inspiratory and expiratory pressures, maximum duration of sustained vowel phonation & prosodia reading a passage
Evans	10 PD	Single group repeated measures Quantitative	Voice QoL	Fortnightly 2 hr 2 years	Group singing (lessons)	Improved speech Improved communication Small improvement in QoL
Elefant	10 PD	Single group repeated measures Quantitative Follow-up: 10 weeks 2 months	Voice Mood	Weekly 1 hr 20 wks	Group singing	Improved singing quality, Improved voice range No change in depression symptoms
Elefant	10 PD <sup>a</sup>	Quantitative	Facial masking	Weekly 1 hr 20 weeks	Music therapy	Improved facial expression
Haneishi	4 PD	Single group repeated measures study	vocal and singing exercises sustained vowel production	Week x3 1 hour 12-14 sessions	Music therapy	Statistically significant improvements for vocal intensity and carer-rated intelligibility
Shih	13 PD	Single group Repeated measures Quantitative	Voice Voice related QoL	Weekly 1.5 hr 12 wks	Choral singing	No changes in vocal loudness, pitch range, phonation time, or maximum loudness No change in voice related QoL
Yinger	10 PD	Single group Repeated measures	Voice	Weekly X2 50 minutes Six wks	Group singing	Significant increases in intensity of conversational speech.
Fogg-Rogers	6 PD 8 stroke 9 sig oths n = 23	Qualitative evaluation (detailed interview)	Mood Psychosocial factors QoL	Weekly 1.5 hr Established & ongoing choir	Choral singing	Improved mood Improved language (stroke participants) Improved breathing and voice parameters Improved social communication QoL scores were higher than published normative data for people with disabilities
Tanner	28 PD	Single group repeated measures study	Voice	Weekly 1.5 hr Six wks	Group singing Other vocal exercises	Statistically significant pre-post measures of max intensity (dB) and average frequency (Hz)
Stegemoller	27 PD	Single group repeated measures Quantitative	Voice, Respiratory pressure & QoL	High dose (2xweekly) Low dose (1x weekly) 8 weeks	Group singing	Improved maximum inspiratory & expiratory pressure. Improved phonation time. Improved voice QoL and whole health QL
Abel	11 PD	Single group qualitative evaluation (detailed Interview)	HRQoL	Weekly 12 months	Groups singing	Analysis revealed 6 categories that characterized the effects of group singing: physical, mood, cognitive functioning, social connectedness, "flow-on" effects, and sense-of-self. All reported positive effects across at least 4 categories. Three participants reported a negative effect in 1 category (physical, mood, or sense-of-self).

This review of the research to date shows that the studies are few in number and vary greatly in terms of their method and sample size (median sample size per study  $n = 16$ ) with no study providing a rationale for the sample size. All the studies were of a single group design using repeated measures and not randomised to address for issues of selection bias and confounding. One study justified the choice of a repeated measures and single group design by choosing a pre-test – post-test within-subject research design with each subject acting as his or her own control for variability between subjects as used by Weismer, McNeil, Rosenbek and Aronson (1984). However, as Barnish et al. (2016) point out, this evidence is derived from tasks of a specific nature and with interventions in studies lasting up to two years, the neurodegeneration associated with PD, they argue, would limit the ability of participants to serve as their own control. Interestingly, the studies were, in the main, ‘voice/speech centric’ in that they included only limited assessment of the impact of group singing on functional communication and psychosocial wellbeing with none of the studies exploring the potential for improvement in cognitive and motor function.

Of those sampled (Table 11), one study (Di Benedetto et al., 2009), a preliminary non-RCT that proposes VCST as a treatment for speech and voice abnormalities assessed 20 people with PD. Participants undertook 20 hours of collective speech therapy for two sessions of one hour every week, and 26 hours of choral singing, one session of two hours every week for five months. Alongside the singing, the sessions also included a series of prosodic, respiratory, and laryngeal exercises. The study found significant respiratory improvements in phonation time, functional residual capacity (FRC), maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP), but no significant differences in forced vital capacity (FVC) or other variables in voice quality. Although small, the authors suggest, the improvements in their study shows that VCST could represent a specific rehabilitation for PD speech and voice abnormalities (Di Benedetto et al., 2009). An explanation for the reduction

of the functional residual capacity, Di Benedetto et al. (2009) suggest, might be from the modification of the diaphragm positioning associated with respiratory muscle training; the same mechanical modification could also be responsible for the enhancement of the static respiratory pressure (MIP and MEP).

Similar findings were found in a study by Stegemöller et al. (2016), which measured the effects of a singing intervention on 27 people with PD led by a certified music therapist. The participants in Stegemöller et al.'s study were assigned to a high (twice weekly) or low (once weekly) dosage group that included singing as well as a series of vocal and articulation exercises. Pre and post treatment measures of voice, respiratory and QOL were recorded each side of an 8 week singing intervention. As with the study by Di Benedetto et al. (2009), the results did not reveal significant improvements in all vocal outcome measures, however results did support the use of singing therapy as a means of increasing respiratory pressure in people with PD.

The study by Stegemöller et al. (2016) was the first to compare the effects of once weekly and twice weekly singing intervention for people with PD. The results revealed no differences on any outcome measure between the two groups but again, as with the Di Benedetto et al.'s (2009) study, both groups showed significant improvements in phonation time, MIP and MEP. These, along with other improvements observed in voice QoL and whole health (WHQoL), suggest that the singing may have a greater impact on respiratory pressure generation and overall QOL than on vocal outcome measures. Interestingly, and a point discussed in the next chapter, they also suggest that engaging in group singing may be a better way of improving adherence to voice and respiratory exercise in persons with PD.

Abell et al. (2017) investigated the effects of group singing on health related quality of life (HRQoL) of eleven people with a formal diagnosis of PD recruited from a community singing group for people with PD that also included family and carers. Perceptions on the

effect of group singing on QoL were captured using a semi-structured interview and analysed using a qualitative Interpretive Phenomenological Analysis (IPA) approach. Their analysis revealed 6 themes characterising the effects of group singing: physical, mood, cognitive functioning, social connectedness, “flow-on” effects, and sense-of-self. All study participants reported positive effects across at least 4 of these categories, although three participants reported a negative effect in 1 category (physical, mood, or sense-of-self). The results suggest that group singing improves HRQoL. With weekly engagement in group singing, all participants reported multiple benefits and positive effects counteracting some of the negative effects of PD regardless of symptom severity or the stage of progression.

A study by Evans et al. (2012) investigated how group singing lessons provided by a professional singing teacher might be effective in improving and maintaining voice dynamics and quality of life in people with PD, found small but statistically significant improvements in three of the four tested parameters of speech: respiration, phonation, movement of facial musculature. In this longitudinal pilot study the participants attended a two hour singing session every fortnight for two years and were assessed using the Frenchay Dysarthria Assessment (Enderby & Palmer, 2008) and 39 element Parkinson’s disease Questionnaire (PDQ-39) (Jenkinson et al., 1997) as a means of measuring outcomes. They found significant differences within the parameters of respiration, phonation, and facial musculature suggesting that group singing is helpful in maintaining voice quality for people with PD as effectively as individual speech therapy.

Overall the studies, notwithstanding significant methodological and intervention differences, the lack of RCTs and small and unexplained sample size, suggest that group singing for people with PD may improve speech in people with PD.

**Table 11***Results Summary of Previous Studies on the Benefits of Group Singing for People with PD (Barnish et al.,2017)*

<b>First Author</b>	<b>Results</b>
Pacchetti	MT had a significant overall effect on bradykinesia as measured by the Unified Parkinson's Disease Rating Scale ( $p < .034$ ). Post-MT session findings were consistent with motor improvement, especially in bradykinesia items ( $p < .0001$ ). Over time, changes on the Happiness Measure confirmed a beneficial effect of MT on emotional functions ( $p < .0001$ ). Improvements in activities of daily living and in quality of life were also documented in the MT group ( $p < .0001$ ). PT improved rigidity ( $p < .0001$ ).
Di Benedetto	Quality of voice reading prosody rating improved significantly from pre-singing to post-singing (mean difference (MD) 0.5, $p=0.046$ ). No significant improvement in quality of voice prosody rating was found for monologue. Quality of voice fatigue rating for reading also improved significantly ( $Z=-2.1$ , $p<0.05$ ). No significant improvement for monologue. MPT was significantly increased ( $t=-5.4$ , $p<0.001$ ). No significant improvement for $F_0$ , $F_0$ variation, jitter, shimmer, peak amplitude variation, $F_0$ tremor intensity or amplitude tremor intensity.
Elefant	No statistically significant improvements from pre-singing to post-singing assessment found for fluency or acoustic parameters ( $F^o$ , $F^v$ variation, intensity, intensity variation and voicing) from read passage. No statistically significant improvement found for VHI total score or functional and psychological subscales scores. A statistically significant improvement was found for VHI physical subscale score (MD last vs first assessment -2.0, $p<0.05$ ).
Evans	Statistically significant improvement from pre to post singing assessment found for three aspects of the FDA Questionnaire: Laryngeal pitch, MD 0.8, $p<0.02$ ; laryngeal volume, MD 0.9, $p<0.01$ ; laryngeal speech, MD 1.4, $p<0.001$ ). Other aspects of this assessment, including intelligible words, sentences and conversation, did not reach statistical significance. No statistically significant change found for any PDQ-39 quality of life sub-scale scores.
Haneishi	Statistically significant improvements from pre to post singing assessment were found for vocal intensity (MD 9.9, $p = 0.03$ ) and carer-rated intelligibility (MD 0.8, $p = 0.04$ ) with marginally significant improvements in self-rated intelligibility (MD = 0.7, $p = 0.07$ ) and $F_0$ (MD 25.4, $p = 0.06$ ). No statistically significant improvements found for maximum duration and fundamental frequency variability.
Shih	No statistically significant improvements were found for intensity, maximum cued volume, maximum phonation time, $F_0$ , read speech pitch range or voicing contrast.
Yinger	Statistically significant improvement in read speech intensity found across the pre-singing, probe and post-singing assessments ( $F=9.65$ , $p=0.001$ ), with a statistically significant difference between the pre-singing and post-singing assessments on post-hoc test (MD 55.6, sig.). No statistically significant improvements found for conversational speech intensity, $F_0$ or $F_0$ variability.

**Table 11**  
(Continued)

Fogg-Rogers	Thematic analysis indicated participants had many unmet needs associated with their condition, motivating them to explore self-management options. CST (choral singing therapy) participation was described as an enjoyable social activity, and participation was perceived as improving mood, language, breathing and voice. The constructs of QoL and participation provide quantitative measures that reflect some aspects of the experience of participation in CST. There was a trend for the mean score of all QoL domains except Social to be higher than the normative data. The WHOQOL-DIS Overall QOL of 3.96 (SD 0.83) was higher than the published European data mean of 3.08 for people with disability. The SIPSO mean score of 27.58 (SD 6.75) was very similar to published scores for stroke survivors (mean 27, interquartile range 17.0–34.5).
Tanner	Statistically significant improvements were found for intensity range (MD 7.1, $p = 0.001$ ), $F_0$ for read speech (MD 4.8, $p = 0.001$ ) and $F_0$ variation for read speech (MD 4.5, $p < 0.01$ ). Clinically significant improvement in intensity range and $F_0$ variation in read speech. $F_0$ for read speech - possibly significant. No statistically significant improvement for MPT, intensity of read speech, $F_0$ of conversational speech or $F_0$ variation of conversational speech.
Stegemoller	No significant between group difference for: age, education, disease duration, MMSE, BDI and UPDRS ( $t < 1.730$ , $p > 0.10$ ). No statistical group effect for intervention measures ( $F_{(1)} < 3.282$ , $p > 0.084$ ). Significant statistical difference across weeks for lip buzzing/trills, glissandos and phrasing ( $F_{(7)} > 41.310$ , $p < 0.001$ ). No significant difference in vocal intensity (decibels) across weeks. Interaction effect for lip buzzing and phrasing only ( $F_{(7)} = 2.929$ , $p = 0.007$ ; $F_{(7)} = 2.450$ , $p = 0.021$ ). Post-hoc analysis for lip buzzing = no between group differences across each week ( $p > 0.032$ , Bonferroni corrected $\alpha = 0.006$ ). High-dosage group performed significantly better on phrasing than low-dosage group in week 2 ( $p < 0.001$ , Bonferroni corrected $\alpha = 0.006$ ) (Post-hoc) - no significant between group differences or interaction effect across weeks. No main group effect across all vocal outcome measures. Pre to post intervention, duration “ah” was significantly different ( $F_{(1)} = 4.233$ , $p = 0.05$ ) - no interaction effects. No significant between group differences for MIP and MEP - significant difference for both measures between pre and post-testing (MIP: $F_{(1)} = 4.288$ , $p = 0.049$ ; MEP: $F_{(1)} = 9.603$ , $p = 0.005$ ) - no interaction effects. No main effect of group for either Voice QoL or WHQoL. Significant pre to post-testing difference ( $F_{(1)} = 8.199$ , $p = 0.008$ ) with interaction effect ( $F_{(1)} = 6.564$ , $p = 0.017$ ) for Voice QoL. No significant between group difference at pre-testing or post-testing post-hoc. Significant pre to post-testing differences ( $F_{(1)} = 228.967$ , $p < 0.001$ ) for WHQoL and an interaction effect ( $F_{(1)} = 4.608$ , $p < 0.042$ ). Post-hoc analysis did not reveal significant between group differences at pre-testing or post-testing.
Abel	Participants’ perceived changes in their body, voice, mood, and thinking skills from attending a choir session were assessed using the semi-structured Choir Participation Interview and associated rating scale. The reported intensity of change in each CPI domain ranged from <i>much better</i> to <i>worse</i> across participants. The duration of positive change lasted from the length of the choir session up to 2–3 days, with the majority of participants experiencing a positive change for the remainder of the day (Half Day). Participants’ reported experiences of the benefits of group singing were coded into six categories: physical, mood, cognitive functioning, social connectedness, flow-on effects, and sense-of-self. All participants reported an improvement in overall wellbeing since commencing group singing and stated they would recommend group singing to others with PD.

Note. MT = Music therapy, PT = Physiotherapy, WHOQoL = World Health Organization Quality of Life Questionnaire, PDQ39 = Parkinson’s disease Questionnaire, SIPSO = Subjective Index of Physical and Social Outcomes, MMSE = Mental State Exam, BDI = Beck Depression Inventory, UPDRS = Unified Parkinson’s Disease Rating Scale, V-RQOL = Voice-Related Quality of Life, MIP = maximal inspiratory pressure, MEP = maximal expiratory pressure, MPT = Max phonation time,  $F_0$  = Fundamental Frequency, VHI = Voice Handicap Index, FDA = Frenchay Dysarthria Assessment.

This chapter has asked questions about the relevance of the current medical model of illness to people's day-to-day experience of PD and suggests that people who engage in creative activities can cope with their health conditions and deal with stress more effectively. The author has reviewed evidence within the current literature suggesting that group singing can lead to improvements in lung capacity, posture, emotional and psychosocial wellbeing as well as offering opportunities for emotional expression and a sense of achievement for people with PD and their carers. However, the strength of the evidence is limited by virtue of the fact that the studies, thus far, are few and have not been high quality randomised trials. The results from this current randomised trial will provide further evidence that will help inform our understanding of the potential phonatory, respiratory and psychosocial wellbeing benefits for people with PD engaging in VCST.

## **Chapter 5: An SLT and Musician's Perspective - A Rationale for Song Choice and Exercise; a Determinant Central to Efficacy?**

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Previous chapters have reviewed studies that have examined the benefits of active participation in group singing for health and wellbeing in both PD and non-PD populations. Few studies have investigated how using song might impact positively on the phonatory and respiratory muscle control systems affecting voice loudness, quality and prosody in people with PD. Even fewer studies examine the nature of the singing, the nature of the songs or how songs are delivered in voice and choral singing therapy (VCST) for people with PD.

The thoughts contained in this chapter are those of the author; a musician of many years, who is also a senior speech and language therapist (SLT). The author has led a community based singing group, the Brainwave Singers (BWS), in New Zealand since September 2010 using VCST as a voice intervention for people with PD. This chapter describes the workings of that singing group and explores how song choices might develop parameters of voice amplitude, voice quality and wellbeing.

### **5.1 Background**

#### **5.1.1 A Cultural Universal**

For thousands of years, in all cultures, in all parts of the world, people have been singing. Chanda and Levitin's (2013) review of the literature on the neurochemistry of music describes music as a “human cultural universal that evokes a wide range of emotions that include exhilaration, relaxation, joy and sadness... with many people using it to regulate mood and arousal as they might use caffeine or alcohol” (p.179). They state that the notion that ‘music is medicine’ has roots that extend deep into human history through healing rituals practised in pre-industrial, tribal-based societies. Although research into the neurochemistry of music is at an early stage, their review of the literature suggests that music influences

health through neurochemical changes in four domains of reward, motivation and pleasure, stress and arousal and immunity and social affiliation. The compelling evidence of the widespread and longstanding significant role of singing throughout history (Potter & Sorrell, 2012; Brown et al., 2014) suggests that it is our genes and the urge to sing and to hear others sing is in all of us. Producing musical sounds with one's voice - singing - is so basic to human beings that its origins are lost in antiquity and predates spoken language (Grauer, 2006; Bonilha et al., 2009).

### **5.1.2 Group Singing**

The human cultural universal described by Chanda and Levitin, (2013) is evidenced by the large numbers of people who regularly come together to sing, motivated primarily by a love of music, the expressive activity of singing itself and sense of community (Clift et al., 2006). Singing together is a socially acceptable and creative activity which Clift et al. (2006) suggest has intrinsic value and reward for those who participate. This theme is expanded by Balsnes (2017), who state that community music has many characteristics, including multiple learner/teacher relationships, access for all members of the community, social and personal growth alongside participants' musical growth, and an awareness of the need to include disadvantaged individuals and groups in the activity. There is a growing body of research with a focus on the positive effects that singing might have on aspects that relate to personal growth and social well-being (Bento-Allpress, 2013). In particular, community group singing can overcome boundaries that often counteract aspects such as inclusion, cultural participation and personal growth, through methods such as improvisation, musical diversity, informal learning and with leaders who are more facilitators than teachers (Clift and Hancox, 2010; Balsnes, 2017).

If one thinks of VCST as the vehicle that facilitates phonatory and respiratory exercise, the songs, therefore, could be considered the 'terrain' for which the phonatory and

respiratory muscle control systems will navigate. The choice of song, and the duration and intensity of how it is delivered, impacts significantly on the level of the exercise and therapeutic outcome; too quiet and on level terrain is likely to see no benefit, whilst too loud and on steep, uneven, terrain could be potentially harmful to the vocal folds. The information on song rationale contained in this chapter does not draw from empirical evidence per se, but serves as an insight into the process behind decisions made on song choices when developing a repertoire for the BWS choir.

## **5.2 Background - The Brainwave Singers Choir**

The BWS held their inaugural meeting in September 2010 and was born out of a smaller community singing and education group for people with PD that had been running for two years previously. Although dominated by people with PD, the BWS is an inclusive choir and open to anyone with a neurological condition including, stroke (cerebrovascular event), progressive supranuclear palsy, multi system atrophy and head trauma. Apart from a gold coin donation to cover the cost of tea and biscuits, membership to the BWS choir is free. Choir members' significant others are encouraged to attend with them, and there are a high number of couples attending who share the experience. The gender ratio of the BWS choir run by the researcher has men making up 62% of the total choir membership; a ratio which reflects the incidence and prevalence in epidemiological studies (Haaxma et al., 2007; Shulman, 2007). The majority of choir members have PD and the principal aim of the choir is the provision of voice therapy for them. It is important to note at this point that, although it is a choir dedicated to people with neurological conditions, it is independent of disease focus. That is to say, that the aims of the choir as a whole and those of the individuals in the choir are not defined by their disability. In that respect, the choir is like many other choirs; they practice, perform public concerts and record songs in a studio.

Of concern when setting up the choir was the need for support from the District Health

Board (DHB) as nurturing their involvement and support was considered important in terms of planning and developing evidence to support the concept of group singing as a mainstream intervention. Having presented my plans and gaining DHB support, an article was placed in the local media calling for a public meeting to gauge the level of interest in the idea of a choir for people with a neurological condition. The response was overwhelming and the choir was formed and given its name shortly after. Today, eight years after its conception, the choir has grown and currently has a regular attendance of over 60 people.

Choirs currently active in New Zealand are led by music therapists (MT), SLTs or by volunteer facilitators including those from Parkinson's New Zealand. Whether community choirs for people with PD are run by one or both MT and SLT disciplines or by an experienced singer or choir leader might depend on a series of factors such as geographical location, funding and availability. Vella-Burrows and Hancox (2012) discuss this in their interesting guidance on setting up and running community singing groups in collaboration with local Parkinson's Society branch community educators and members. Apart from finding a local 'champion', the most important factor in the successful continuation of a singing group, they say, is a choir leader with qualities that include experience of leading a singing group, a knowledge of neurological conditions and a knowledge of the type of exercises, which will strengthen vocal and respiratory muscles and personal charisma to enthuse the singers; qualities held by MTs and some SLTs.

With unique, but complementary knowledge and skills, the opportunity for interdisciplinary collaboration of MTs and SLTs would be advantageous. Collaboration could facilitate research and evidence base in a 'clinical' setting and enable an equally important advisory or consultative model of supporting local champions and choir leaders in community groups as described by Vella-Burrows and Hancox.

### 5.3 Intervention for Voice

The inspiration for the author's interest in VCST as a potential voice therapy stems from three convergent strands; his passion for music, a chance meeting with a PD choir in London in 2004, and a study published by Di Benedetto et al. (2009) in which significant respiratory and maximum phonation (MPT) improvement was observed in a group of people with PD undergoing collective speech therapy and choral singing. A later unpublished study; a longitudinal feasibility study of two groups of people with PD; one undertaking VCST and one (control) receiving no intervention also identified significant between group differences in MPT, voice amplitude and quality (Matthews, 2013).

One 'mainstream' approach to voice therapy for people with PD such as the Lee Silverman Voice Treatment (LSVT<sup>®</sup>) uses loud phonation and high intensity vocal exercise to improve respiratory, laryngeal, and articulatory function during speech and is reported as having a positive and long-term effect on amplitude, MPT and fundamental frequency ( $F_0$ ) (Baumgartner, Sapir, & Ramig, 2001; Dromey, Ramig, & Johnson, 1995; Dromey, Ramig, & Johnson, 1995; Fox et al., 2006; Spielman et al., 2011). However, despite this, it is suggested that as few as 3-4% of people with PD actually participate in treatment (Shih et al., 2012). Common barriers to participation relate to perceptions that LSVT<sup>®</sup> is too intensive and not sufficiently engaging to sustain long long-term commitment to practice (Shih et al., 2012). With a focus on increased respiratory and phonatory effort, LSVT<sup>®</sup> also has the potential to adversely affect the voice because it raises vocal pitch and laryngeal muscle tension (de Swart, Willemse, Maassen, & Horstink, 2003).

Another approach to voice therapy is the Pitch Limiting Voice Treatment (PLVT), which is similar to LSVT<sup>®</sup> in that it is shown to increase loudness but, by setting vocal pitch at a lower level, prevents strained or pressed voicing (de Swart et al., 2003). There is encouraging evidence that suggests that the sophistication of voice production through the

process of (high intensity) singing could have a beneficial effect on phonatory and respiratory function in a similar way to established treatments (Harris et al., 2016; Bento-Alpress, 2013; Clark & Harding, 2012) as well as significant increase in positive mood and psychological and social wellbeing (Clift et al., 2017).

#### **5.4 Wellbeing**

In addition to voice, there is the associated positive effect that group singing has on the wellbeing, uplift and health of participants (Clift, Nicol, Raisbeck, Whitmore, & Morrison, 2010; Clift & Hancox, 2010; Clift et al., 2007, 2017). Certainly, from personal observation when leading the BWS, the effect that group singing and sense of belonging to a mutually supportive community has on personal wellbeing is tangible and often reported by choir members and their partners. Unpublished questionnaire findings of members' and carers' perception of participation in the BWS choir are similar to those of the SPICCATO (Fogg & Talmage, 2011) study in that it was also found that group singing facilitates self-expression, emotional release and a sense of belonging. Choir members who, by their own admission, were experiencing deterioration in wellbeing, confidence and withdrawal from social networks, now flourish with a sense of purpose through this 'collaborative community'.

Being part of a wider group that requires cooperation not only encourages individuals to leave behind their own problems, but to contribute to the whole. Thus, opportunities for gaining and giving support and understanding are other benefits of a therapeutic choir. This latter point is evidenced and expanded by the BWS who have reach beyond their 'community' to organise and perform public concerts to raise funds for different associations and foundations like the Neurological Foundation and Parkinson's New Zealand.

A person's wellbeing can be significantly affected by their view of their physical, psychological and social status and a sense that these are diminishing can result in a severe sense of ill-being. Being active in a singing group that has a purpose, develops goals and

promotes a sense of value as a member, alongside mutually supportive people who share an understanding, can help counter some of the challenges that arise from living with PD (Vella-Burrows & Hancox, 2012). Personal observation suggests that singing together can also significantly enhance relationships between choir members with PD and their partners as well as helping form new friendships with other choir members.

Being part of a community that nurtures cooperation also encourages members to leave behind their personal problems and contribute to the whole. Thus, opportunities for gaining and giving support within an ethos of mutual understanding, although originally subsidiary to the BWS choir's original aims, are now an extremely important part of belonging to this 'therapeutic' choir. This point is evidenced beautifully in the way choir members regularly reach beyond their 'community' to organise and perform public concerts to raise funds for charitable causes.

### **5.5 Therapeutic Singing**

Singing has the potential to treat speech abnormalities because it directly stimulates the musculature associated with respiration, phonation, articulation and resonance (Natke et al., 2003). Singing requires breathing to be regulated to sustain notes and increase intensity and control compared to speaking alone and has been suggested; increases respiratory muscle strength (Wiens, Reimer, & Guyn, 1999). Respiration is key to generating voice and is thus an essential factor for singing. Singing involves strong and fast respirations followed by extended, regulated expirations requiring accurate control of breathing. In addition, singing requires a particular type of respiratory exercise that repeatedly demands diaphragm contractions for full inspirations followed by sustained contractions of expiratory muscles with semi closed vocal folds during expirations (Pettersen, 2005).

## **5.6 Feedback and Amplitude**

Singing serves as a valuable therapeutic tool because as a universal form of expression it is as natural as speaking. Moreover, singing engages an auditory-motor feedback loop in the brain more intensely than other music making activities such as instrumental playing (Wan, Rüber, Hohmann, & Schlaug, 2010). An overall diminishing of articulatory movement and acoustic parameters recorded in people with PD support the notion that speech therapies should be directed at increasing speech effort (Walsh & Smith, 2011).

People with PD have abnormal speech loudness modulation, often failing to increase loudness in response to the audio feedback and background noise in the same manner as someone who is non-PD. When given instruction or specific auditory cues people with PD are able to increase loudness suggesting that this is a PD feature that can be overridden (Ramig et al., 2008). Singing benefits people across different clinical populations and for people with PD, it also provides the potential of improving articulatory movement and increasing amplitude. It has the potential to engage and enhance auditory feedback improving the person's internal perception of the differentiation between that of old 'habitual' voice and that of a 'new normal' voice.

There is encouraging evidence showing exercise involving laryngeal and respiratory mechanisms and increased vocal intensity can produce significant and durable increases in habitual vocal amplitude whether through LSVT<sup>®</sup>, PVL, VCST or the Lombard effect (de Swart et al., 2003; Ramig et al., 2001; Stathopoulos et al., 2014; Matthews, 2013).

## **5.7 Brainwave Singers Session Format**

The BWS number 70 members and meet for VCST each week on Wednesday mornings. Sessions begin at 9:45 and consist of around 15 minute singing and non-singing (warm-up) relaxation exercises for oro-facial, vocal tract, laryngeal movement, neck and shoulder along with general posture, stretches and shake downs.

### **5.7.1 Posture**

Careful attention is paid at all times to good posture when exercising and singing. Everyone sits on comfortable padded seating, sitting up straight with good symmetry and with arms unfolded resting on thighs. Attaining good posture is helped greatly by the use of a digital projector connected to a laptop, which enables a large projection on to a facing wall of all song lyrics (Arial font size 48 with double spacing) as well as the exercise regime.

Choir members are encouraged to maintain good sitting posture and comfort when they are singing. Apart from the exercises, movement is not encouraged and is not part of the programme. LaPointe, Stierwalt and Maitland (2010) discovered that multi-tasking can be difficult and potentially dangerous for people with PD. They found that increasing cognitive and linguistic demands affected the gait of individuals with PD and state that the clinical implication of this finding is that doing several things at once, such as moving to music while reading lyrics and singing, may be more challenging for individuals with PD.

### **5.7.2 Warm Ups**

Study findings of a non-clinical professional singing population suggest that warm up routines should be between 5 and 10 minutes in duration and use simple vocalisations that might include ascending/descending five-note scales, ascending/descending octave scales and ascending/descending arpeggios and glissandi. The warm-up should also include non-singing exercises targeting the face, head, and neck muscles, breathing exercises, and postural alignment exercises (Gish, Kunduk, Sims, & McWhorter, 2012).

### **5.7.3 Choir Exercises**

A series of respiratory and phonatory exercises designed to improve diaphragmatic involvement, vocal fold adduction and vocal support are undertaken before starting the first of two 30 minute singing sessions separated by a 30 minute refreshment break. A vocal warm up routine is considered essential (Gish et al., 2012) and the warm up exercises adopted by

the BWS are similar to those used to prevent vocal fold injury. The warm-up also includes non-singing exercises targeting oro-motor, face, head and neck muscles, breathing exercises and postural alignment exercises (Appendix 12).

Weekly exercises undertaken by the choir members include:

- Stretching - gliding from the lowest note to the highest.
- Contracting - gliding from the highest note to the lowest.
- Adductory power/subglottic pressure: sustaining /a/ for as long as possible.
  - A five note scale of back close vowel /u/ and front open to open-mid /a/ sang as /u.u.u/ /a.a.a.a.a/.
  - Sustaining /a/ for 15 seconds and as loudly as is comfortable without straining.
- Eight, slow, extended “meows” ( /i/ /a/ /o/ ) over an octave scale, with exaggerated lip positioning to develop intrinsic and extrinsic laryngeal muscle strength and excursion.
- Vocal support: a graduated rhythmic singing of numbers - starting at 5 and moving up to 10 and back on one breath e.g. 123454321, 12345654321, 123456789876543231, etc.
- Semi occluded vocal tract (SOVT) exercises: Lip and tongue trills
- Voice dynamics: the days of the week spoken in a whisper and then gradually increasing volume (crescendo <) over the seven days reaching maximum volume before going back through the week gradually reducing volume (diminuendo >) returning to a whisper.

## **5.8 Benefits of Live Musical Accompaniment**

Live accompaniment using a digital piano, guitar or tenor ukulele is preferred to that of recorded accompaniment, because it connects the leader to the choir in a way that the duality of listening and reacting to recorded music is not able to. The connection and interaction generated between leader and choir is of utmost importance. Apart from keeping everyone together and creating an atmosphere of fun, playing live enables orchestration of the

choir around the songs to introduce effects such as movement, light and shade (crescendo and diminuendo) and, of course, tempo and the important dynamic required for driving ‘vitality’ or intensity.

### **5.9 Song and Repertoire Selection**

Over seven years, choir members have developed an awareness of their breathing and the changes brought about by exercise and singing. They take a great interest in the selection of songs used and have collectively chosen material not particularly because of a song’s popularity, but because of a genuine feeling that the song will have therapeutic benefit helping to develop their breathing and voice.

Currently, the choir enjoys a large and varied repertoire using 10 different song lists each comprising 15 songs. This enables a 10 week rotation of the lists and by doing so reduces the potential risk of repetition, boredom and reduced motivation. The rotation of songs in this way, however, is not rigid in structure. Other songs from the repertoire are often added if requested and often repeated if the choir have enjoyed singing it or we want to improve how it is sung. The introduction of new songs takes time to learn and this too will change the running order. Songs are chosen that are fun, have a comfortable tempo and provide the best ‘terrain’ to facilitate an increase in respiratory and phonatory effort. That said, to remove strain and over reaching, the digital piano is transposed four chromatic steps to adjust the pitch to be a major third lower. The reader will remember that the designers of PVLT also recognised this effect and also set vocal pitch at a lower level to limit increase pitch to prevent straining or pressed voicing (de Swart et al., 2003).

### **5.10 Song Parameters That Need Consideration**

A sample of the songs are presented to illustrate how and why particular songs are chosen. When choosing a song, consideration is given to enjoyment, tempo and effort and how the ‘terrain’ might improve parameters of laryngeal mobility as well as the respiratory

and phonatory involvement required to sing them.

The songs selected for the BWS choir produce the necessary parameters for laryngeal mobility, respiratory and phonatory effort but, most songs will provide some aspect of the elements listed to a greater or lesser extent. This explanation serves as an insight into subjective decisions made on particular song choices and how they might fulfil the parameters, remembering that intensity is very important for voice improvement in those with PD. Selected songs are evaluated for potential and suitability. Attention is paid to how the tempo, melody, diadochokinesis (complexity of articulation) and vocal range might provide the dynamic parameters and coordination to maintain the intensity generated from the pre-singing exercises and other songs.

### **5.11 Word/Syllable Count (Diadochokinesis)**

According to legend kissing the Blarney Stone, a block of limestone built into the battlements of Blarney Castle in Ireland, endows the kisser with the ‘gift of the gab’ (Samuel & Hamlyn., 2007). Luckily, this Irish phenomenon is also true of their songs and it is no coincidence that the choir has many songs of Irish origin in its repertoire.

Three songs that exemplify this trait very well are *Delaney’s Donkey* (Hargreaves, 1948), *O’Rafferty’s Motor Car* (Connor, 1964) and *Paddy McGinty’s Goat* (Lee & Weston, 1917).

The songs fall within the genre of Irish folk, but are contemporary-humorous rather than traditional. Both are very funny, contain a lot of words and require considerable concentration on breathing and diadochokinetic coordination. As such, the songs are very rhythmic in structure with a tempo, accents and stresses typical of Irish folk songs and jigs.

Very different, but with similar characteristics is the Sherman Brothers, (1964) song *Supercalifragilisticexpialidocious* from Disney’s *Mary Poppins*®. This too is a humorous and much loved song. Verses alternate between the men and women, which creates gentle rivalry as well as mutual appreciation. As with the Irish songs above, this song also puts pressure on

respiration and emphasises the importance of the vocal support exercises. The rhythm of this song is very important to respiration as it is organised line by line owing to the relative linearity of a regular beat and simple melody.

*Gilly Gilly Ossenfeffer Katzenellen Bogen by the Sea* (Hoffman & Manning, 1954) is another popular song, which the men and women also share but, with this song, each line is sung first by the men and repeated by the women. It too has good tempo with each line naturally and alternately gliding from low to high and high to low. The song requires good breathing coordination for all of the four word, five syllable lines contained in the verse and particularly for the last line of the verse which consists of a longer eight word, 21 syllable line (the song title). The nature of the tempo and balance of repetition means the song is sung easily with high intensity.

Cliff and the Shadows' *The Young Ones* (Tepper & Bennett, 1961) is another popular song with the choir. It has extensive vocal range and long lines containing sustained vowels; some with portamentos, which expend a lot of expiratory air and as such requires good respiratory coordination, whilst also providing good laryngeal mobility.

These examples are in a  $4/4$  time signature. However, many of the songs in the repertoire are in  $3/4$  or  $6/8$ , which is deliberate. Songs in these time signatures have an infectious tempo and are structured in such a way that pausing and breathing is helped greatly by the structure and tempo. *Que Sera Sera* (Livingstone & Evans, 1956) and *Never Say Never* (Stubblings, 2003) are good examples of how the momentum of a song in  $3/4$  facilitates breathing, tempo and intensity very efficiently and in a way that pulls the singer along. Songs in  $3/4$  or  $6/8$  signature have a strong emphasis on the onset and the beat; a rhythm which choir members find easier to follow as well as easier to organise their breathing.

Baird et al. (2018) are the first to examine the emotional effects of group singing in 11 people with PD, and explored if differences in music reward modulated the emotional effects

of group singing with participants reporting three conditions: immediately after group singing, familiar songs, unfamiliar songs, and no singing. Positive affect scores were higher in the singing than no-singing condition. They found no significant difference in positive affect scores between the familiar and unfamiliar song condition and a positive but not statistically significant relationship between music reward and positive affect scores after singing. This study by Baird et al. (2018) documents enhanced positive affect in people with PD immediately after group singing which is in keeping with similar previous studies. With regard to song familiarity they found no difference in positive affect between group singing of familiar or unfamiliar songs suggesting that group singing has holistic emotional benefits, regardless of the familiarity of the songs.

### **5.12 Conclusion**

There are many reasons to believe that singing is good for people with PD. The literature indicates a growing acceptance and a convergence of ideas related to health and singing. Music and singing makes rehabilitation enjoyable and can provide an alternative entry point into a “broken” brain system for remediation of impaired neural processes or neural connections (Schlaug et al., 2010).

Group singing can also have a significant psychosocial benefit for people with a neurological condition with active singing providing opportunities for physical, emotional, cognitive, and social engagement (Clark & Harding, 2012; Clift et al., 2017). The bringing together of a ‘community’ through group singing nurtures connectedness that helps choir members to re-evaluate their ability to exercise some control over how they interact with their environment (Buetow, Talmage, McCann, Fogg, & Purdy, 2013). Connectedness, intrinsic value and reward can impact positively on how choir members approach the management of their condition (Buetow et al., 2010).

The author's observations from running the BWS singing group support many of the outcomes cited from previous studies on therapeutic group singing. Questionnaire data as well as anecdotal evidence from members over seven years of membership describe themselves as "being in the same boat" and in a "non-fail" intervention. What the singing group members are referring to is the distinction between a singing environment and that of a clinical environment where, as an individual, they might sit across a desk from their clinician in a 'confrontational' situation with them worrying that they "might fail" or "didn't get it right".

Apart from it being extremely enjoyable, choir members also say the group singing environment differs in that their voices are submerged into a collective that isn't one where you have to get it right but where, as a collective, their voices aren't heard as a single entity, but as part of the whole.

Although the precise mechanisms underlying the therapeutic efficacy of singing remain largely unexplored, the physical 'sophisticated' act of singing has the potential to improve speech motor deficits (subglottic pressure, voice amplitude and quality) in people with PD if intensity, as reflected in established treatments like LSVT<sup>®</sup>, are carefully built in to the choir protocol.

Singing, therefore, can help people in a number of ways. There is moderate evidence showing the beneficial effect of singing in groups, be it wellbeing, connectedness and the potential to impact significantly on communication (Clift et al., 2007; Clift et al., 2010; Clift & Hancox, 2010; Baird et al., 2018). However, most of these studies do not describe the singing choices or how and why the song format was selected. Baird et al. (2018) have contributed interesting data suggesting that song familiarity does not affect outcomes of positive effect. It is hypothesised in this present study that, if greater consideration is given to song choices and reporting this information, this area of research will be strengthened. The

right song choices will bring together fun, tempo and intensity to enhance the effect and experience of choir participation for people with Parkinson's disease.

## Chapter 6: Study Two

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### 6.1. Introduction

This chapter is an overview of the rationale and aim of Study Two, which sets out to investigate the efficacy of voice and choral singing therapy (VCST) as a voice treatment and to investigate what effect group singing has on the wellbeing of people with PD.

The study design is built upon personal clinical experience and research findings found in the published literature and discussed in the preceding chapters. Specific detail relating to the study protocol is found in Chapter 7 - Method.

PD or idiopathic Parkinsonism is a chronic, progressive neurodegenerative condition. It is more commonly seen in the elderly population with most cases occurring after the age of 50 and affects 1-2% of people older than 60 years of age (Skodda, 2011). PD is a disorder of the central nervous system and described by Pavão et al. (2012) as a progressive degeneration of dopaminergic neurons and tracts located in the corpus striatum and lesions located in the substantia nigra, which results in a specific disorganisation of the complicated basal ganglia circuits. It is the most common form of movement disorder and the second most common neurodegenerative disorder and currently affects an estimated five million people worldwide (Dorsey et al., 2007) with an estimated 70 to 75% having speech and voice-related communication problems (Benedetto et al 2009; Skoda et al., 2009).

The motor and cognitive symptomology of the condition are precursors of disorders of speech, characterised as quiet, hoarse and breathy with imprecise articulation (Dean et al., 2010; Sapir, Ramig, & Fox, 2007). During the course of their illness almost 90% of people with PD will develop such disorders which worsen as the condition progresses. This impacts significantly on their communication; limiting the ability and willingness to participate in conversation (Sapir, Ramig, & Fox, 2008) as voice quality, respiration and changes to

prosody reduce intelligibility (Darley et al., 1975) and contribute to reductions in quality of life (Den Oudsten et al., 2007).

Currently, the country of this present study, New Zealand, does not have a preferred approach to speech and language therapy for people with PD. There is little evidence for the effectiveness of standard therapy for New Zealanders with PD (McAuliffe, 2008) and even less for novel community-based therapy approaches such as VCST as a means of treating voice (Buetow et al., 2013).

Speech and language treatments for people with PD such as the Lee Silverman Voice Treatment (LSVT<sup>®</sup>) have been used to treat the PD population since 1987. LSVT<sup>®</sup> has been extensively researched and is an evidence-based intervention approach (Ramig et al., 1996; Ramig et al., 2001).

The basic mechanism underlying the success of the LSVT<sup>®</sup> for increasing voice loudness is improving subglottic pressure and thus improving vocal fold adduction and vibration. LSVT<sup>®</sup> is considered the most effective speech and therapy to date, but it has limitations owing to insufficient availability and prescription (Skodda, Gronheit, Mancinelli, & Schlegel, 2013).

The treatment dosage of LSVT<sup>®</sup> and LSVT-X<sup>®</sup> (Spielman, Ramig, Mahler, Halpern, & Gavin, 2007) and similar group singing studies are set out in Table 12 with comparisons of SPL outcomes (LSVT-X<sup>®</sup> and LSVT (Herd et al., 2012).

VCST has been suggested as a rehabilitative therapy and a long term accessible therapy for people with PD to maintain vocal ability and delay decline. Di Benedetto et al. (2008) state that the aim of VCST is to improve speech and voice disorders through a collective, amusing, and agreeable therapy. Their study found an improvement in phonation time and fatigue and a reduction in the volume of air in the lungs after a normal, passive exhalation; referred to as functional residual capacity (FRC). This mechanical modification,

associated with respiratory muscle training, they suggest, could be responsible for the enhancement of the static respiratory pressure - maximal inspiratory and expiratory mouth pressures (MIP and MEP).

**Table 12**

Samples of Speech Loudness (SPL) According to Different Therapies and Treatment Dosage

		Hrs	Wks	Mic cm	MSP /a/			Reading			Conversation		
					Pre Mean (SD)	Post Mean (SD)	+dB	Pre Mean (SD)	Post Mean (SD)	+dB	Pre Mean (SD)	Post Mean (SD)	+dB
Ramig and Dromey, (1996)	LSVT®	16	4	50	67.7 (4.2)	81.7 (3.1)	14	67.5 (3.4)	74.2 (3.5)	6.7	64.5 (2.9)	70.0 (3.5)	5.5
Ramig et al., (2001)	LSVT®	16	4	30	69.1 (5.1)	82.4 (3.9)	13.3	71.3 (3.2)	77.9 (4.2)	6.6	69.0 (3.6)	74.5 (4.0)	5.5
Spielman et al., (2007)	LSVT-X®	16	8	30	72.0 (6.3)	83.0 (3.9)	11	72.7 (3.5)	79.6 (3.3)	6.9	69.6 (2.5)	75.7 (2.6)	6.1
Spielman et al., (2011) Average SPL	LSVT®	16	4	30			71.4 (1.6)	75.3 (1.7)	4.2				
Wight and Miller, (2015)	LSVT®	16	4	30	79.1 (8.2)	88.4 (3.6)	9.3	65.7 (7.1)	74.3 (4.9)	8.6	63.3 (6.8)	71.8 (5.7)	8.5
Halpern et al., (2012)	LSVT®	16	4	30	67.7 (3.6)	85.0 (2.4)	17.3	67.4 (1.1)	76.5 (3.6)	9.1	67.2 (1.4)	73.0 (3.6)	5.8
Shih et al., (2021)	Singing	18	12	50	ns	ns	-	68.8 (3.6)	68.5 (5.4)	-0.3	ns	ns	-
Tanner et al., (2016)	Singing	6	27	5	45.7 (10.16)	52.9 (7.03)	7.2	60.4 (3.5)	59.4 (4.7)	-1	59.6 (3.9)	58.6 (4.9)	-1
Stegemöller et al., 2016	Singing	16	8	61	104.0 (16.7)	104.2 (16.7)	-	-	-	-	-	-	-

Note. Hrs = length in hours of session, Wks = number in weeks of treatment, Mic cm = distance of microphone to participants' mouth.

The theoretical framework by which this study is constructed is derived from an unpublished master's thesis on VCST for people with PD (Matthews, 2013) as well as research findings from previous studies on different voice treatments that include group singing and LSVT® (Benedetto et al., 2009; Fox, 2008; Ramig et al., 1996, 2001; Vella-Burrows & Hancox, 2012). The non-randomised longitudinal (12 month) study undertaken by Matthews, (2013) on the effectiveness of VCST evaluated the acoustic and perceptual measures of vocal function of two groups of people with PD, one group receiving VCST and a non-treatment group and showed significant between-group differences in MSP, voice amplitude and quality.

This present study has widened its interest to include psychological wellbeing measures alongside instrumental measures of voice and respiration. Self-report outcome measures of voice, QoL, depression/anxiety and neuropsychological tests for cognitive impairment have been appraised from the findings of literature searches (Chapter 3) that feature consistently in studies on aspects of voice and psychosocial PD research.

There are many publications containing research into depression, apathy and anxiety within in the PD population (Stefanova et al., 2013; Walsh & Bennett, 2001; Reijnders et al., 2008; Gison et al., 2014). There is also an abundance of research on group singing and the benefit in relation to participants' physical/psychological wellbeing and QoL in non-PD populations (Clift and Hancox, 2010; Bento-Allpress, 2013; Buetow et al., 2013).

There are very few studies, however, researching a relationship between factors of anxiety, depression, wellbeing, voice and group singing with people with PD (Elefant et al., 2012).

A small pilot study of group singing therapy for PD related voice/speech disorders suggested that future studies might explore the effectiveness of different intensities and frequencies of therapy (Shih et al., 2012). Randomised studies of VCST versus a social control condition are

required to determine the impact of VCST on vocal intensity, respiration as well as psychological and psychosocial wellbeing.

The proposed research will examine voice, respiratory/glottal function and psychosocial outcomes in people with PD participating in VCST. These new data will serve to inform future research studies of singing based intervention for PD on what might be the optimum intensity and frequency of intervention.

## **6.2. Treatment Dosage**

Participants of the Choir group and the Music group attended once weekly sessions of 105 minutes (1.75 hours) over a period of nine weeks, giving a total of 16 hours treatment, which compares to the internationally used treatment dosage for LSVT<sup>®</sup> X of 2 hours per week for eight weeks.

## **6.3. Description of Acoustic and Respiratory Variables**

Previous studies that have investigated singing in people with PD have shown improvement in speech intelligibility and increased vocal intensity, voice quality and range (Di Benedetto et al., 2009; Haneishi, 2001; Stegemöller, Radig, Hibbing, Wingate, & Sapienza, 2016). Conversely, other studies have not found significant effects on voice (Shih et al., 2012).

Of the singing studies completed thus far, all have different design, method, frequency and duration of intervention. Data capture and instrumentation vary significantly between studies with inconsistent method, especially relating to measures of respiratory and glottal function. A review of the studies that have measured vocal intensity, quality and range as well as respiratory function and glottal behaviour described in Chapter four, has helped to direct the design of this particular study.

Below is a description of the measures used in this study and an explanation for why they were chosen. Further information on the acoustic and respiratory dependent variables

and protocol used in this study are found in Chapter 7.

### **6.3.1. Sound Pressure Levels (SPL)**

Maximum Sustained Phonation (MSP) is a widely used traditional measure of respiratory integrity and laryngeal valving (Solomon, Garlitz, & Milbrath, (2000) efficiency. It has been a feature in all published data on voice and people with PD and has been shown to have improved with singing (Di Benedetto et al., 2009; Tanner, Rammage, & Liu, 2016; Yinger & Lapointe, 2012). As well as MSP, the other main SPL data is derived from reading and conversation speech volume, which is captured as maximum and average SPL.

### **6.3.2 Voice Quality**

Production of voice requires that the vocal folds vibrate and create disturbances of airflow through the vocal tract (Stemple, Glaze, & Klaben, 2000). Acoustic or spectral measurement of the voice provides an indirect measure of laryngeal functioning. Using MDVP Kay Pentax<sup>®</sup> software, 29 dependent variables across four different acoustic measures are evaluated with those data of similar previously published studies (Bonilha & Dawson, 2012). Those of interest and used in this study are measures of Pitch Range – mean  $F_0$ , maximum and minimum  $F_0$ , standard deviation  $F_0$ , and semitone range to provide information on prosodic changes. Frequency analysis also provides an approach to the evaluation of the disturbance or noise in the voice as the amount of in-harmonic spectral component correlates to the perception of hoarseness (Deliyski, 1993). This can be detected in frequency perturbation measures of Jitter%, relative measure of the pitch disturbance RAP and  $F_0$  variation ( $vF_0$ ). Also of particular interest to this study are measures of perturbation intensity: Shimmer% and NHR, which is a general evaluation of the noise presence in the analysed sample (including amplitude and frequency variations, turbulence noise, sub-harmonic components and/or voice breaks); VTI, which correlates with the turbulence components caused by incomplete or loose adduction of the vocal folds and SPI, which

evaluates the poverty of a high frequency harmonic component that may be an indication of loosely adducted vocal folds during phonation (Deliyski, 1993). These latter components of the spectral analysis are characteristics of PD voice are of particular interest to this study and which Bonilha and Dawson, (2012) and Rosa et al. (2009) state are measurements sensitive to Parkinson's voice.

### **6.3.3. Respiration**

Vital capacity is the maximum amount of air expired after a maximum inspiration and is measured by asking the person to breathe out as quickly as possible after a maximum inspiration and is referred to as forced vital capacity (FVC) of which expired volume is measured in litres. Another common measure is the measure of the volume of air expired in the first second of the FVC task referred to as forced expiratory volume (FEF) measured in l/s.

Air flow measures may be useful to assess the laryngeal and respiratory contributions to phonatory onset as both respiratory and laryngeal control deficits may contribute to phonatory errors in PD (Hammer, 2013). People with PD, when compared with healthy controls, have a shorter voice onset time; exhale less of their lung volume per syllable during speech and have a larger airflow declination (Jiang & Maytag, 2014).

Spirometric analysis of respiratory function in PD supports the contention that respiratory exercise improves respiratory function and voice in someone with PD. (Murdoch, 2010) found that only a minority of people with PD have lung volumes and capacities outside normal limits and half of the Parkinson's subjects exhibited irregularities in their chest wall movements while performing vowel prolongation and syllable repetition tasks suggesting that their presence was in some way related to neuromuscular function. Di Benedetto et al. (2009) postulate that hypokinesia, stiffness or rigidity of respiratory muscles, could be improved by

acoustic cues or music rhythms found in choral singing and thus could be used for the treatment of speech and voice abnormalities in PD.

#### **6.3.4. Voicing Efficiency - Glottal Behaviour**

Subglottal pressure and ratio measures of glottal resistance and efficiency are laryngeal function measures commonly described in the assessment of aerodynamic function. These measures could be of clinical interest for people with PD who have a hypofunctional voice (Scherer & Cooper, 1991). Voice production is the result of a complex interaction between the aerodynamic input to the larynx from the lungs, the reactionary vibration of the vocal folds, and the resulting acoustic output (Jiang & Maytag, 2014). A combination of increased subglottal air pressure and vocal fold adduction is necessary to optimise the aerodynamic mechanism of intensity control in patients with Parkinson disease (Ramig & Dromey, 1996). Di Benedetto et al. (2009) state that voice abnormalities in people with PD are attributed to inadequate vocal fold adduction, reduced laryngeal muscles activation, muscle atrophy or fatigue, asymmetric vocal fold movements, rigidity of the vocal folds, and or respiratory muscles.

In this study, measurements are used to describe glottal behaviour. Evidence for the usefulness of aerodynamic resistance (ARES) peak air pressure (PAP), peak expiratory airflow (PEF) and expiratory volume (FVC) in describing glottal behaviour is well documented in the literature for a non-PD population (Holmberg, Hillman, & Perkall, 1989; Rosenthal, Lowell, & Colton, 2014).

There is however, a paucity of published material relating to glottal behaviour in people with PD, which is surprising given the importance of its potential to ameliorate hypophonia. Methods used to measure glottal behaviour vary from instrumental assessment of similar design to this study (Matheron, Stathopoulos, Huber, & Sussman, 2017; Ramig & Dromey,

1996; Stathopoulos et al., 2014) and to estimated visual measurement via endoscope (Smith, Ramig, Dromey, Perez, & Samandari, 1995).

#### **6.4. Psychological Wellbeing and Function**

The self-report questionnaires to assess quality of life (QoL), quality of voice, depression/anxiety and symptom severity in people with PD, as well as a measure of cognition, were assessed for reliability and suitability in Study 1 and were found to be suitable for the purpose of this study. Data from Study 1 also showed that participants referred positively to the timing and duration of the two test occasions confirming the importance of brevity and ease of administration. Being able to negotiate the time of the test occasion as well as being seen in their homes rather than in clinic were regarded as very positive and helped reduce the potential negative effects of fatigue and proximity to medication timings. For this reason, with the exception of the ACE-III, the self-report questionnaires for study 2 were mailed to the participants enabling them be completed at a convenient time at home and at close proximity (within two hours) to taking their anti-Parkinson's medications.

When Study 1 had been completed it was apparent that, for logistical reasons, moving sensitive testing equipment needed for the present study determined that individual home visits were not a realistic option. The need for location consistency when using the equipment, and keeping the assessment session with participants to an acceptable length were also important contributing factors in this decision. However, as shown in the Study 1 participant interviews, with adequate time and flexibility to negotiate the day and time for pre and post-treatment test occasions, indicated that if the instrumental assessment took place in a friendly and non-clinical environment it might be acceptable. This was a factor that was carefully planned in to the present study protocol and participant information sheet.

The self-rating questionnaires used in this current study are the Voice Handicap Index-10 (VHI-10) (Rosen, Lee, Osborne, Zullo, & Murry, 2004; Zraick et al., 2007), and the (VHI-

10P) Partner variant (Zraick et al., 2007). The VHI is widely used and has high reproducibility and excellent clinical validity (Schindler et al., 2010; Verdonck-de Leeuw et al., 2008) and has proved to be a useful instrument to monitor the treatment efficacy for voice disorders (Rosen et al., 2004). The VHI-10 is a short form questionnaire containing 10 statements from the 30-item VHI. There is no loss of utility or validity of the VHI-10 compared with the VHI for assessing initial patient-based voice handicap evaluation and longitudinal follow-up after treatment (Rosen et al., 2004).

Depression, Anxiety and Stress are evaluated using the Depression Anxiety Stress Scale (DASS-21) (Lovibond & Lovibond, 1995). The DASS-21, a short form version of the original DASS has been validated in a number of populations. The DASS-21 is psychometrically sound with excellent reliability and validity (Henry and Crawford, 2005).

Quality of life is measured using the Parkinson's disease Questionnaire-8 (PDQ-8) (Jenkinson, Fitzpatrick, Peto, Greenhall, & Hyman, 1997) . The PDQ-8 is an established assessment and is a short form version of the 39 item PDQ-39 which has been validated and demonstrates adequate internal consistency.

Symptom severity is measured using the Movement Disorder Society-Revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS), which is the most widely used scale for the clinical study of PD and has become the standard scale used in clinical care and research (Fahn & Elton 1987; Goetz et al., 2008). The self-rating subscales of Part I: Non-Motor Aspects of Experiences of Daily Living (nM-EDL) and Part II: Motor Aspects of Experiences of Daily Living (M-EDL) measure the general function of the participants through a basic diagnostic measure of their self-rated perception of severity of motor difficulties in relation to experiences during activities of daily living.

A baseline assessment of cognition is undertaken by a trained research assistant using the cognitive screening measure: Addenbrookes Cognitive Assessment-III, NZ Version A

(ACE-III) (Hsieh, Schubert, Hoon, Mioshi, & Hodges, 2013) which assesses five cognitive domains: Attention, Memory, Verbal Fluency, Language and Visual-spatial. Cut-off scores of (88 and 82 out of 100) are suspicious of dementia.

## **6.5. Hypothesis**

Based on the findings of a systematic review of the published literature, this study hypothesised that the Choir group would show an improvement on the acoustic, spirometric and quality of life measures compared to the Music group. More specifically, it is hypothesised that the Choir group:

Hypothesis 1: SPL - There will be a post treatment improvement in SPL: maximum and average volume and MSP duration in seconds.

Hypothesis 2: Respiration - There will be a post treatment respiratory improvement in FVC and FEV.

Hypothesis 3: Glottal Behaviour - There will be a post treatment improvement in overall vocal fold adduction and aerodynamic measures of ARES, PAP and PEF.

Hypothesis 4: Voice Quality - There will be a % reduction in measures of perturbation and post treatment improvement in pitch range and in acoustic properties with improved Mean  $F_0$ ,  $vF_0$ .

Hypothesis 5: Psychological Wellbeing and Function - There will be a post treatment self-report improvement in perceived voice, QoL and measures of stress, anxiety and PD symptom severity.

## Chapter 7: Study Two Method

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### 7.1 Study Design

This study is a two armed parallel – Randomised Control Trial (RCT) of quantitative design. Using a range of internationally recognised approaches to measure aspects of voice, respiration, prosody, wellbeing and cognition this study investigates whether there are significant differences between two groups of people with PD, one attending a choir and receiving VCST and the other attending a music appreciation group viewing and discussing music videos, participating in a music trivia quiz and reminiscing on music related lifetime milestones to control for the effects of social group participation.

The trial is reported according to the Consolidated Standards of Reporting Trials for experimental non-pharmacological treatment (Schulz, Altman, & Moher, 2010). Analysis is by intention to treat. The trial is registered with the Australian and New Zealand Clinical Trial Registry ACTRN12616000367448

**Ethics approval** - Ethics approval has been granted from the Health and Disability Ethics Committees ref: 16/NTA/53 (Appendix 7).

### 7.2 Inclusion and Exclusion Criteria

Inclusion criteria for the volunteer participants was limited to people with PD and otherwise good general health and no history of other neurological or psychiatric disease. They had no comorbidities such as a stroke, seizures, head trauma or COPD and had not received treatment for depression, alcoholism or drug abuse. They were non-smokers (more than 5 years not smoking) and had not received speech and language therapy within 1 year of this study. There were no other exclusion criteria. Data analysis of a pilot study (Chapter 3) comparing ACE-III data of the ‘healthy’ cognition scores (89 to 100) with that of the

‘cognitive risk’ group (88 and lower scores) across all domains showed no statistically significant group difference in self-reported measures outcomes between the ‘healthy’ and ‘cognitive risk’ groups, which suggested that cognition scores need not be a parameter of exclusion criteria in this study. Furthermore, Ramig et al. (2001) claim that correlations between prognostic variables such as stage of disease, speech/voice severity rating, depression, time since diagnosis and magnitude of treatment-related change indicated that these factors did not significantly predict treatment effectiveness.

### **7.3 Participant Recruitment**

The researcher gained the support of two local Parkinson’s New Zealand groups, community educators from Parkinson’s New Zealand (PNZ) in the Bay of Plenty and Waikato regions of New Zealand, who assisted with the recruitment of potential participants over the two locations. 175 people with idiopathic PD were identified by the PNZ community educators from their databases and were sent an invitation letter (Appendix 8) introducing the study, providing key points and a means of replying. Those who returned the signed reply were contacted by a researcher to confirm their willingness to participate, answer any questions that they had and ascertain recruitment eligibility. Time was taken to discuss the trial and what participation in the trial would involve including being randomised in to one of two groups, their required attendance over the 9 week treatment period and the pre and post treatment assessments that were required to complete. Participants and their partners were then sent a Patient Information Sheet (PIS) and consent (Appendix 9&10) in accordance with HDEC guidelines. This letter provided an introduction to the study, key points and a prepaid postal consent form for participants to sign and return.

One month prior to the pre-treatment assessment, consenting participants received full details pertaining to the assessment along with four self-reported questionnaires of voice quality, quality of life, anxiety and experience of daily living with PD.

The PIS and consent forms were mailed out with  $N=48$  (27.4%) signed and returned comprising ( $n=30$  males,  $n=18$  female). Participants were aged from 40-83 years ( $M = 69.15$   $SD = 8.27$ ) (Table 13). To account for an anticipated attrition rate of 15% - 20%, final participant numbers were estimated to be approximately 38 (19 per group).

Sample size and power calculation: On the basis of a study by Shih et al. (2012) to detect a 4 dB difference in the primary outcome measure (SPL) would require a sample size 32 participants divided between a singing intervention arm and a non-singing intervention for a 0.05 difference with a power of 80%. The target number of participants recruited was 40 (20 per group) to account for an anticipated attrition rate of 15% - 20%.

The participants were diagnosed with idiopathic Parkinson's disease by a Consultant Neurologist and were receiving usual PD clinical care. They had no other neurological disorder other than PD. Symptom severity was assessed according to the Hoehn and Yahr rating scale - Hoehn and Yahr stage 2-3 (Goetz et al., 2008) (Appendix 1).

All participants were on a stable regimen of anti-Parkinson medication (prescribed levodopa) of which 14 were also taking a dopamine agonist. PD symptoms can vary significantly according to medication levels (Fritsch et al., 2012).

To safeguard against On - Off motor fluctuations and to improve the chance that participants were in an optimum On phase whilst undergoing assessments, appointments were arranged so they occurred no more than two hours after participants had taken their Parkinson's medication. Participants were contacted by phone prior to their appointment to remind them of the appointment and to remind them to take their medications at the correct time.

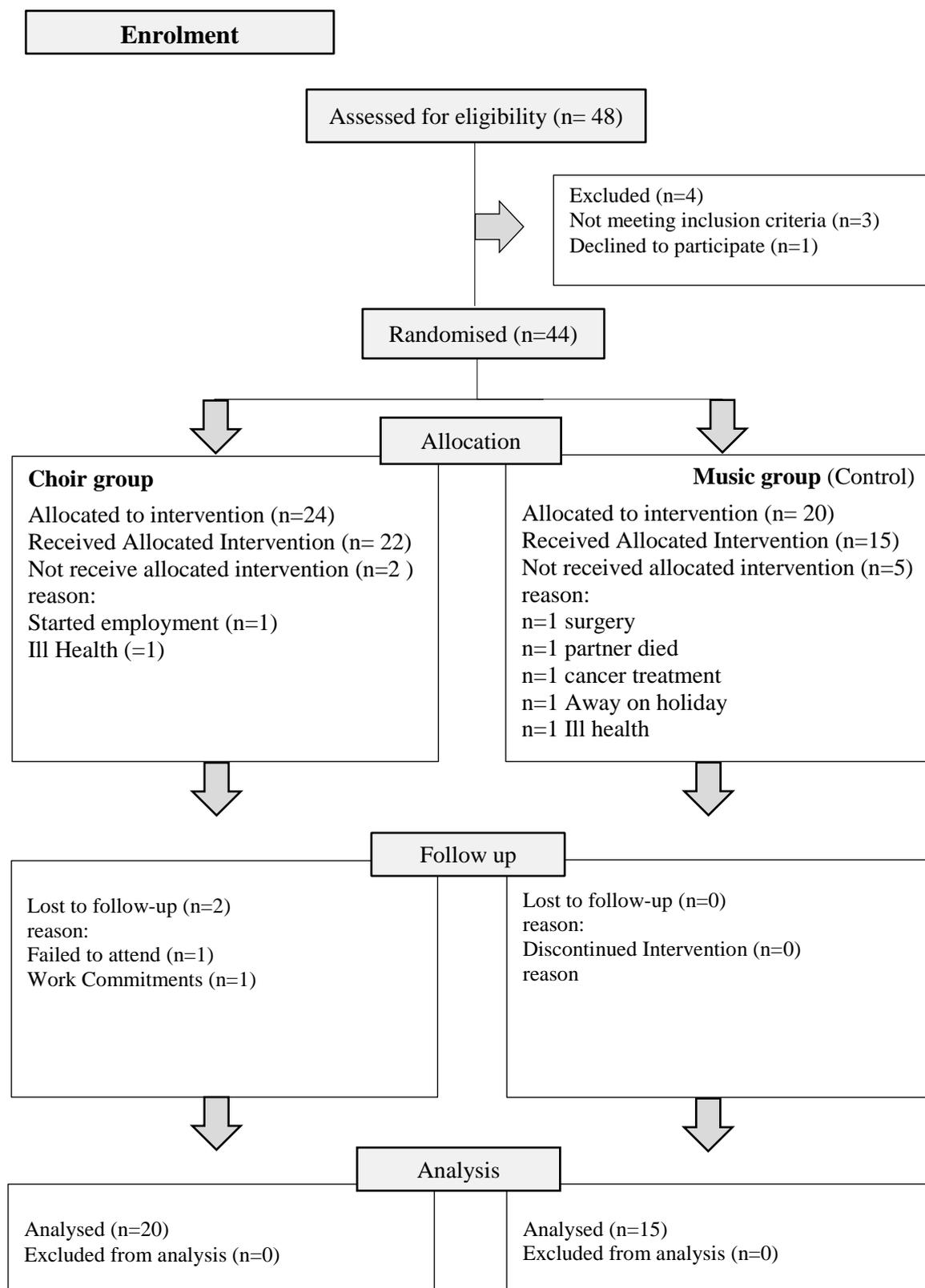
For the same reason, an effort was also made to ensure that scheduled appointment times for both pre and post-treatment assessments occurred at the same time of day to avoid fluctuations that may have influenced the outcome measures.

## **7.4 Randomisation**

Randomisation for this study controlled only for even spread of gender across the two groups. The 48 people (Figure 2) who consented to participate were randomly assigned to one of two groups in two locations. - Hamilton and Tauranga. Two choirs received voice and choral singing therapy (VCST) and two organised non-singing music groups participated in social and music appreciation activities to control for the effects of social group participation.

The Choir groups participated in singing with voice and respiration exercise activities. The non-singing Music groups received a placebo music appreciation activity comprised of listening to, and watching, videos of music and singing and discussing it. To ensure concealment of treatment allocation, the randomisation was undertaken by a trained clinician and coordinator at the Bay of Plenty Clinical Trials Unit (BOPCTU) using computer-generated randomisation software.

The participants and the attending research assistant (RA) were blind to the treatment allocation at the time of the pre-treatment (baseline) assessments. The participants were informed of their treatment allocation after completing the pre-treatment assessment when they attended their respective treatment groups one week later.



**Figure 2.** Consort flowchart showing how the study population was recruited and handled during the course of this RCT.

## 7.5 Pre-Trial Participant Withdrawal

Of the original 44 consenting participants, 7 withdrew from the study before the pre-treatment assessment process with 2 withdrawing after the pre-treatment assessment process (Figure 2). To avoid bias and to provide fair comparisons an intention to treat (ITT) analysis of the results was undertaken with withdrawing participants analysed in the groups to which they were randomised. The most commonly used method in the analysis of continuous outcomes is the last observation carried forward (LOCF) analysis (Altman, 2009). Based on the number of missing data (two Participants) it was determined that ITT and LOCF was appropriate (Gupta, 2011). This method has been adopted for the current study with outcome variables replaced by the last known value (pre-treatment) before the participant was lost to follow up.

## 7.6 Characteristics of Participants

**Table 13**

*Demographic Characteristics of Choir and Music Group*

	Sex		Age		Years with Parkinson's		UPDRS Part1 Motor		UPDRS Part2 Non-Motor		ACE-III Cognition	
	M	F	Mean (SD)	Min-Max	Mean (SD)	Min-Max	Mean (SD)	Min-Max	Mean (SD)	Min-Max	Mean (SD)	Min-Max
Choir	11	9	68.6 (7.75)	54-83	9.73 (5.44)	2-22	10.25 (4.99)	1-18	14.65 (8.62)	2-33	88.59 (5.72)	74-98
Music	9	6	67.7 (8.90)	40-76	8.33 (5.22)	2-16	9.20 (3.44)	4-17	12.86 (5.06)	6-22	86.93 (8.24)	64-97

Table 14 shows the demographic characteristics of both the Choir group and Music Group for pre and post-treatment assessment of cognition using the ACE-III. The table includes a total score and also includes the five domains of attention, memory, fluency, language and visuospatial.

**Table 14**

*Demographic Characteristics of Choir and Music Group for Cognition. Median (IQR) and Range of ACE-III Total Scores and Five Elements Pre and Post Treatment*

Total 5 Domains		Choir Group				Music Group			
		Range				Range			
		Median	(IQR)	Min	Max	Median	(IQR)	Min	Max
Total	Pre	86.9	8.0	74.0	98.0	88.0	11.0	64.0	97.0
	Post	88.5	11.0	74.0	100.0	89.0	8.0	72.0	97.0
Attention	Pre	17.0	1.0	13.0	18.0	16.0	4.0	13.0	18.0
	Post	17.0	2.7	13.0	18.0	16.0	3.0	14.0	18.0
Memory	Pre	22.5	2.0	17.0	25.0	21.0	6.0	10.0	26.0
	Post	24.0	7.0	17.0	26.0	24.0	4.0	11.0	26.0
Fluency	Pre	10.5	4.0	7.0	14.0	11.0	3.0	5.0	14.0
	Post	10.5	7.3	6.0	14.0	11.0	5.0	6.0	14.0
Language	Pre	25.0	3.0	20.0	26.0	25.0	3.0	20.0	26.0
	Post	25.0	1.7	22.0	26.0	24.0	2.0	22.0	26.0
Visuospatial	Pre	16.0	1.0	10.0	16.0	15.0	2.0	9.0	16.0
	Post	15.0	1.0	12.0	16.0	15.0	1.0	14.0	16.0

Note. IQR = interquartile range. Five cognitive domains (max possible score): Attention (18 points), Memory (26 points), Verbal Fluency (14 points), Language (26 points) and Visual-spatial (16 points).

### 7.6.1 Gender and Age Characteristics in Relation to Group and Location

Chi-square tests showed no significant differences in gender balance across treatment groups ( $\chi^2(1) = 108, p = .742$ ) or locations ( $\chi^2(1) = 1.616, p = .204$ ). An independent t-test showed no significant differences in age balance ( $t(35), 0.350, p = .728, d = 8.85$ ) or years with PD ( $t(35) = 0.778.14, p = .442, d = 1.78$ ) across treatment groups.

### 7.7 Instrumental Voice Assessment

Voice quality, amplitude, affective prosody and stability were measured acoustically and data were extracted from spontaneous and elicited utterances. Participant voices from both groups were measured individually. The recordings (44.1 kHz sampling rate, 16 bit) were captured using an AKG C577L (Harman International, Austria) head mounted condenser microphone connected, via an AKG MPA VL phantom power adapter, to a 24-bit/96kHz audio interface preamp (M-Audio Mobile Pre USB) and recorded digitally on to a Dell Latitude E6540 Laptop computer using Sona-Speech II™ Software (KayPENTAX) and saved as .nsp and .wav files. The AKG C577L microphone was chosen because it is omnidirectional and has no proximity effect and suitable for the application for which it was

being used (AKG Acoustics Professional Division, Austria, email - AKG Technician, email - Michael Amon July 1, 2016; Department of Clinical Science, (CLINTEC) Karolinska Institutet, Sweden, email - Svante Granqvist PhD, June 12, 2015). The microphone was placed at a distance of 1 cm behind the corner of the participant's mouth in accordance with AKG guidelines.

### **7.7.1 Acoustic Analysis**

Acoustic analysis of all the speech samples was completed using Sona-Speech II™ Software (KayPENTAX). Sona-Speech extracts acoustic parameters e.g. pitch, amplitude, and spectral characteristics during speech/voice production.

The Real Time Pitch (RTP) application was used to capture and edit voice samples taken from the reading and spontaneous conversation tasks which were recorded with a sampling rate of 44100 Hz. Pitch range was captured by sampling comfortable to highest pitch and comfortable to lowest pitch as per the RTP protocol. Unwanted (strained) onset and offset sections were removed by trimming those portions of the signal prior to analysis.

The RTP sample rate was set at 44100 Hz with the analysis range always set (for ease of administration) at a blanket floor of 50 Hz and a ceiling value of 400 Hz and this was not adjusted for male versus female voice analysis, It has been suggested suggested in the literature that should be standardised for differently for males and females with values of 70 Hz to a midlevel pitch ceiling of 250 Hz for males and 100 Hz and to a ceiling of 250 and 300 Hz for females (Vogel et al., 2009). Vogel et al. (2009) found that customising the pitch analysis range for male versus female speakers in PRAAT improved accuracy of the pitch analyses. To our knowledge this has not been investigated using for the Sona-Speech II software.

The particular parameters extracted for the purpose of this study are described below. Results of the acoustic analyses were examined to determine changes over time and to

compare findings to normative data (Table 15) such as that reported by Williams, 2006; Coutinho, Diaféria, Oliveira, and Behlau, 2009; Zraick, Smith-Olinde, and Shotts, 2012; Holmes, Oates, Phyland, and Hughes, 2000 to whom I refer in the discussion.

Explanations of the dependent variables described here are based on measures presented in Sona-Speech II™ KayPENTAX - Issue F (2009).

The research assistant's voice and all other extraneous 'noises' were removed from the captured samples before analysis generated a wide selection of values that included Mean Fundamental Frequency ( $F_0$ ) in Hertz (Hz) (Mean  $F_0$ ), Standard Deviation (SD), Variance in Fundamental Frequency ( $vF_0$ ), phonatory  $F_0$  range in semi-tones (STR) and Standard Deviation Semitone (SDS).

### **7.7.2 Comfortable Sustained Phonation**

Measurements of comfortable sustained phonation (CSP) were captured using the Multi-Dimensional Voice Programme (MDVP) during a sustained open vowel /a/. Samples captured of a deep breath and production of a sustained /a/ at a comfortable pitch and loudness for as long as comfortable (about 7 seconds). The captured sustained /a/ sample was edited so that phonation at onset and offset are excluded to leave a 'mid' three second sample captured for spectral analysis. ) The MDVP sample rate was set at 44100 Hz. Analysis Range: 70 Hz – 625 Hz (normal MDVP default).

The MDVP analysed values of Average Fundamental Frequency (Ave  $F_0$ ), Standard Deviation of Fundamental Frequency (STDF $_0$ ), Relative Average Perturbation (RAP), Shimmer %-Shim (Shim), Noise to Harmonic Ratio (NHR), Voice Turbulence Index (VTI), Fundamental Frequency Variation ( $vF_0$ ), and Soft Phonation Index (SPI).

Description of the captured data are based upon fundamental frequency ( $F_0$ ) measurement, obtained by extracting fundamental frequency from the speech sample as the lowest audio frequency with the highest intensity, less harmonic content, calculating  $F_0$

variation both as  $F_0$  standard deviation  $FSD$ ,  $vF_0$  variation range in Hz and Standard Deviation (Semitone). The measure of variability in the data is expressed in semitones reflecting the spread of the data, or the average amount by which the data deviates from the harmonic mean.

**Table 15**

*Normative Data of Average Speaking  $F_0$  (Williamson, 2006, p. 177)*

	<b>Women</b>	<b>Men</b>
Mean $F_0$ (Hz)	225	128
Frequency range (Hz)	155-334	85-196

### 7.7.3 Affective Prosody - Reading

A task to elicit prosody consisted of a given reading passage: *The Rainbow Passage* (Appendix 11). The Rainbow Passage, a standard and commonly used means of eliciting a sample of connected speech is a passage from a text book published by Fairbanks in 1960 (cited in Yinger & Lapointe, 2012) and frequently used by speech and language therapists to assess vocal functioning, since when read aloud, it includes most of the sounds of the English language. The participants were recorded reading aloud an excerpt from the passage printed in large font onto a laminated sheet (Yinger & Lapointe, 2012).

### 7.7.4 Affective Prosody - Spontaneous Conversation

Picture description tasks are widely used and one of the simplest means of eliciting speech and obtaining diagnostic speech samples for evaluation. However, discourse typically generated through picture descriptions has led some researchers to question whether such tasks elicit sufficient language and present sufficient cognitive-linguistic spontaneity to reveal ‘normal’ speech and language production, as it is not representative of most communicative interactions (Giles et al., 1996). For this reason, ‘natural’ spontaneous conversation was chosen over picture description for this study. Spontaneous conversation was elicited through a set questions asked by the RA e.g. *How was that for you? What do you*

*think of the assessments so far? What do you have planned for the weekend?* The questions were the same for each participant. The questions were not tested prior to implementation.

## **7.8 Aerodynamic Analysis**

Instrumental analysis of the aerodynamic component of vocal function was obtained using the KayPENTAX Phonatory Aerodynamic System (PAS) Model 6600 (KayPENTAX Corp, Lincoln Park, NJ). The PAS captured phonatory acoustic/aerodynamic data (frequency, sound pressure, airflow, and air pressure) of voice signals.

The PAS programme uses a variety of macros to configure graphics and to execute pre-programmed clinical protocols to capture the data and display an analysis of results. A menu of protocols provide the macros, which are the recommended method of performing the programme operations of which there are seven pre-defined protocols - Vital Capacity, Maximum Sustained Phonation, Variation in Sound Pressure Level and Voicing Efficiency. Of the seven pre-defined protocols provided by the PAS, three were chosen for this study and are detailed below.

There is no specific published information on the physical clinical application of the PAS. The following procedures are based on recommendations by Michael Hammer (Airway Sensory Physiology Laboratory, University of Wisconsin School of Medicine and Public Health, email - Dr Michael J Hammer August 31, 2016).

Sterilisation was also undertaken as per the PAS protocol with all components thoroughly cleaned using bactericidal, mycobactericidal, fungicidal, sporicidal and virucidal disinfection wipes between use. Components: mask, airflow head, and airflow head-to-mask coupler were sterilised and washed in warm liquid detergent to remove sputum or coughed up material that might be on the mask after use.

To adjust for changes in airflow head resistance over time and to adjust for differences between airflow heads, calibration of the airflow head was done as per the PAS protocol; on start-up and before each participant or as prompted by the PAS.

### **7.8.1 Maximum Sustained Phonation (MSP)**

Maximum Sustained Phonation is a widely used traditional measure of respiratory integrity and laryngeal valving efficiency. The maximum volume of air exhaled on a sustained phonatory task is called phonation volume, which is the product of MSP and flow and is thus directly related to vital capacity (Aronson & Bless, 2009). MSP was assessed twice on each test occasion with the best of the two data used (Di Benedetto et al., 2009; Ramig & Dromey, 1996). The captured data using this protocol are maximum sustained phonation time in seconds (MSP secs), maximum volume (SPLmax) and average volume (SPLavg) over the duration. The maximum expiratory volume of air on a maximum sustained vowel /a/ phonatory task is called phonation volume, which is the product of MSP and is thus directly related to vital capacity and valving of the glottis having a direct relationship with vital capacity and glottal behaviour described below (Aronson & Bless, 2009). NB. For MSP the PAS microphone is 16 cm away from the participant's mouth.

### **7.8.2 Vital Capacity**

Vital capacity is a measure of the maximum amount of air potentially available for use in respiration or phonation (Table 16). Vital capacity is the maximum volume of air that can be expired following a maximum inspiration and is, therefore, the respiratory volume necessary for speech and/or singing tasks. This process was repeated three times with the best of the three data used (Di Benedetto et al., 2009; Ramig & Dromey, 1996). Data captured using this protocol were Peak Expiratory Airflow (PEF l/s) and Forced Expiratory Volume (Vital Capacity) (FEV litres).

**Table 16**

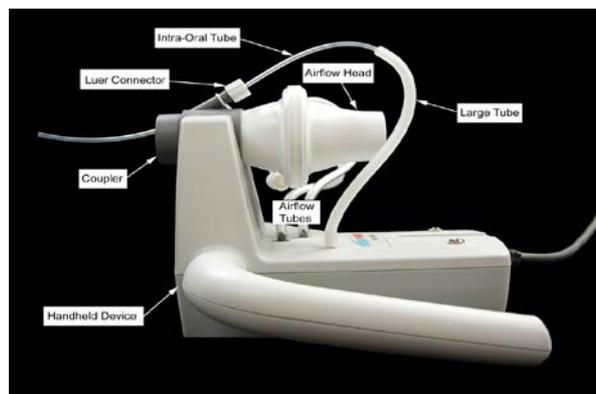
*Normative data - Mean and Standard Deviation of Vital Capacity PAS Protocol for Male and Females aged 60+ (KayPENTAX Corp, Lincoln Park, NJ, 2010)*

	Units	Female Mean (SD)	Male Mean (SD)
PEF	l/s	2.09 (1.00)	3.41 (1.29)
FEV	Litres	2.24 (0.60)	3.22 (1.06)

Note. PEF = Peak Expiratory Airflow (PEF l/s), FEV = Forced Expiratory Volume (Vital Capacity Litres).

### 7.8.3 Glottal Behaviour - Aerodynamic Resistance (ARES)

Common in the clinical evaluation of the aerodynamics of voicing is subglottal pressure, which refers to the amount of pressure required below vocal cords (glottis) to force them open. It is only possible to directly measure the air pressure below the glottis through a needle puncture into the trachea below the glottis, but it is possible to calculate the pressure indirectly. Subglottal pressure is measured indirectly when the participant produces successive /pa/ /pa/ /pa/ with lips closed around an intra-oral pressure tube (Fig 3) within the PAS external module. At that moment of production of /pa/ the pressure in the oral cavity is the same as the subglottic pressure.



**Figure 3.** *External Hardware PAS External Module (without mask) showing intra-oral tube. (KayPENTAX Corp, Lincoln Park, NJ)*

Voicing Efficiency is, therefore, the ratio of acoustic power to aerodynamic power, calculated as the ratio of vocal intensity to the product of the airflow and subglottal pressure. Measurements taken using the Voicing Efficiency protocol are used to describe participants'

glottal behaviour. This protocol calculates laryngeal - subglottal pressure and glottal resistance parameters related to voicing efficiency during the production of successive /pa/ /pa/ utterances. Rate of repetition was set at 2 syllables per second which was modelled using a digital Yamaha PR7™ metronome.

Data captured using this protocol were Peak Air Pressure measured in cm/H<sub>2</sub>O (PAP), Peak Expiratory Airflow measured litres/sec (PEF), Aerodynamic Resistance measured in cm/H<sub>2</sub>O/litres/s (ARES).

### **7.9 Sound Pressure Levels (SPL)**

Voice/speech levels were measured using a sound level meter (SLM) (CEL-246 Digital Integrating Sound Level Meter Class 2, Casella) mounted on a tripod and placed **50 cm** from, and directly in line with, the participant's mouth. Participants were seated in a quiet room for the sample capture. Calibration was performed before each participant was tested using the CEL-110/2 Acoustic calibrator. To enable accurate measurement of the voice levels, all instruction was given before the start of each recording. The SLM provided two acoustic values that were included in the analyses: a slow C-weighted average sound level (SPLavg); and a maximum sound level (SPLmax). C-weighted readings were used because these are minimally filtered and hence gave the most accurate representations of the sound levels. 'C' weighting is one of the standard frequency correction curves (or weightings) applied to sounds in a measurement device to simulate the hearing capability of the human hearing mechanism. The C weighting is most often used for the measurement of transient or impulsive noise levels. It is specified in certain noise standards for the response of the meter to peak noise measurements since it has a defined characteristic unlike the linear (or un-weighted) frequency weighting (Selwyn & Casella, 2010). All edited and analysed data were recorded on to an Excel spreadsheet for further analysis.

Data captured using this protocol were: Pitch Range - Minimum, Maximum, STR and Range Hz. Comfortable Sustained Phonation /a/ (CSP) - Jitter, RAP, Shimmer, NHR, VTI, SPI, SPLmax and SPLavg. Reading - Mean F0, SD, vF0, STR, SD Semi, SPLmax and SPLavg. Conversation - Mean F0, SD, vF0, STR, SD Semi, SPLmax and SPLavg.

## **7.10 Self-Report Questionnaires**

Selecting appropriate measures for the assessment of cognition, quality of life (QoL), quality of voice and depression/anxiety in people with Parkinson's disease (PD) is not straight forward. The captured data has to be comprehensible, relevant to the study and the measures demonstrate as accurately as possible validity, reliability as well as sensitivity to the presenting condition (Callow, 2013). One further overriding requirement, given the number of measures included in the study is the need for brevity and ease of administration.

### **7.10.1 Self-Report Questionnaire Distribution**

Four self-reported questionnaires of voice quality, quality of life, anxiety and experience of daily living with PD (19) were posted, with a letter of explanation, to the participants one week prior to the pre-treatment (baseline) session of instrumental assessments of phonation, respiration and prosody thereby enabling the participants to complete the questionnaires in good time and in the comfort of their homes. The same questionnaires were given to the participants nine weeks later on the final day of the group activity (treatment completion) and one week before the post-treatment assessments enabling participants to complete them in good time and in the comfort of their home. On both occasions, the participants brought their completed questionnaires to the assessment session where they handed them over to the RA who was able answer any questions and check them for completion. Participants also completed a further post-treatment questionnaire (see below) to determine their views on enjoyment, engagement and meaningfulness of study participation.

### 7.10.2 Questionnaire Background

The four self-rating questionnaires were the impairment centred Voice Handicap Index-10 (VHI-10) of (Rosen, Lee, Osborne, Zullo, & Murry, 2004; Zraick et al., 2007), the (VHI-10P) Partner variant (Zraick et al., 2007). The participant's partner ( $N=32$ ), (4 participants did not have a partner) independently completed the partner's variant VHI-10P. The VHI-10P has the same ten questions as the VHI-10 adjusted to read in the third person enabling perceptual rating of the participant's voice by the partner. The Voice Handicap Index (VHI) measures voice handicap and is widely used internationally and found to have high reproducibility and excellent clinical validity (Schindler et al., 2010; Verdonck-de Leeuw et al., 2008) and has proved to be a useful instrument to monitor the treatment efficacy for voice disorders (Rosen et al., 2004). The VHI-10 was designed to be a shortened questionnaire containing 10 statements from the 30-item VHI form. There is no loss of utility or validity of the VHI-10 compared with the VHI for assessing initial patient-based voice handicap evaluation and longitudinal follow-up after treatment (Rosen et al., 2004).

The Depression Anxiety Stress Scale (DASS-21) (Lovibond & Lovibond, 1995) enabled assessment of participant anxiety stress and depression. The DASS-21, a short form version of the original DASS has been validated in a number of populations such as Hispanic adults, American, British and Australian and the PD population (Bucks, Cruise, Skinner, Loftus, Barker, & Thomas, 2011). The shortened version of the Depression, Anxiety and Stress scale assesses depression (7 items;  $\alpha = 0.89$ ), anxiety (7 items;  $\alpha = 0.76$ ) and stress (7 items;  $\alpha = 0.86$ ) and is suitable for participants with limited concentration, whilst retaining reliability (Henry & Crawford, 2005; Bucks et al., 2011). It is a screening tool for identifying, differentiating and assessing depression, anxiety, and stress through a 21 item self-completed questionnaire divided into 7 questions in each of the three domains of depression, anxiety and stress.

Lovibond and Lovibond, (1995) state that emotional syndromes like depression and anxiety are intrinsically dimensional as they vary along a continuum of severity. Hence the selection of a single cut-off score to represent clinical severity is necessarily arbitrary, but can for clinical purposes be helpful to characterise a degree of severity relative to the population. The cut-off scores shown in Table 17 were developed for defining mild/moderate/severe and extremely severe scores for each DASS scale.

**Table 17**  
*DASS-21 Severity Scores*

Cut Off Scores	Normal	Mild	Moderate	Severe	Extreme
Depression	0-4	5-6	7-10	11-13	14+
Anxiety	0-3	4-5	6-7	8-9	10+
Stress	0-7	8-9	10-12	13-16	17+

Severity labels are used to describe the full range of scores in a population, so ‘mild’ for example means that the person is above the population mean, but most likely below the typical severity of someone needing help, i.e. it does not mean a mild level of disorder.

Quality of life was measured using the Parkinson’s disease Questionnaire-8 (PDQ-8) (Jenkinson, Fitzpatrick, Peto, Greenhall, & Hyman, 1997). The PDQ-8 is an established assessment and is a short form version of the PDQ-39 which has been validated in the UK and US as well as being translated into 11 other languages. Both measures demonstrate adequate internal consistency, reliability and evidence of cross-sectional validity with patient-reported measures of similar concepts (Damiano, Snyder, Strausser, & Willian, 1999). The PDQ-8 is based upon analysis of the original data set on which items for the PDQ-39 were selected. Each of the 39 items of the PDQ were correlated with the dimension total to which they contributed. The most highly correlated item from each dimension have been used to construct the PDQ-8.

The Movement Disorder Society-Revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS) is the most widely used scale for the clinical study of PD and has become the standard scale used in clinical care and research (Fahn & Elton, 1987; Goetz et al., 2008). Part I: Non-Motor Aspects of Experiences of Daily Living (nM-EDL) and Part II: Motor Aspects of Experiences of Daily Living (M-EDL) measured the general function of the participants. These self-rating subscales are a basic diagnostic measure of the participant's self-rated perception of severity of motor difficulties in relation to experiences during activities of daily living.

### **7.10.3 Participation Questionnaire**

Participants also completed a questionnaire to evaluate any perceived personal changes owing to group participation, to determine opinion of the study process and the experience of their participation in the group activity (Fogg & Talmage, 2011). Participants rated their agreement with 23 social and personal dimensions of wellbeing regarding group participation, (Appendix 19). A Likert rating 5-point scale was used to assess the degree of agreement with each statement within the questionnaire, *with 1 representing strongly disagree and 5 representing strongly agree*. The questionnaire also contains a space for participants to write in their own words their experience of the group activity. The questionnaire was completed after the nine week treatment period and returned along with the other self-report questionnaires when the participants attended for their post treatment assessment.

### **7.10.4 Assessment of Cognition**

The Addenbrookes Cognitive Examination-III - (ACE-III NZ) (Hsieh, Schubert, Hoon, Mioshi, & Hodges, 2013) was administered and scored by the research assistant trained in its use and in accordance with the ACE-III administration manual. The ACE-III is scored on a scale from 0-100. Cut-off scores (88 and 82) are suspicious of dementia. It

assesses five cognitive domains: Attention (18 points), Memory (26 points), Verbal Fluency (14 points), Language (26 points) and Visual-spatial (16 points).

The two cut-off values for the ACE composite score (88 and 82) are of optimal utility depending on the target population (Table 18). The ACE has high reliability, construct validity, and sensitivity (93%, using 88 as cut-off). Using the lower cut-off of 82, the ACE had a higher sensitivity (82%) and predictive value than other similar assessments (Mathuranath, Nestor, Berrios, Rakowicz, & Hodges, 2000).

**Table 18**

*Addenbrookes Cognitive Examination-III Cut Off Scores by Group and Showing Change between Pre and Post Treatment*

Cut Off	Singing Group			Music Group		
	Pre	Post	-/+	Pre	Post	-/+
88	14	12	-2	9	8	-1
87-83	5	8	+3	2	5	+3
82	3	2	-1	4	2	-2
Participants	22	22		15	15	

Note. Addenbrookes Cognitive Examination-III cut-off scores (88 and 82) are suspicious of dementia.

Currently there are no data with regard to a minimum time before retesting with the ACE-III. Neuroscience Research Australia (NeuRA) suggests that a duration of 6 months would be acceptable with 12 months advisable (Neuroscience Research Australia, NeuRA, email - Prof John Hodges October 12, 2015). The short 9 week test re-test interval could result in participants remembering elements in the memory domain of the ACE-III. To counter this potential problem, participants completed two regional versions – (**A** NZ) pre-treatment and (**B** NZ) post-treatment. The ACE-III has been validated as a reliable cognitive screening tool in early onset dementia (EOD) (Elamin et al., 2016). The Addenbrookes and its cognitive domains are found to correlate significantly with standardised neuropsychological tests used in the assessment of attention, language, verbal memory and visuospatial function and this assessment compares very favourably with its predecessor, the ACE-R, with similar

levels of sensitivity and specificity. Results of these two tests are significantly correlated ( $r = 0.99, p < 0.01$ ).

Wilcoxon Signed-Rank test indicated that, except for a statistical trend for the Choir group in the ACE-III domain for Language ( $Z = 1.69, p = 0.91, r = .38$ ), there were no statistical pre and post treatment within-subject differences across all five cognitive domains of the ACE-III for either group.

One participant (#16) in the Music group had a total score of 64, which is significantly lower than the cut off score 82. In Chapter 3 (Study 1) a comparison of ACE-III data of participants with healthy cognition scores (89 to 100) was undertaken with those who scored 88 and lower (cognitive risk) in all domains and resulted in no statistically significant group differences across a range of independent variables suggesting that cognition scores need not be a parameter of exclusion criteria. To check that this person did not negatively affect the results of this study, a simple ANOVA of all dependent variables was re-run with participant #16 removed. The resulting data indicated that the participant's removal did not affect the outcome and accordingly a decision was made not to remove the participant from the data.

**Table 19**  
*Self-Reported Questionnaires and RA Administered Cognition Assessment*

<b>Measure</b>	<b>Questionnaire</b>	<b>Domains, Elements &amp; Questions</b>
Voice	VHI-10 Voice Handicap Index	Total score 10 Questions
	VHI-10P Voice Handicap Index (Partner)	Total score 10 Questions
Quality of life	PDQ-8 Parkinson's disease quality of life scale	Total score 8 Questions
Depression Anxiety	DASS-21- Depression Anxiety Stress Scales	1. Depression
		2. Anxiety
		3. Stress
Symptom Severity	UPDRS: Part 1 Non-Motor Aspects of Experiences of Daily Living (nM-EDL) <i>sleep, daytime sleepiness, pain and other sensation, urinary &amp; constipation problems, lightheadedness on standing and fatigue.</i>	Total Score + 7 questions
	UPDRS: Part 2 Motor Aspects of Experiences of Daily Living (M-EDL) <i>speech, swallow, handwriting, dressing, hygiene, falling, salivating, turning in bed, walking, transfers.</i>	Total Score + 12 Questions
Mild Cognitive Impairment (MCI)	ACE-III - (NZed A&B) Addenbrookes Cognitive Examination <i>memory/organisation/spatial awareness</i>	1. Attention 2. Memory 3. Fluency 4. Language 5. Visuospatial
Participant Questionnaire (Post treatment only)	To determine participant view on the process, the experience of their participation in the group activity.	23 questions

Note. PDQ-8 questions related to issues during the last month, DASS-21 questions related to how they felt over the past week. UPDRS questions related to symptoms over the past week

### **7.11 Face to Face Assessment Session Protocol**

Participants completed a baseline assessment prior to the choir and music intervention and repeated the same assessment at the end of 9 weeks. Effort was made to schedule baseline and post assessment appointments so that participants attended at the same the time and day of the week for each thus reducing the potential for fluctuations in medication that could influence outcome measures and to ensure participants were tested in their most optimal state.

The assessments were conducted in a quiet, well lit room, with participants sat in a comfortable chair at a table beside the research assistant (RA). The RA ensured that participants were helped to feel welcome and comfortable before being offered tea, coffee or water and were reassured that they could stop to drink or rest at any time during the session. Participants were also informed of toilet location and building exit protocol in case of emergency. Before starting the instrumental assessments, the RA collected the self-report questionnaires brought in by the participants and checked that they were correctly completed. All participants underwent an identical sequence of assessment tasks as set out in the assessment guidelines listed in Table 20.

When the participant was relaxed and comfortable, the RA described the equipment laid out in front of them and explained how they were going to be used. Set out on the table were the Phonatory Aerodynamic System (PAS) External Module (mask); a PC, head-worn microphone, USB audio interface, laptop computer, desk mounted sound pressure level (SPL) meter and Yamaha PR7<sup>TM</sup> metronome.

Before assessment tasks started, all participants were given the PAS mask (Figure 4) to handle. This enabled them to become familiar with the device and to learn how it felt when held against their face. After familiarisation, the participants were then trained how to use the external module for three different protocols and given time to practice.



**Figure 4.**  
External Hardware PAS External Module (mask) Product knowledge presentation (KayPENTAX Corp, Lincoln Park, NJ)

If required, the RA held the mask to ensure adequate seal. Specifically, with the left hand on the participant and the right hand holding the mask to the face to ensure a firm seal with no leaks. Carefully attention was paid to the intra-oral pressure tube and the mouth to monitor location and lip closure.

The computer monitor was placed behind the participant to enable observation of the data recording and to check if the intra-oral pressure tube had become occluded because of saliva or misplacement. A comfortable seated position for all speech and respiratory tasks was ensured for all participants. When the participant indicated that they were happy to begin the tasks, the RA took them through each of the tasks in turn as set out in Table 20 demonstrating and explaining what was needed from them to complete the tasks. When each task was completed, the RA carefully recorded and saved the data as .nsp and .wav files onto hard drives on either the PC or laptop and immediately recorded the SPL data depending on the task.

### **7.11.1 Respiratory Tasks 1, 2 and 3**

Tasks 1, 2 and 3 were completed using the PAS to assess for vital capacity, maximum phonation time and sub-glottic pressure respectively.

For the Forced Expiratory Volume and Peak Airflow tasks the participant was instructed to inhale maximally, hold their breath briefly while placing the mask firmly against their face for a tight seal, and then to exhale maximally into the PAS mask. This task was repeated three times.

When the participant indicated they were comfortable and ready, the maximum sustained phonation task (MSP) was undertaken. The participant was instructed to press the mask firmly against their face so their nose and mouth were both covered and then instructed to take a deep breath and to produce a sustained /a/ with a constant pitch and loudness for as long as possible. Every effort was made to ensure that the sample was representative of the overall phonation and to avoid such effects as straining at the termination of phonation (Kent, Vorperian, Kent, & Duffy, 2003).

The participant undertook the sub-glottic pressure task after having time to rest whilst they were given further instruction and demonstration. The participant was instructed to press the mask firmly against their face so that the nose and the mouth were both covered with the intra-oral tube placed between their lips. They were then instructed to repeat the utterance “pa pa pa” seven times on a single breath with a repetition rate of 1.5 to 2 syllables per second.

At this point, the participant was offered a drink and the opportunity to rest. When the participant had finished their drink or indicated that they were ready to continue, the RA prepared the Sona-Speech software and carefully placed the head-worn microphone on to the participant’s head ensuring that it fitted comfortably and was properly located with the microphone capsule approximately one centimetre 1 cm behind the corner of the participant’s mouth ensuring optimum signal level and minimum pop noise.

#### **7.11.2 Voice Tasks 4, 5, 6 and 7**

With the microphone fitted and with the participant’s agreement the Pitch Range (Glissando) /a/ Task 4 was undertaken. For this task the participant was asked to take a big

breath and say /a/ starting as low as they can and sliding to as high as you can before pausing, taking a breath and saying /a/ from as high as they can and sliding to as low as you can.

With the head-worn microphone still in situ, Tasks 5, 6 and 7 were undertaken. Each task was completed in a timely sequence with a period for rest in between, whilst the RA prepared the software for each.

Task 5 was Comfortable Sustained Phonation (spontaneous /a/) assessment measuring voice quality requiring the participant to produce /a/ at a comfortable pitch and volume for about seven to ten seconds without straining.

For Task 6 the participant read an excerpt from the Rainbow Passage.

Task 7 was the final task using the Sona-Speech software and with the head-worn microphone still in situ the RA recorded spontaneous conversation using prompts such as: “*How was that for you? What do you think of the assessments so far*” and “*what are your plans for the weekend*”? For each of these tasks the RA carefully monitored the SPL meter readout and recorded the levels at the end of each task.

### **7.11.3 Cognitive Assessment Task 8**

On completion of the voice assessments, the head-worn microphone was carefully removed from the participant’s head and time given for them to rest, have a drink or to walk around if they desired.

The RA administered Task 8 - cognitive assessment - the ACE-III (NZed) - Version A at baseline and Version B on the post treatment test occasion. The assessment sessions for each of the participants were completed within 45 minutes with them setting the pace, whilst the RA gave continual reassurance throughout.

**Table 20**

*Voice, Respiratory and Cognitive Data Capture Tasks in the Sequence in Which They Were Administered and by Application*

Pre-checks: Collect and check self-report questionnaires for completion.	
Check that the participant has taken their PD meds within two hours of the session	
<b>Task 1. Vital Capacity x 3</b>	
<i>“Breathe in as much as you can, hold your breath briefly while placing the mask firmly against your face and then breathe out as much air as you can”</i>	
<b>Task 2. MSP Sustained /a/ Maximum sustained phonation (Max phonation time) PAS x 2</b>	
<i>“Take a deep breath and produce the sustained vowel /a/ with a constant pitch and loudness for as long as possible without straining”.</i>	
<b>Task 3. Subglottic pressure - PAS</b>	
<i>“Take a deep breath and then repeat the syllable /pa/ seven times “pa-pa-pa-pa-pa-pa”</i>	
<b>Task 4. Pitch Range (Glissando) /a/ phonation range Sona-Speech: RTP</b>	
Upward and downward pitch glides.	
<i>“I want you to take a big breath and say ah starting as low as you can and sliding to as high as you can go – pause – take a breath saying ah as high as you can and sliding to as low as you can go”.</i>	
<b>Task 5. Comfortable Sustained Phonation /a/ - voice quality (Perturbation)</b>	*SPL Reading
Sona-Speech: MDVP <i>“Please take a breath and say at a comfortable pitch and volume”.</i>	
<b>Task 6. Reading prosody - The Rainbow Passage Sona-Speech: RTP</b>	*SPL Reading
<i>“Please read the passage you have in front of you”.</i>	
<i>When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colours. These take the shape of a long, round arch, with its path high above and its two ends apparently beyond the horizon.</i>	
<b>Task 7. Spontaneous conversation – Sona-Speech: RTP</b>	*SPL Reading
Leave the headphones on and in a very relaxed attitude ask the questions below	
<i>“How was that for you? What do you think of the assessments so far”?</i>	
<b>Task 8. Cognitive Examination ACE-III (NZed) Version A and B</b>	

Note. MPT – Maximum Phonation Time, MDVP – Multi-Dimensional Voice Programme, RTP – Real Time Pitch, PAS – Phonatory Aerodynamic System, ACE – Addenbrookes Cognitive Assessment, \*SPL – Sound Pressure Level – tasks require reading SPL meter.

## 7.12. Home Voice Maintenance Programme - Pilot

A small study was piloted prior to this study in which members of an established Parkinson’s choir were asked to undertake a Home Voice Maintenance Programme (HVMP) of voice and respiratory exercise including singing two songs for one month at the end of which they completed an evaluation questionnaire (Appendix 12). The Participants rated their agreement with 9 questions regarding participation in the home work activity. A Likert rating

3-point scale was used to assess the degree of agreement with each statement within the questionnaire, with 1 representing, disagree, 2 neither agree nor disagree and 3 representing agree. The questionnaire also asked if they were able to complete the exercise on each day and, if not, how many times a week were they achieved. They were also asked to comment on how many times a week was practical. The purpose of the study was to determine if the design and format of the HVMP (Appendix 13) was acceptable and achievable.

Twenty one choir members volunteered to participate in the pilot and agreed to comply with the programme for a four week period over which they followed the format and completed the listed exercises.

The participants were asked to complete the HMVP each day for 20 minutes, which was an abridged version of the voice, respiration and song exercise activity undertaken at the beginning of the weekly choir session.

At the end of the four week period, the 21 questionnaires were returned and the data analysed. The data indicated a broad acceptance of the format and agreement that the requirement of the twenty minute daily exercise were achievable and that the design required no modification.

Participants indicated that they understood the need for the exercises and did them on average six times each week (not including choir day) and confirmed that six times a week was practical. There was unanimous agreement with the statement that the level of difficulty and the time required to do each task was acceptable. 83% of participants agreed that the exercises improved their voice volume with the remaining participants agreeing that the exercises maintained the volume of their voice.

### **7.13 Treatment Duration and Data Collection**

Participants attended either the Choir groups (experimental) for VCST or the Music appreciation groups (control) depending to which they were randomly assigned.

Within a week of completing the pre-treatment (baseline) assessment, the participants began attending once weekly sessions of 105 minutes (1.75 hours) over a period of nine weeks, giving a total of 16 hours treatment (Table 21). Over the two locations both singing groups and control groups completed identical activities as per the group protocol.

**Table 21**  
*Treatment Dosage of the Two Interventions*

Group	Session hrs	Sessions p/w	Weeks	Hours	HVMP
Choir	1.75	1	9	16	20 mins days a week for nine weeks
Music					

Note. HVMP = Home Voice Maintenance Programme

### 7.13.1 Choir Group (Experimental) Activity

The participants randomised to the choir joined one of two established Parkinson's choirs depending on their location. The author; a musician and experienced senior speech and language therapist led both choirs. Great care was taken to ensure that both choirs received identical treatment over the nine weeks with strict adherence to the exercise and song protocol to reduce as much as possible the potential for location outcome differences. Choir sessions comprised of three components. The first component consisted of a 15-20 minute warm up routine. This was followed by the second component; 90 minutes of high intensity singing separated by the third component; a 30 minute refreshment break, which enabled participants to rest, relax and to socialise developing new friendships with other choir members. Choir members were also able to easily access toilets and refreshments at all times during the session. A pianist playing a digital piano and the choir leader playing guitar and tenor ukulele provided the music for the choir. The choir leader orchestrated the choir to create an atmosphere of fun and direct movement such as crescendo, diminuendo and tempo and, importantly, the dynamic required for driving vitality and intensity. One of nine different

song lists each comprising 15 familiar songs were used during each of the nine consecutive weekly singing sessions over a period of nine weeks gave a total of 16 hours treatment.

The aggregate attendance over the nine week treatment period for both Choir groups was 96.9%. Two choir participants withdrew from the study before completion.

### 7.13.2 Posture

Careful attention was paid to ensure good posture when exercising and singing so that the group members were as comfortable as possible.

### 7.13.3 Warm-Up and Exercises

A warm up routine of about 15-20 minutes were undertaken by the choir before singing that included non-singing exercises (Table 22) targeting oro-facial and neck muscles and postural alignment were accompanied with a series singing and non-singing respiratory and phonatory exercises designed to improve diaphragmatic involvement, phonation intensity, vocal fold adduction, laryngeal movement and vocal support (Appendix 14).

**Table 22**

*Weekly Exercise Undertaken by the Singing Group*

Exercise	Description
Stretching	Gliding from the lowest note to the highest
Contracting	Gliding from the highest note to the lowest
Adductory power (subglottic pressure)	<ol style="list-style-type: none"> <li>1. Sustaining /a/ for as long and as loud (without strain) as possible x 4</li> <li>2. Five note scale of back close vowel /u/ and front open to open-mid /a/ sang as /u.u.u/ /a.a.a.a.a/</li> </ol>
Laryngeal strength	Eight, slow, extended vowels /i/ /a/ /o/ over an octave scale with exaggerated lip positioning to develop intrinsic and extrinsic laryngeal muscle strength
Vocal Support	Graduated singing of numbers - starting at 5 and moving up to 10 and back on one breath e.g. 123454321, 12345654321, 12345678987654321etc
Voice dynamic	Days of the week said starting with a whisper and gradually increasing volume (crescendo <) over the seven days to maximum volume (without strain) before going back through the week gradually reducing volume (diminuendo >) returning to a whisper

#### **7.14 Home Voice Maintenance Programme (HVMP)**

Participants had information on the homework component of the study in the Participant Information Sheet as well as other correspondence they received prior to commencing the study. The first day of the treatment began with a cup of tea, a welcome and induction with full information for choir study participants. At this point, all Choir group members received the Home Voice Maintenance Programme (HVMP) with the contents explained along with the expectation of compliance and had any questions answered. The Home Voice Maintenance Programme (HVMP) is an important element of this study. The HVMP and the high intensity singing approach integrated into the Choir group singing sessions are adopted from the LSVT-X<sup>®</sup>. The HVMP is designed to maintain and generalise any SPL gains. The choir were required to undertake the HVMP; an abridged version of the voice and respiration exercises they were doing each week at the beginning of each choir session. Apart from the Choir group treatment days, the exercises were completed each day for 20 minutes with compliance monitored using a self-report HVMP homework diary (Appendix 15). Analysis of the Choir groups' homework diary data at the end of the nine week treatment period showed that all participants complied with the required exercise regime on 89% of a possible 54 days.

#### **7.15 Music Group (Control) Activity**

The Music group participants were randomised to one of two groups depending on their location. The author also administered both Music groups. Great care was taken to ensure that both Music groups received identical treatment over the nine weeks with strict adherence to the protocol to reduce as much as possible the potential for a location effect.

The groups met each week in a comfortable board room with a large table, comfortable chairs and a large digital video screen. On the first day (week one) the group were welcomed and introductions made over tea and biscuits. The introduction included

detail on emergency evacuation in case of fire, orientation for toilets and location of the kitchen and full information and rationale on the purpose of the (control) group. Participants were able to freely walk around the room and make themselves a refreshment or use the toilet.

The music appreciation activity comprised of three sections. The first involved listening to music and watching video recordings of songs displayed on a large screen. Initially, the songs included those used in the singing group and were categorised by genre and decade of release.

As homework, participants were asked to take time when at home to think about influential or prominent music that they considered very pleasurable or that captured an important lifespan event and bring their choice and reason to the sessions for general discussion. The music choices and related explanation from each participant generated much discussion around personal music preferences, group consensus and reminiscences of past memories associated with the music and the era from which the music was derived.

The second section involved a 30 minute tea/coffee and biscuit rest break, which enabled the group to socialise, make new friendships and discuss non-group topics such as current affairs or topics related to Parkinson's.

The third section involved a music quiz in which the participants divided themselves into two teams to answer music related questions. The author obtained a large quantity of music related questions from material downloaded from music trivia sites accessed from the internet. As with the first section, the questions were categorised into genre and the decade in which the music was released.

The aggregate attendance over the nine week treatment period for both Music groups was 96.5%. No music appreciation participants withdrew from the study.

## **7.16 Analysis of the Data**

Using the SPSS Descriptive Statistics Explore function all dependent variables were checked with the Shapiro Wilk test for normality (Shapiro & Wilk, 1965) to ascertain if the data were normally distributed. For dependent variables that were not normally distributed, a number of transformation options e.g. logarithmic, square root, exponential and power were used depending on whether the data were positively or negatively skewed (Leech, Barrett, & Morgan, 2014).

Dependent variables that could not be transformed successfully were analysed using non-parametric statistics. All normally distributed and transformed data were analysed using t-tests for simple comparisons. For these variables equality of variance was checked using the Levene's test for equality of variance (Gastwirth, Gel, & Miao, 2009). Within group comparisons were performed using Wilcoxon Signed Rank tests and paired t tests. Between-group comparisons were performed using the Mann-Whitney U tests and independent t tests. For normally distributed dependent variable repeated measures analysis of variance (ANOVA) was undertaken to investigate treatment and other effects on outcome measures.

### 7.16.1 Dependent Variables

Table 23 provides a complete list of the dependent variables used in this study to ascertain within and between group differences of the two interventions; a Choir group and a Music group.

**Table 23**

*List of Dependent Variables with Abbreviations*

Dependent Variable	Abbreviation	Elements/questions
Maximum Sustained Phonation	MSP	
Time in seconds	/s	
Sound Pressure Level	SPL	
Maximum SPL	SPLmax	
Average SPL	SPLavg	
Vital Capacity		
Peak Expiratory Airflow	PEF	
Expiratory Volume	FEV	
Glottal Behaviour		
Peak Air Pressure	PAP	
Peak Expiratory Airflow	PEF	
Aerodynamic Resistance	ARES	
Pitch Range		
Minimum	Min	
Maximum	Max	
Semitone Range	STR	
Range	Range (Hz)	
Comfortable Sustained Phonation	CSP	
Jitter%	Jitt%	
Shimmer%	Shim%	
Relative Average Perturbation	RAP	
Fundamental Frequency Variation	$vF_0$	
Noise to Harmonic Ratio	NHR	
Voice Turbulence Index	VTI	
Soft Phonation Index	SPI	
Maximum SPL	SPLmax	
Average SPL	SPLavg	
Reading:		
Mean Fundamental Frequency	$F_0$	
Variance Fundamental Frequency	$vF_0$	
Semitone Range	STR	
Standard Deviation Semitone Range	SDSTR	
Maximum SPL	SPLmax	
Average SPL	SPLavg	

**Table 23** (continued)

Conversation:		
Mean Fundamental Frequency	F <sub>0</sub>	
Variance Fundamental Frequency	vF <sub>0</sub>	
Semitone Range	STR	
Standard Deviation Semitone Range	SDSTR	
Maximum SPL	SPLmax	
Average SPL	SPLavg	
Addenbrookes Cognitive Examination	(ACE - III)	Total score Domains: Attention Memory Fluency Language Visuospatial
Depression, Anxiety Stress Scale -21	(DASS – 21)	Traits (questions) Depression (7) Anxiety (7) Stress (7)
Parkinson's disease Quality of Life Questionnaire	(PDQ – 8)	8 questions
Voice Handicap Index	(VHI-10)	10 Questions
Voice Handicap Index Partner	(VHI-10P)	10 questions
Unified Parkinson's disease Rating Scale	(MDS-UPDRS)	Part 1 - Non Motor 7 questions
Unified Parkinson's disease Rating Scale	(MDS-UPDRS)	Part 11 - Motor 13 questions

A full description of the data and analysis is set out in Results Chapter 8

## Chapter 8: Results – Study Two

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### 8.1 Data Analysis

Statistical analysis was undertaken using IBM® SPSS® Statistics 24 software.

Normality of the data was explored using the Shapiro-Wilks normality test. For non-normally distributed data that could not be transformed successfully, Wilcoxon Signed Rank tests were used to compare untransformed pre-post treatment data and Mann-Whitney U tests were used to compare post-treatment between groups (Appendix 16). Paired and independent t tests were used to analyse normally distributed data to explore pre-post treatment and group differences, respectively. Group and pre-post treatment effects explored using between and within-subject t tests are included in this document reflecting the way in which the analysis was undertaken. This involved multiple comparisons and hence creates a risk of type 1 errors. Bonferroni corrections can be applied to minimise this risk. This analysis was undertaken in the preliminary phase of the data analysis; whilst learning about the data, I explored the main effects of group and time using t tests and found this very helpful.

After these simple analyses were performed, the main effects of group and time and interactions were more robustly demonstrated using the main statistical approach of repeated measures ANOVA. The normally distributed dependent and transformed variables were analysed using repeated measures analysis of variance (ANOVA) group (Choir and Music) as a between-subject factor and pre-post (time) as a within-subject factor to look for main effects of group and time and the group x time interaction. Post-hoc comparisons were undertaken using t tests with Bonferroni adjusted p values for significant interaction effects. Main effects and interactions observed from the ANOVA are described with statistical trends ( $p < .10$ ), statistically significant ( $p < .05$ ) values and corresponding *F* statistics reported for all dependent variables. Data are presented as boxplot figures, with features defined in SPSS as:

whiskers = 1.5 times the inter-quartile range (IQR); top whisker: highest case within 1.5 times IQR; top of box = 3rd quartile; line in the middle = median; bottom of box = 1st quartile and the bottom whisker = lowest case within 1.5 times the interquartile range (IQR).

## 8.2 Baseline Comparison of Locations and Interventions

Independent t-tests and Mann-Whitney U tests (Appendix 17 & 18) comparing results for all dependent variables at baseline found only a few significant differences between the two test locations (MSP-SPLmax) and between the two treatment groups (Jitter% and RAP). Therefore data from the two locations were combined to form one Choir group and one Music group.

## 8.3 Data Transformation

All dependent variables were successfully transformed (Table 24).

**Table 24**  
*Independent Variables Transformed and by Which Transformation*

Measure	Dependent Variable	Transformation
Vital Capacity	PEF l/s	logarithmic
Glottal behaviour	PAP, PEF, ARES	logarithmic
Pitch Range	Minimum	logarithmic
Pitch Range	Maximum, STR	square root
Comfortable Sustained Phonation	Shim%	logarithmic
Comfortable Sustained Phonation	Jitt%, RAP, NHR, SPI.	square root
Comfortable Sustained Phonation	VTI	exponential
Reading	STR	square root
Conversation	STR	square root
VHI-10		square root
VHI-10P		square root
DASS-21	Depression, Anxiety, Stress	square root

A Square Root transformation was applied to the VHI-10 total scores. Although the VHI-10P data were normally distributed, these data were also transformed using square root transformation so that participant and partner versions of the VHI-10 could be compared in a repeated measures ANOVA.

## 8.4 Within-Group Data Comparison

### 8.5 Self-Report Measures

For all the self-report measures the lower the score, the better the outcome.

#### 8.5.1 DASS-21 Depression, Anxiety and Stress Traits

A review of the DASS-21 normative cut off scores (Table 17, Chapter 7) indicates that, on average, the Choir and Music groups fall within the normal to mild range of severity (Lovibond & Lovibond, 1995). For this measure, the participants were asked to respond to how they felt in the week preceding completing the questionnaire.

**Depression:** The DASS-21 data shown in Table 27 and Figures 5 and 6 suggest that Depression scores for the Music group improved after treatment. However a paired t-test showed that the post-treatment mean was not significantly different ( $M = 3.80$ ,  $SD = 3.21$ ),  $t(14) = 2.25$ ,  $p = .051$ ,  $d = 0.58$ ) from the pre-treatment mean ( $M = 5.40$ ,  $SD = 4.22$ ). Pre and post-treatment Depression scores for the Choir group were also unchanged after treatment.

**Anxiety:** Anxiety scores for the Choir group improved after treatment. The post-treatment mean was significantly lower ( $M = 4.15$ ,  $SD = 3.22$ ),  $t(19) = 4.87$ ,  $p = .049$ ,  $d = 0.52$ ) than the pre-treatment mean ( $M = 4.90$ ,  $SD = 3.08$ ).

**Stress:** For both groups Stress improved after treatment. Means were significantly lower post-treatment ( $M = 3.50$ ,  $SD = 3.91$ ) than at pre-treatment ( $M = 4.75$ ,  $SD = 3.54$ ,  $t(19) = 2.30$ ,  $p = .037$ ,  $d = 0.51$ ) for the Choir group and for the Music group (Post:  $M = 5.13$ ,  $SD = 2.89$ ; Pre:  $M = 6.13$ ,  $SD = 2.54$ ,  $t(14) = 2.48$ ,  $p = .034$ ,  $d = 0.64$ ). Five participants classified as 'mild' pre-treatment were in the 'normal' category for Stress scores post-treatment (Table 25). A Chi-square test showed a significant change in the severity category for Stress for both groups when pre versus post categories were compared (Table 26).

**Table 25***Crosstabulation of Pre and Post Stress Rank Severity Scores*

		Post DASS Stress Rank				Total
		Normal	Mild	Moderate	Extreme	
Pre DASS Stress Rank	Normal	26	1	0	0	27
	Mild	5	1	0	0	6
	Severe	0	0	1	1	2
	Total	31	2	1	1	35

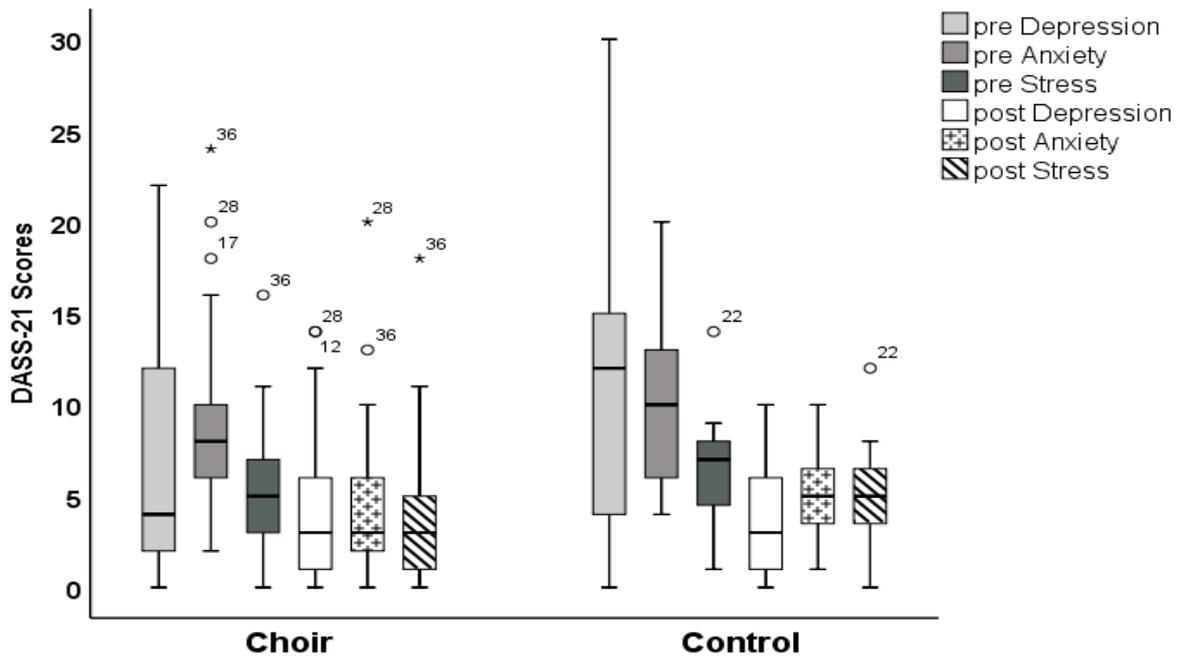
**Table 26***Chi-Square Test of DASS Stress of Choir Group and Music Group*

Group	Pearson Chi-Square Value	df	Asymptotic Significance (2-sided)
Choir Group	20.000	2	.000
Music Group	15.563	4	.004
Total	36.537	6	.000

**Table 27***Means (SD) Three DASS-21 Traits Pre and Post Treatment*

DASS-21 Trait		Choir Group		Music Group	
		Mean (SD)	<i>p</i> value	Mean (SD)	<i>p</i> value
Depression	Pre	3.80 (3.45)		5.40 (4.22)	
	Post	3.85 (3.91)		3.80 (3.21)	.051
Anxiety	Pre	4.90 (3.07)		5.80 (2.51)	
	Post	4.15 (3.22)	.049**	5.27 (2.55)	
Stress	Pre	4.75 (3.54)		6.13 (3.29)	
	Post	3.50 (3.91)	.037*	5.13 (2.90)	.034*

Note. \* $p < .05$  \*\* $p < .008$  (Bonferroni corrected *p* value) Standard deviation appear in parentheses beside means



**Figure 5.** Pre - post treatment results for the three DASS-21 traits for Choir and Music Groups.

A closer inspection of the means of the 21 individual questions show some statistical trends, when a Bonferroni adjusted  $p$  value of .002 ( $.05 / 21$ ) is applied. The data presented in Table 28 show that the Choir group reported stress related apathy (in the form of difficulty working up the initiative to do things), but was not significantly better post-treatment. The Music group improved post treatment for six questions (2 x Anxiety, 2 x Depression and 2 x Stress) dispersed across traits but this difference is not significant after adjusting the critical  $p$  value for multiple comparisons.

Anxiety related experiences of dryness in the mouth and trembling or tremor (also PD symptoms) were reported to be better or improved post treatment. Music group participants also perceived that they were less agitated and found it easier to become enthusiastic about things post treatment.

**Table 28***Mean (SD) DASS-21 Individual Questionnaire Questions Pre and Post Treatment*

Group	Trait	Q No	Questions	Pre-treatment Means (SD)	Post-treatment
Choir	Stress	8	<i>I felt that I was using a lot of nervous energy</i>	0.85 (0.8)	$M = .45, SD = 0.88$ $t(19) = 2.63, p = .017, d = 0.59$
	Anxiety	2	<i>I was aware of dryness of my mouth</i>	1.60 (0.91)	$M = 1.33, SD = 0.82$ $t(14) = 2.26, p = .041, d = 0.58$
		7	<i>I experienced trembling (e.g. in the hands)</i>	1.53 (0.91)	$M = 0.63, SD = 0.91$ $t(14) = 2.45, p = .028, d = 0.63$
Music	Depression	5	<i>I found it difficult to work up the initiative to do things</i>	1.13 (0.64)	$M = 0.67, SD = 0.49$ $t(14) = 3.50, p = .004, d = 0.58$
		16	<i>I was unable to become enthusiastic about anything.</i>	0.87 (0.64)	$M = 0.40, SD = 0.51$ $t(14) = 2.82, p = .014, d = 0.72$
	Stress	11	<i>I found myself getting agitated</i>	1.13 (0.64)	$M = 0.73, SD = 0.70$ $t(14) = 2.45, p = 0.28, d = 0.46$
		12	<i>I found it difficult to relax</i>	1.07 (0.70)	$M = 0.80, SD = 0.68$ $t(14) = 2.26, p = .041, d = 0.19$

Note. Bonferroni adjusted  $p$  value of .002 (.05 / 21)  $p$  values are shown for significant paired t-tests. Agreements to questionnaire statements indicate how much the statement applied to the participant over the past week.

### 8.5.2 Parkinson's Disease Questionnaire - PDQ-8

There was a significant statistical pre-post treatment within-group difference in the PD QoL PDQ-8 questionnaire (Table 29). A paired t-test indicated that scores for the Choir group were significantly better at the post-treatment measuring point ( $M = 6.20$ ,  $SD = 3.56$ ),  $t(19) = 2.34$ ,  $p = .030$ ,  $d = 0.52$ ) than at pre-treatment ( $M = 8.40$ ,  $SD = 4.94$ ). Responses for PDQ-8 individual items were also compared (Table 29), and some statistical trends were evident assuming a Bonferroni-adjusted  $p$  value of  $p < .006$  (.05/8).

**Table 29**

*Mean (SD) Parkinson's disease Questionnaire (PDQ-8) Total Scores and Eight Questions Pre and Post-Treatment*

		Choir Group		Music Group			
		Mean	(SD)	<i>p</i> value	Mean	(SD)	<i>p</i> value
Total	Pre	8.40	(4.94)	.030	9.06	(5.22)	
	Post	6.20	(3.56)		7.66	(4.58)	
Q1	Pre	.75	(0.91)		1.06	(1.10)	
	Post	.85	(1.04)		.86	(0.91)	
Q2	Pre	.85	(0.99)		1.06	(1.16)	
	Post	.55	(0.69)		.86	(0.99)	
<i>Felt depressed</i>							
Q3	Pre	.90	(1.02)		1.13	(0.74)	.009
	Post	.60	(0.75)		.73	(0.59)	
Q4	Pre	.50	(0.69)		.87	(0.91)	
	Post	.35	(0.49)		.73	(0.70)	
Q5	Pre	.95	(0.76)		1.00	(0.76)	
	Post	.70	(0.57)		.73	(0.59)	
Q6	Pre	1.50	(1.23)		1.13	(1.06)	
	Post	1.00	(0.86)		1.20	(1.08)	
<i>Had painful muscle cramps or spasms</i>							
Q7	Pre	1.70	(1.12)	.021	1.53	(1.25)	
	Post	1.50	(1.00)		1.20	(1.08)	
<i>Felt embarrassed in public due to having PD</i>							
Q8	Pre	1.20	(1.00)	.017	1.26	(1.33)	
	Post	.65	(0.75)		1.20	(1.08)	

Note.  $p$  values indicate statistical trends based on paired t-tests for individual items.

Although both groups improved on average, as seen by the lower PDQ-8 scores, the Choir group's reduction was statistically significant indicating a positive change in their self-reported quality of life. The statistical trends evident for questions 7 and 8 for the Choir group suggest both physical and social benefits relating to choir membership. They perceived an

improvement to cramps and pain alongside a greater sense of confidence as a person with PD when socialising and when in public. There was also a trend for the Music group for an improvement in self-reported depression post treatment.

### 8.5.3 Voice Handicap Index -VHI-10

There was a significant statistical pre-post within-group difference in total scores for the VHI-10 questionnaire for the Choir group only (Table 31).

There were no significant differences in pre and post-treatment total scores or subscale scores for the Music group (Figure 7). A paired t-test indicated that scores for the Choir group were significantly better post treatment ( $M = 11.25, SD = 1.79$ ),  $t(19) = 2.81, p = .011, d = 0.63$  than at pre-treatment ( $M = 14.15, SD = 1.52$ ) (Figure 7).

The post-treatment reduction in the VHI-10 total score for the Choir group indicates that they perceived their voices to have improved. A trend for improvement in self-perception of speech volume is also evident when differences are examined for the individual items in the three subscales (Table 32).

These data compare with a number of LSVT® studies and one LSVT-X® study (Halpern et al., 2012; Spielman et al., 2007; Wight & Miller, 2015) (Table 30) investigating intensive voice treatment for PD which have used the VHI to measure participant voice evaluation. All report post-treatment improvement.

**Table 30**

Mean (SD) Voice Handicap Index (VHI) and short form (VHI-10) Total Scores According to the Different Interventions

		Pre		Post	
		Mean	(SD)	Mean	(SD)
Spielman et al., (2007)	LSVT-X®	44	(22.0)	30	(17.0)
Spielman et al., (2011)	LSVT®	39	(17.8)	27.5	(23.9)
Wight et al., (2015)	LSVT®	54*	(69-33)	29*	(43-12)
Halpern et al., (2012)	LSVT®	45.6	(20.9)	36.6	(18.3)
Shih et al., (2012)	Singing	43.7	(22.2)	47.0	(15.4)
Elefant et al., (2014)	Singing	22.4	(19.03)	24.3	(23.84)

Note. \*Median (IQR) (Wilcoxon), Choir group = VHI-10

Two of the items in the functional subscale show a significant improvement for the Choir group, with participants reporting that others had less difficulty understanding them when they were in a noisy room and they were left out of conversation less often. Also, there was a significant improvement for the Choir group, who reported that people asked them less often what was wrong with their voice.

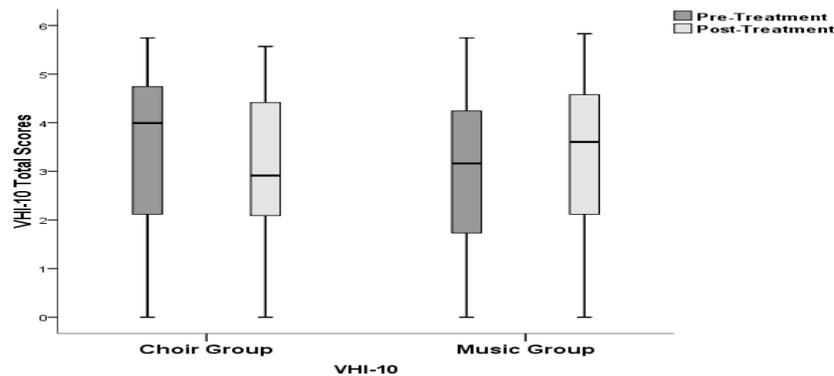


Figure 6. Pre and post means for the VHI-10.

Table 31

Mean (SD) Voice Handicap Index (VHI-10) Total and Individual Item Scores

(subscale)		Choir Group	<i>p</i> value	Music Group
		Mean (SD)		Mean (SD)
Total Score	pre	14.15 (1.53)	.011	12.66 (1.68)
	Post	11.25 (1.79)		13.06 (1.79)
(F) Q1	Pre	1.70 (0.98)		1.80 (1.15)
	Post	1.45 (0.94)		1.60 (1.12)
(F) Q2	Pre	2.25 (1.16)	.012	1.87 (1.36)
	Post	1.60 (1.14)		1.80 (1.26)
(F) Q3	Pre	1.15 (1.27)		1.27 (1.28)
	Post	1.15 (1.23)		1.40 (1.35)
(F) Q4	Pre	1.50 (1.32)	.025	1.13 (1.25)
	Post	1.05 (1.19)		1.40 (1.30)
(F) Q5	Pre	1.25 (1.07)		0.93 (1.09)
	Post	1.10 (1.07)		1.20 (1.08)
(P) Q6	Pre	1.55 (1.23)		1.71 (1.26)
	Post	1.10 (1.12)		1.14 (1.10)
(P) Q7	Pre	1.60 (1.14)		1.47 (1.30)
	Post	1.50 (1.19)		1.47 (1.25)
(E) Q8	Pre	1.25 (1.29)		1.33 (1.11)
	Post	1.00 (1.12)		2.87 (5.78)
(E) Q9	Pre	1.05 (1.23)		1.07 (1.10)
	Post	0.80 (1.06)		1.20 (1.37)
(P) Q10	Pre	0.85 (1.09)	.005	0.53 (0.83)
	post	0.50 (0.89)		0.67 (1.11)

Note. *p* values indicate statistical trends based on paired t-test for individual items. Sub Scales: (F) = Functional, (P) = Physical and (E) = Emotional

**Table 32**

*Mean (SD) Choir Group Voice Handicap Index (VHI-10) Individual Questionnaire Questions Pre and Post Treatment*

Q Subscale	Question	Pre-Treatment		Post-Treatment
		Means	(SD)	Means with <i>p</i> values
2 (F)	<i>People have difficulty understanding me in a noisy room</i>	2.25	(1.16)	<i>M = 1.60, SD = 1.14, t(19) = 2.795, p = .012, d = 0.62.</i>
4 (F)	<i>I feel left out of conversation because of my voice</i>	1.50	(1.32)	<i>M = 1.05, SD = 1.19, t(19) = 2.438, p = .025, d = 0.54.</i>
10 (P)	<i>People ask "what is wrong with my voice"?</i>	0.85	(1.09)	<i>M = 0.50, SD = 0.89, t(19) = 3.199, p = .005, d = 0.71.</i>

Note. *p* values indicate statistical trends based on paired t-test for individual items. Sub Scales: (F) = Functional, (P) = Physical and (E) = Emotional

### 8.5.3.1 Voice Handicap Index (Partner) VHI-10P

The results of the VHI-10P were also significant, indicating that the partners of the Choir group were in agreement with the improved outcomes reported by the people with PD completing the VHI-10. The partners of the Music group were also in agreement with the people with PD, neither reported improvements in voice QoL based on the VHI-10 and VHI-10P. There was a significant statistical pre-post treatment within-group difference in total scores for the VHI-10P questionnaire for the Choir group (Table 33). A paired t-test indicates that scores for the Choir group were significantly better post treatment ( $M = 11.09$ ,  $SD = 1.82$ ),  $t(16) = 2.569$ ,  $p = .021$ ,  $d = 0.62$  than at pre-treatment ( $M = 15.09$ ,  $SD = 3.42$ ) (Figure 8). There was no significant difference in pre and post-treatment total scores for the Music group, however there was a statistical trend observed post-treatment for one item in the functional subscale (Table 34), where the partners of the Music group observed that the person with PD was not running out of air when they talked. There was a trend for post-treatment improvement for the Choir group for individual items in the three subscales. As with the Music group, the partners of the Choir group also observed a post-treatment functional improvement with the group participants not running out of air when they talk. There was a trend for the partners of the Choir group to observe an improvement in post-

treatment attitude to how their voice problem upset them and to how their voice makes them feel handicapped; both of these items are in the emotional subscale.

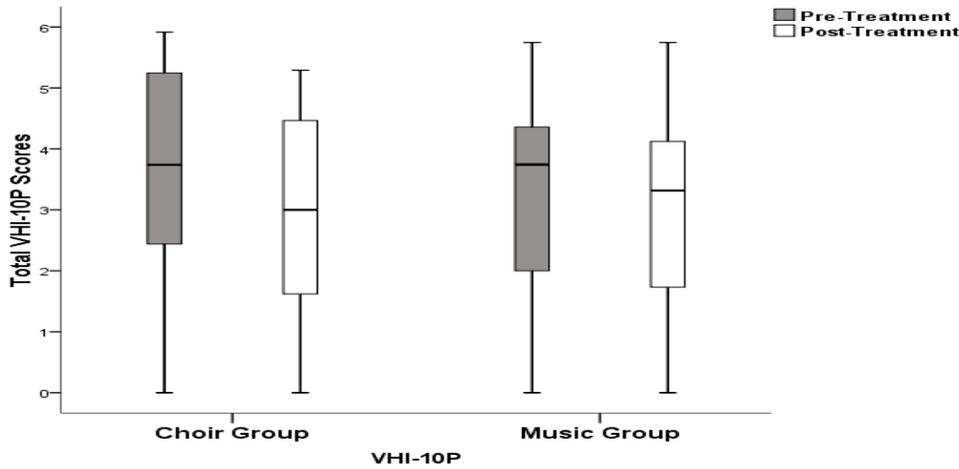


Figure 7. Pre and post means for the VHI-10P.

Table 33

Mean (SD) Voice Handicap Index Partner (VHI-10P) Total and Subscale Scores

(subscale)	Choir Group			Music Group			
		Mean	(SD)	Sig	Mean	(SD)	Sig
Total	Pre	15.09	(1.88)	.021	13.78	(10.36)	
	Post	11.01	(1.82)		13.14	(11.01)	
(F) Q1	Pre	1.41	(1.23)		1.57	(1.16)	
	post	0.94	(1.03)		1.64	(1.33)	
(F) Q2	Pre	1.65	(1.37)		1.93	(1.38)	
	Post	1.29	(1.10)		1.86	(1.35)	
(F) Q3	Pre	1.41	(1.37)		1.14	(0.95)	
	Post	1.17	(1.24)		1.21	(1.31)	
(F) Q4	Pre	1.17	(1.51)		1.14	(1.16)	
	Post	1.17	(1.29)		1.29	(1.26)	
(F) Q5	Pre	1.47	(1.12)	.015	1.29	(1.14)	.029
	Post	0.94	(1.14)		0.79	(1.12)	
(P) Q6	Pre	1.47	(1.28)		1.71	(1.26)	
	Post	1.24	(1.20)		1.43	(1.45)	
(P) Q7	Pre	1.53	(1.23)		1.86	(1.23)	
	Post	1.53	(1.33)		1.93	(1.32)	
(E) Q8	Pre	1.59	(1.23)	.003	1.29	(1.27)	
	Post	1.06	(0.97)		1.21	(1.89)	
(E) Q9	Pre	1.29	(1.21)	0.14	1.29	(0.99)	
	Post	0.88	(1.05)		1.07	(1.07)	
(P) Q10	Pre	0.76	(1.03)		1.00	(1.04)	
	Post	0.65	(0.86)		0.71	(0.91)	

Note. *p* values are shown for significant paired t-tests. Sub Scales – (F) = Functional, (P) = Physical and (E) = Emotional. VHI-10P (Zraick et al., 2007)

**Table 34***Mean (SD) Voice Handicap Index Partner (VHI-10P) Individual Questionnaire Questions*

Group	Q Subscale	Question	Pre-Treatment Means (SD)	Post-Treatment Means with <i>p</i> values
Music	5 (F)	<i>They run out of air when they talk</i>	1.29 (1.14)	$M = 0.79, SD = 1.12, t(13) = 2.463, p = .029, d = 0.66$
	5 (F)	<i>They run out of air when they talk</i>	1.47 (1.12)	$M = 0.94, SD = 1.14, t(16) = 2.729, p = .015, d = 0.66$
Choir	8 (E)	<i>Their voice problem upsets them</i>	1.59 (1.23)	$M = 1.06, SD = 0.97, t(16) = 3.497, p = .003, d = 0.84$
	9 (E)	<i>Their voice makes them feel handicapped</i>	1.29 (1.21)	$M = 0.88, SD = 1.05, t(16) = 2.746, p = .014, d = 0.66$

Note. *p* values are shown for significant paired t-tests. Sub Scales – (F) = Functional, (P) = Physical and (E) = Emotional.

#### 8.5.4 Unified Parkinson’s Disease Rating Scale - UPDRS

As with the self-reported measures above, the scores for the UPDRS, are better if they are lower. There were no statistically significant perceived pre-post treatment differences in non-motor symptoms for either group (Table 35). There was no significant perceived pre-post treatment difference in motor symptoms for the Music group.

There was a significant statistical perceived pre-post treatment difference in non-motor symptoms for the Choir group. A paired t-test indicates that scores for the Choir group were significantly better post treatment ( $M = 12.05, SD = 6.81$ ),  $t(19) = 2.639, p = .016, d = 0.59$ ) than at pre-treatment ( $M = 14.65, SD = 8.62$ ) suggesting that the singing activity has had a significant perceived beneficial impact on the motor symptoms of PD.

Interestingly, there was an improvement with one question, which compares with question 7 of the PDQ-8. Question 2.10 of part 2 of the UPDRS: Tremor - *Over the past week, have you usually had shaking or tremor?* For this question the Choir group were better post treatment ( $M = 1.05, SD = 0.89$ ),  $t(19) = 2.2.101, p = .049, d = 0.47$ ) than at pre-treatment ( $M = 1.40, SD = 1.09$ ), but after a Bonferroni correction was not significant.

**Table 35**  
Mean (SD) *Unified Parkinson Disease Rating Scale Pt 1 & Pt 2*

		Choir Group			Music Group	
		Means	Range	Sig	Means	Range
Part 1:	Pre	10.25 (4.99)	1-18		9.20 (3.44)	4-17
Non Motor	Post	9.60 (4.36)	2-18		9.73 (3.47)	6-17
Part 2:	Pre	14.65 (8.62)	2-33		12.86 (5.06)	6-22
Motor	Post	12.05 (6.81)	3-29	.016	12.66 (4.53)	4-20
Q2.10	Pre	1.40 (1.09)			1.27 (0.25)	
Tremor	Post	1.05 (0.89)		.049	1.33 (0.21)	

Note. Note. *p* values are shown for significant paired t-tests. Q2.10 individual question Part 2 UPDRS

## 8.6 Respiratory Measures

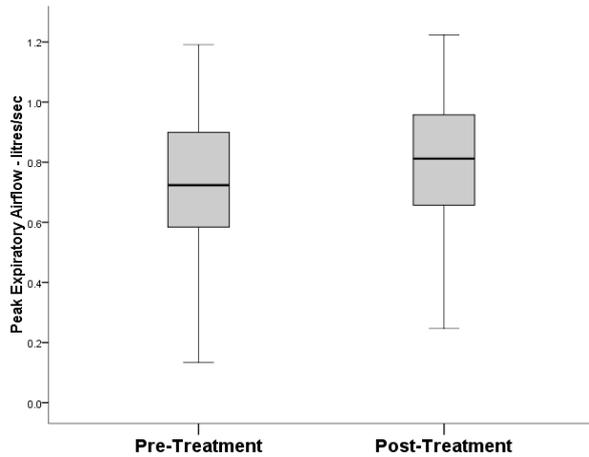
### 8.6.1 Vital Capacity

There was a significant statistical result for Peak Expiratory Airflow (PEF) (l/s) for the Choir group (Table 36 Figures 9 & 10). A paired t-test indicated that means for the Choir group were better post treatment ( $M = 7.18$ ,  $SD = 3.55$ ),  $t(19) = 1.89$ ,  $p = .044$ ,  $d = 0.42$ ) than at pre-treatment ( $M = 6.16$ ,  $SD = 3.36$ ). Vital capacity measured as Forced Expiratory Volume showed that both groups declined over the treatment period (Figures 11 & 12).

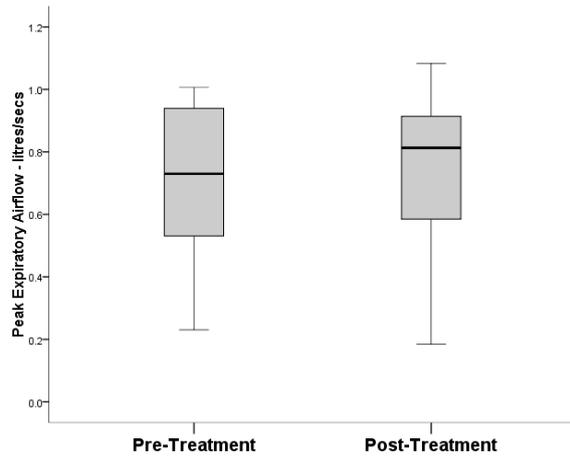
**Table 36**  
Mean (SD) *Vital Capacity Values Pre and Post Treatment and Significant p values*

		Choir Group			Music Group	
		Mean	(SD)	<i>p</i> value	Mean	(SD)
PEF l/s	pre	6.16	(3.36)		6.04	(3.12)
	post	7.18	(3.55)	.044	6.53	(3.30)
FEV Litres	pre	3.11	(0.88)		3.15	(1.08)
	post	3.05	(0.78)		3.05	(1.03)

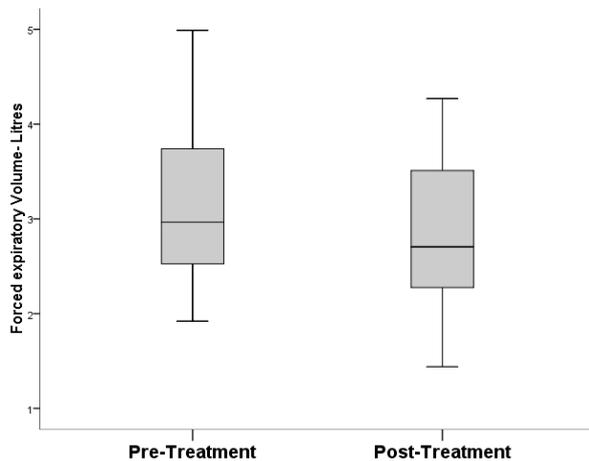
Note. *p* values are shown for significant paired t-tests. PEF l/s = Peak Expiratory Airflow, FEV = Forced Expiratory Volume.



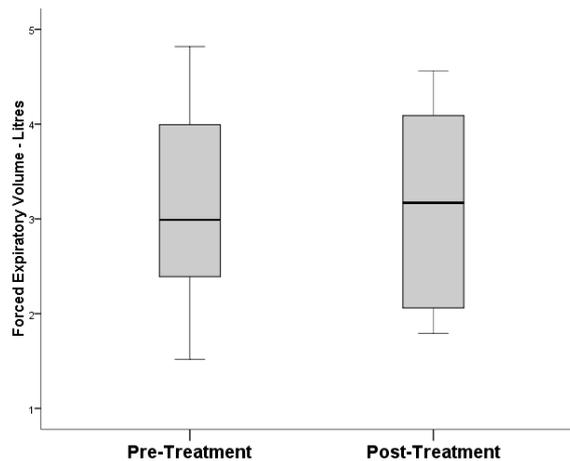
**Figure 8.** Choir group pre and post-treatment means for PEF (l/s).



**Figure 9.** Music group pre and post-treatment means for PEF (l/s).



**Figure 10.** Choir group pre and post treatment means of volume for FEV (litres).



**Figure 11.** Music group pre and post treatment means of volume for FEV (litres).

### 8.6.2 Glottal Behaviour

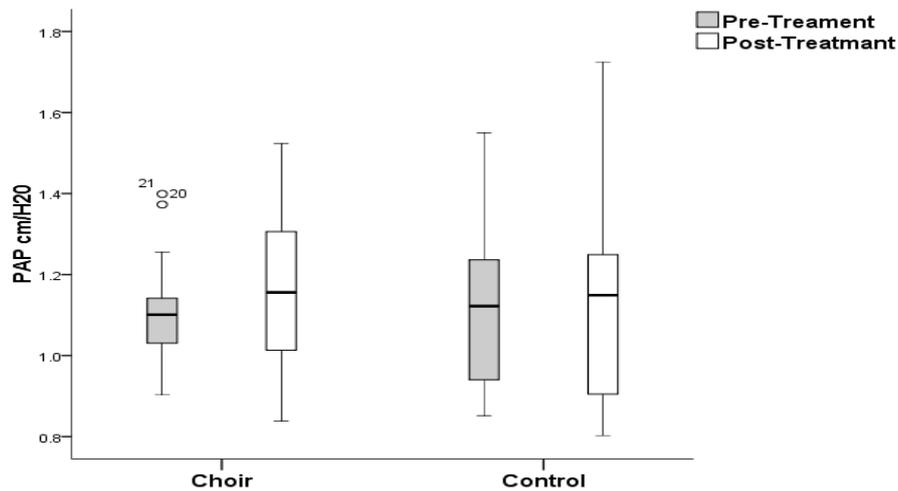
There were no statistically significant within-group pre-post treatment differences in glottal behaviour: PAP and PEF for either group (Figures 13 & 14). There was a significant change of within-group pre and post treatment means for ARES (cm H<sub>2</sub>O/l/s) for the Music group (Table 37; Figure 15). The mean was significantly worse post treatment ( $M = 28.9$ ,  $SD = 0.22$ ),  $t(14) = 2.87$ ,  $p = .012$ ,  $d = 0.73$ ) than at pre-treatment ( $M = 35.2$ ,  $SD = 0.17$ ) indicating aerodynamic resistance (subglottic pressure) had deteriorated for the Music group.

Although not statistically significant, the Choir group showed a trend for improvement when means pre ( $M = 32.13$ ,  $SD = 9.83$ ) and post ( $M = 38.33$ ,  $SD = 16.84$ ) were compared.

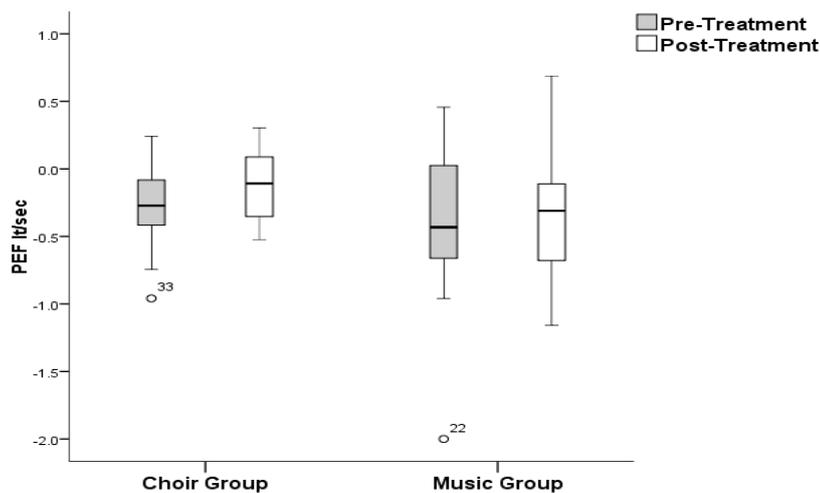
**Table 37**  
*Mean (SD) of dependent variables for Glottal Behaviour*

		Choir Group		Music Group	
		Mean	(SD)	Mean	(SD)
PAP	Pre	13.34	(4.21)	14.51	(7.93)
cm/H <sub>2</sub> O	Post	15.91	(7.05)	15.59	(11.87)
PEF	Pre	0.69	(0.50)	0.69	(0.77)
lt/s	post	0.90	(0.53)	0.77	(1.16)
ARES	Pre	32.13	(10.62)	35.24	(13.01)
Cm/H <sub>2</sub> O/(lt/s)	Post	38.33	(16.83)	28.88	(14.33)

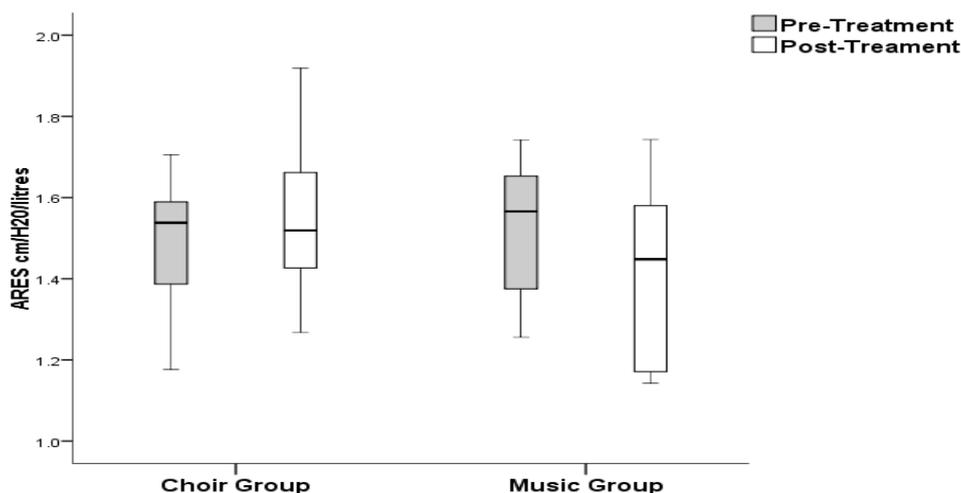
Note. PAP = Peak Air Pressure, PEF = Peak Expiratory Airflow, ARES = Aerodynamic Resistance.



**Figure 12.** Pre and post treatment means for peak air pressure (cm/H<sub>2</sub>O).



**Figure 13.** Pre and post treatment means for peak expiratory airflow (l/s).



**Figure 14.** Pre and post treatment means for aerodynamic resistance (cm/H2O/l/s).

## 8.7 Voice

### 8.7.1 Maximum Sustained Phonation (MSP)

There were no statistically significant within-group pre - post differences for MSP (seconds) for either group (Table 38). A paired t-test shows that the means of SPLmax decibel (dB) for the Choir group were significantly better post treatment ( $M = 99.5$ ,  $SD = 4.88$ ),  $t(19) = 2.14$ ,  $p = .045$ ,  $d = 0.48$ ) (3.3dB) than at pre-treatment ( $M = 96.2$ ,  $SD = 4.62$ ) (Figure 16). The pre-post SPLmax means for the Music group did not differ significantly.

**Table 38**

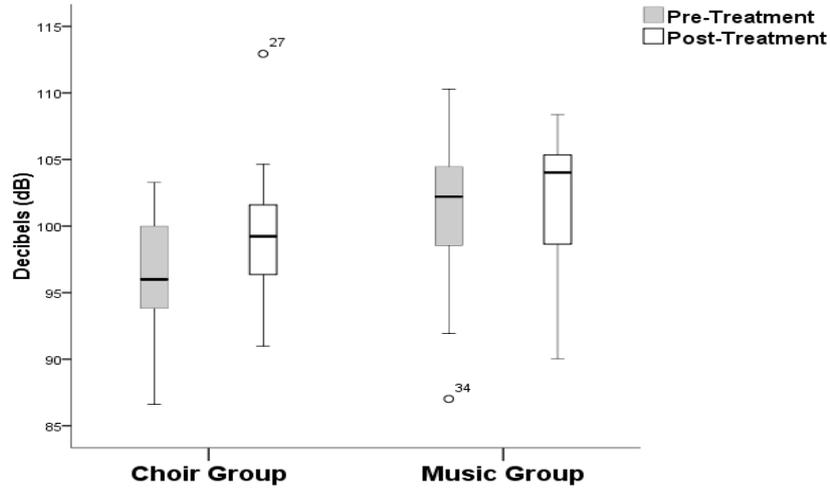
*Mean (SD) Maximum Sustained Phonation - Sound Pressure Levels*

		Choir Group			Music Group
		Mean (SD)	Sig		Mean (SD)
Seconds	Pre	16.1 (7.75)			15.2 (7.80)
	Post	16.7 (7.91)			15.4 (9.02)
SPLmax (dB)	Pre	96.2 (4.62)			101.1 (6.09)
	post	99.5 (4.88)	.045		101.8 (4.92)
SPLavg (dB)	Pre	91.3 (4.61)			94.4 (5.42)
	Post	94.1 (4.91)	.026		93.5 (6.41)

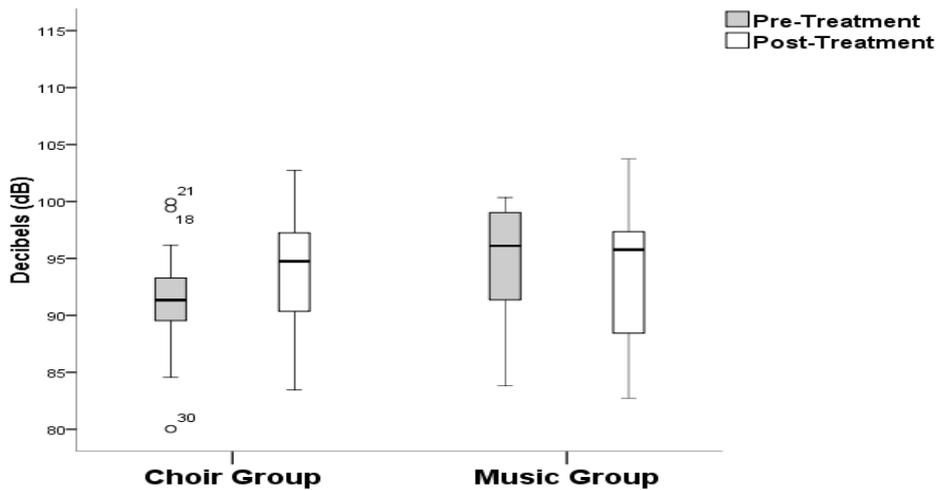
Note.  $p$  values are shown for significant paired t-tests. SPLmax (dB), SPLavg (dB) = Sound Pressure Level: Maximum and Average dB Decibels.

The dB means for SPLavg for the Choir group were significantly better post treatment ( $M = 94.1$ ,  $SD = 4.91$ ),  $t(19) = 1.96$ ,  $p = .026$ ,  $d = 0.50$ ) (2.8dB) than at pre-treatment ( $M =$

91.3,  $SD = 4.61$ ) (Figure 17). As with the SPLmax means, the pre-post SPLavg means for the Music group were not significant.



**Figure 15.** Pre and post treatment means in dB for SPLmax - Maximum Sustained Phonation.



**Figure 16.** Pre and post treatment means in dB for SPLavg - Maximum Sustained Phonation.

### 8.7.2 Pitch Range

There were no statistically significant within-group pre - post treatment differences for minimum pitch range for either group. There was, however, a statistical significant difference in maximum pitch range for both groups. Paired t-tests indicate (Table 39) that the means of maximum pitch for both groups were significantly higher post-treatment. The means were

significantly higher post-treatment treatment ( $M = 348.1$ ,  $SD = 1.36$ ),  $t(19) = 17.9$ ,  $p = .001$ ,  $d = 4.02$ ) than at pre-treatment ( $M = 340.4$ ,  $SD = 1.58$ ) for the Choir group and the Music group (Post:  $M = 345.9$ ,  $SD = 1.97$ ),  $t(14) = 13.1$ ,  $p = .001$ ,  $d = 3.39$ ; Pre: ( $M = 343.7$ ,  $SD = 1.67$ ).

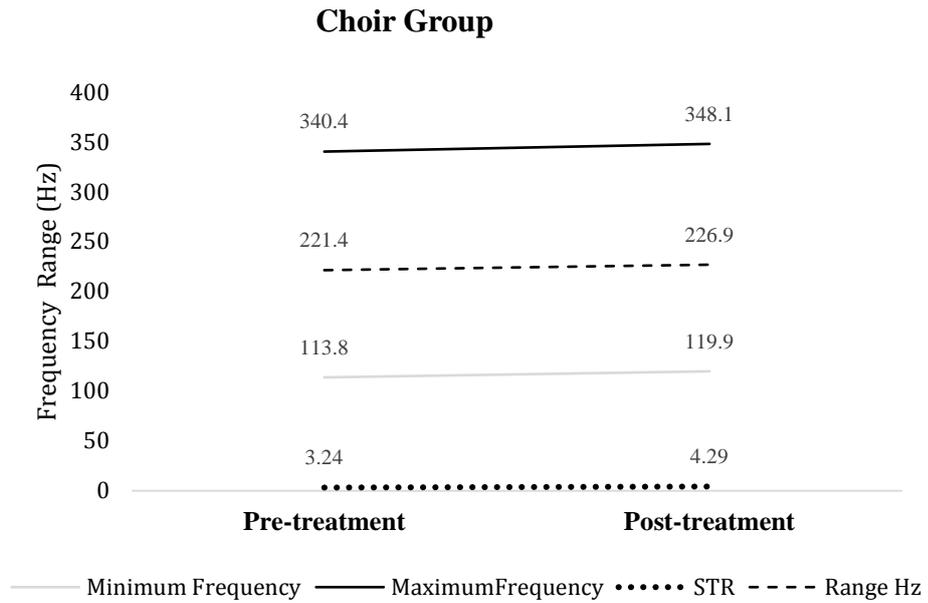
Although not significant, this trend is evident in the means for range where, as expected, both groups increased overall range. In line with the increase in range, there was a significant pre -post treatment difference for both groups for Semitone Range. A paired t-test indicates that the means (adjusted  $\sqrt{}$ transformation) were significantly higher post-treatment treatment ( $M = 4.29$ ,  $SD = 0.64$ ),  $t(19) = 5.86$ ,  $p = .001$ ,  $d = 1.31$ ) than at pre-treatment ( $M = 3.24$ ,  $SD = 0.24$ ) for the Choir group and the Music group (Post:  $M = 4.03$ ,  $SD = 0.62$ ), (14) = 3.58,  $p = .003$ ,  $d = 0.92$ ; Pre:  $M = 3.34$ ,  $SD = 0.25$ ).

Interestingly, although both groups showed an increase in range, the increase was gained at the maximum (higher end) as both groups were unable to maintain or improve on the lower frequency produced at pre-treatment (Figures 18 & 19).

**Table 39**  
*Means (SD) of Pitch Range*

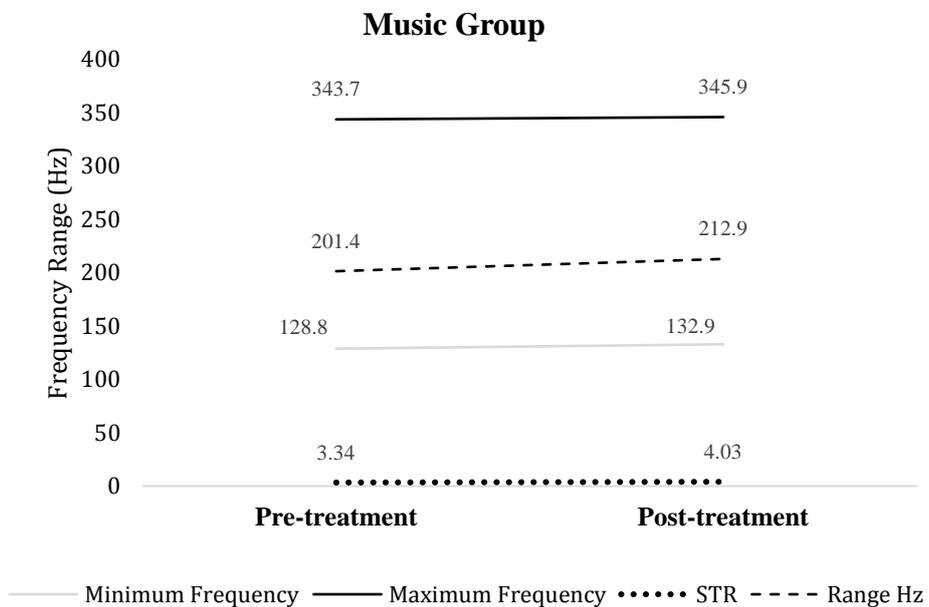
		Choir Group			Music Group		
		Mean	(SD)	Sig	Mean	(SD)	Sig
Minimum	Pre	113.8	(1.88)		128.8	(10.36)	
	Post	119.9	(1.82)		132.9	(11.01)	
Maximum	Pre	340.4	(1.58)		343.7	(1.67)	
	post	348.1	(1.36)	.001	345.9	(1.97)	.001
Semitone Range	Pre	3.2	(0.24)		3.3	(0.25)	
	Post	4.3	(0.64)	.001	4.0	(0.62)	.003
Range Hertz (Hz)	Pre	221.4	(61.7)		201.4	(54.6)	
	Post	227.0	(56.8)		213.0	(64.8)	

Note.  $p$  values are shown for significant paired t-tests.



**Figure 17.** Pre and post treatment pitch range means of Choir group including semitone range.

Note. Frequency Range (Hz) and Semitone Range (STR) (1 semitone =  $\frac{1}{12}$ <sup>th</sup> of an octave)



**Figure 18.** Pre and post treatment pitch range means of Music group including semitone range.

Note. Frequency Range (Hz) and Semitone Range (STR) (1 semitone =  $\frac{1}{12}$ <sup>th</sup> of an octave)

### 8.7.3 Comfortable Sustained Phonation (CSP)

There were significant statistical within-group pre - post treatment differences across four CSP independent variables for the Choir group. Acoustic perturbation measurements of fluctuations in phonation are outlined in Table 40 below and in the following figures.

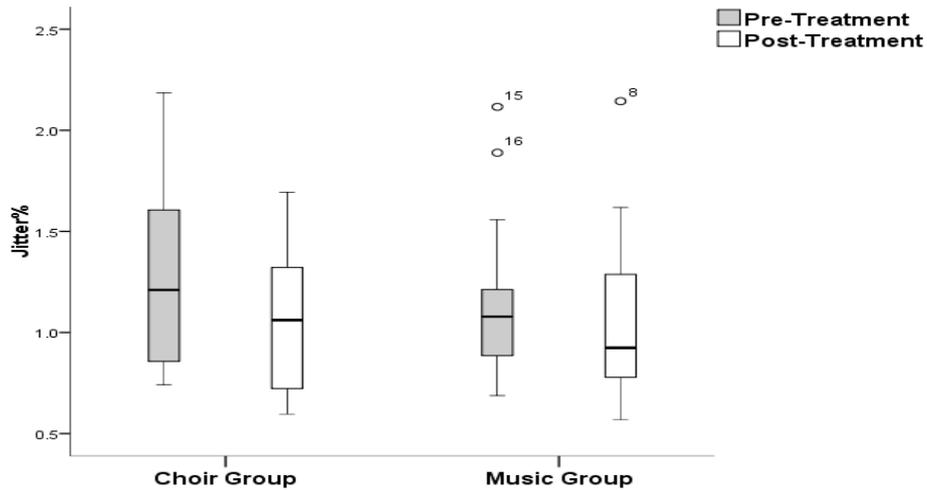
Other than VTI and NHR, these data indicate that for the Choir group voice quality improved over the duration of the treatment period across a number of separate measures. There were no statistically significant pre or post treatment differences in these variables for the Music group.

**Table 40**  
Perturbation Means (SD) - *Comfortable Sustained Phonation*

CSP /a/		Choir Group		Music Group	
		Mean (SD)	Sig/trend	Mean (SD)	Sig
Jitter %	Pre	1.87 (0.43)		1.46 (0.41)	
	Post	1.21 (0.34)	.011	1.32 (0.43)	
RAP %	Pre	1.03 (0.31)		0.86 (0.33)	
	post	0.72 (0.28)	.036	0.83 (0.33)	
Shimmer %	Pre	4.88 (0.19)		4.99 (0.20)	
	Post	4.05 (0.20)	.065	4.37 (0.22)	
NHR	Pre	0.14 (0.03)		0.15 (0.03)	
	Post	0.14 (0.03)		0.13 (0.03)	
VTI	Pre	0.03 (0.01)		0.03 (0.01)	
	Post	0.03 (0.01)		0.04 (0.02)	
SPI	Pre	25.6 (12.76)		17.2 (8.80)	
	Post	20.2 (10.51)	.038	21.4 (13.26)	
Lmax (dB)	Pre	75.5 (4.49)		73.4 (5.76)	
	Post	77.2 (5.39)		75.0 (6.21)	
Lavg (dB)	Pre	67.3 (6.64)		65.2 (6.52)	
	Post	72.5 (7.03)	.009	69.7 (8.37)	.027

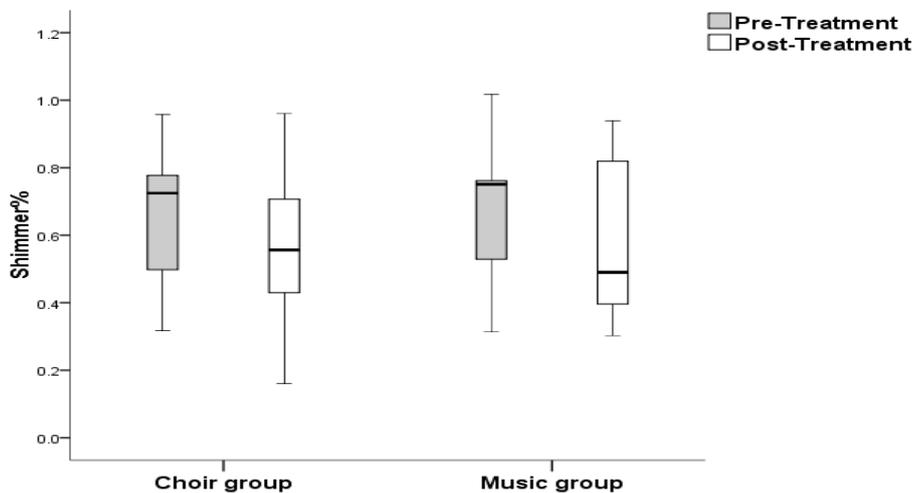
Note. *p* values are shown for significant paired t-tests. Jitter %, RAP % = Relative Average Perturbation, Shimmer %, NHR = Noise Harmonic Ratio, VTI = Voice Turbulence Index, SPI = Soft Phonation Index, SPLmax (dB), SPLavg (dB) = Sound Pressure Level: Maximum and Average dB Decibels.

A paired t-test shows that the means (Figure 20) for Jitter % (cycle-to-cycle variation in frequency) was significantly better for the Choir group post-treatment ( $M = 1.21$ ,  $SD = .034$ ),  $t(19) = 2.80$ ,  $p = .011$ ,  $d = 0.63$ ) than at pre-treatment ( $M = 1.87$ ,  $SD = 0.43$ ).



**Figure 19.** Pre and post treatment means of Jitter (%).

Figure 21 shows a statistical trend in the Shimmer (cycle-to-cycle variation in amplitude) for the Choir group with a post-treatment mean ( $M = 4.05$ ,  $SD = 0.20$ ),  $t(19) = 1.96$ ,  $p = .065$ ,  $d = 0.44$ ) and pre-treatment mean of ( $M = 4.88$ ,  $SD = 0.19$ ).

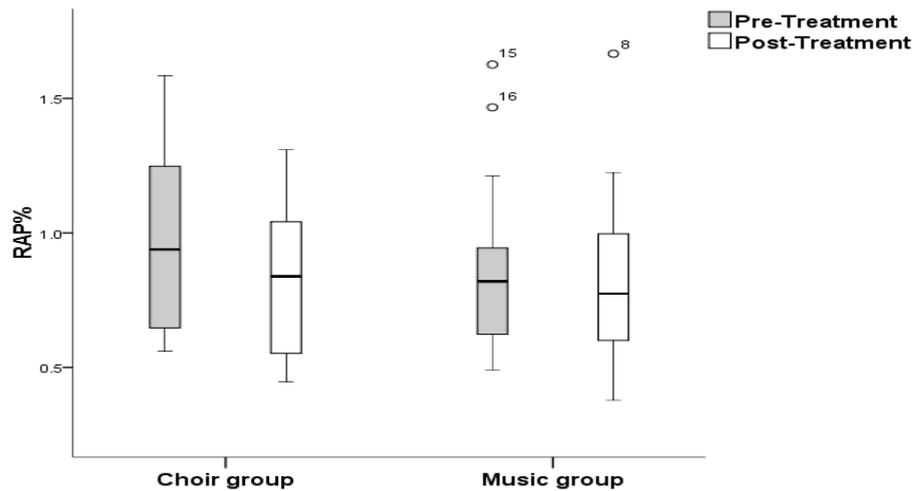


**Figure 20.** Pre and post treatment means of Shimmer (%).

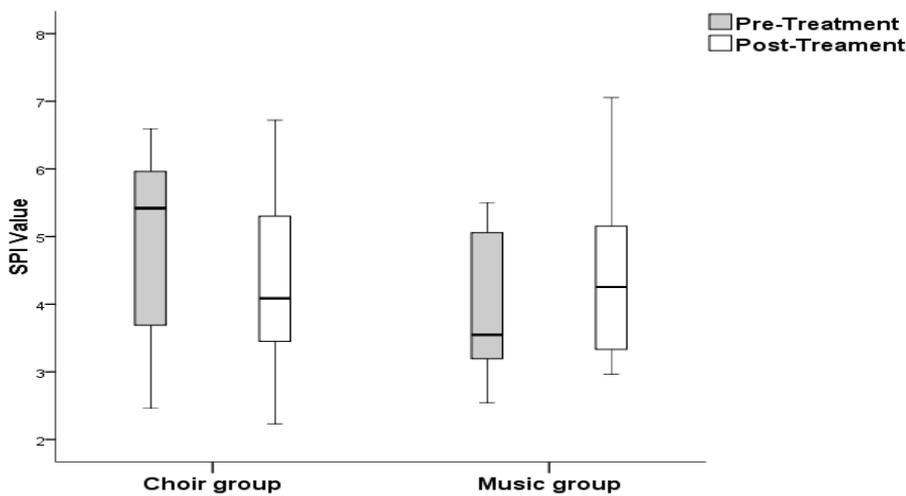
The Multi-Dimensional Voice Program (MDVP) (Kay Elemetrics, 2008) indicates a threshold of pathology of  $\leq 1.040\%$  for Jitter and  $\leq 3.810\%$  for Shimmer. The Choir group

improved for these measures. However, the post-treatment scores are above these threshold figures suggesting a sign of potential pathology.

RAP% (Figure 22) was significantly better for the Choir group post treatment ( $M = 0.72$ ,  $SD = 0.28$ ),  $t(19) = 2.25$ ,  $p = .036$ ,  $d = 0.50$ ) than at pre-treatment ( $M = 1.03$ ,  $SD = 0.31$ ).



**Figure 21.** Pre and post treatment results for Relative Average Perturbation (RAP) (%).



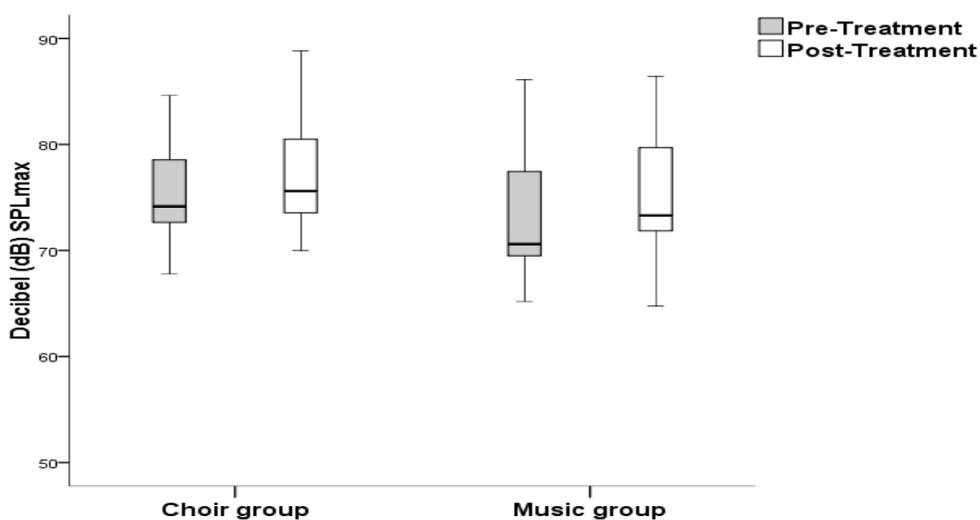
**Figure 22.** Pre and post treatment means of Soft Phonation Index (SPI).

SPI was significantly better for the Choir group post-treatment ( $M = 20.16$ ,  $SD = 10.51$ ),  $t(19) = 2.22$ ,  $p = .038$ ,  $d = 0.50$ ) than pre-treatment ( $M = 25.60$ ,  $SD = 12.76$ ) (Figure 23). SPI is an average ratio of the lower frequency harmonic energy (70-1600 Hz) to the

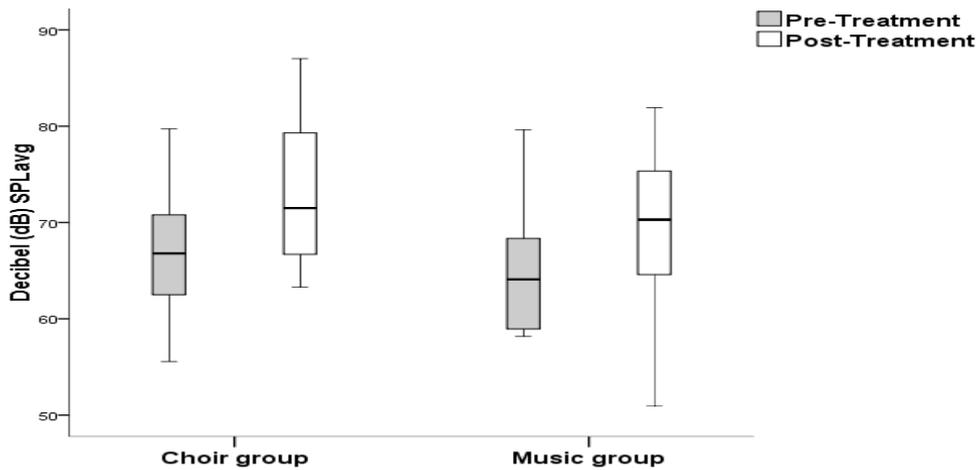
higher frequency (1600-4500 Hz) harmonic energy. An increased value of SPI may be an indication of incomplete or loose vocal fold adduction during phonation; a characteristic that appears to have improved over the treatment period for the Choir group. Interestingly, the data for VTI was not significant although, similarly to SPI, it is also a measure of the turbulence caused by incomplete or loose adduction of the vocal folds (Di Nicola, Fiorella, Spinelli, & Fiorella, 2006).

There were no significant pre and post treatment differences in SPLmax for either group (Figure 24). There was a significant within-group pre post treatment difference for both groups for SPLavg (Figure 25). A paired t-test shows significantly lower pre-treatment average SPL means for the Choir group and Music group indicating that both groups improved.

SPLavg was significantly higher post-treatment ( $M = 72.5, SD = 7.03, t(19) = 2.93, p = .009, d = 0.65$ ) (5.2dB) than at pre-treatment ( $M = 67.3, SD = 6.64$ ) for the Choir group and the Music group (Post:  $M = 69.7, SD = 8.37, t(19) = 2.47, p = .027, d = 0.64$ . (4.5dB); Pre: ( $M = 65.2, SD = 6.52$ ).



**Figure 23.** Pre and post treatment means (dB) of /a/ SPLmax Comfortable Sustained Phonation.



**Figure 24.** Pre and post treatment means (dB) of CSP /a/ SPLavg Comfortable Sustained Phonation.

### 8.7.4 Reading and Conversation

There were no significant statistical within group pre - post treatment differences observed in the spectral analysis of the Reading and Spontaneous Conversation variables:

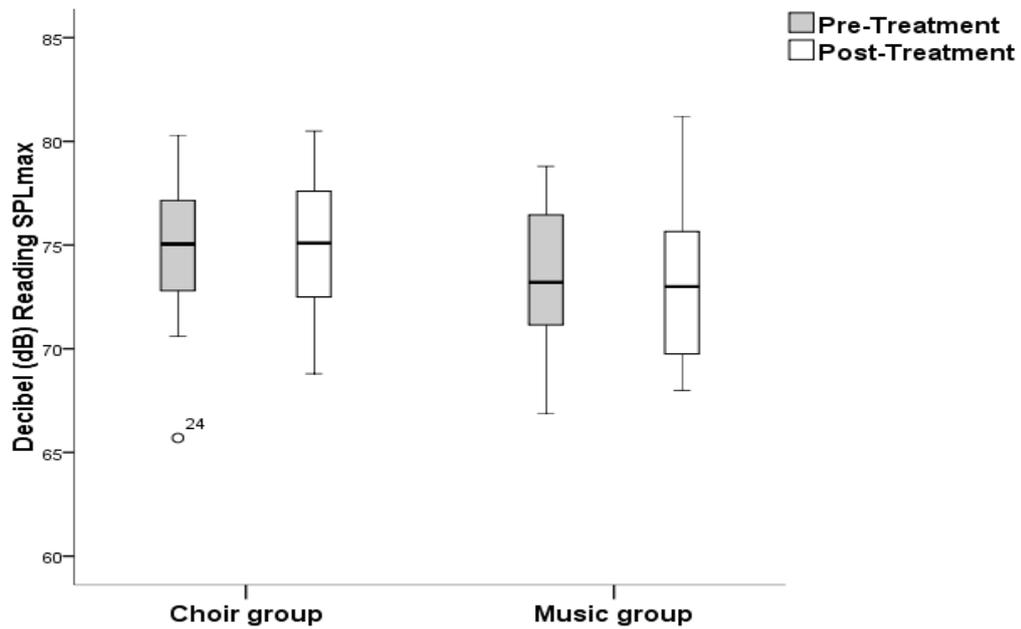
Mean F<sub>0</sub>, SD, vF<sub>0</sub>, STR and SD Semitone (Table 41).

**Table 41**  
*Mean (SD) Acoustic Parameters Hertz (Hz)\**

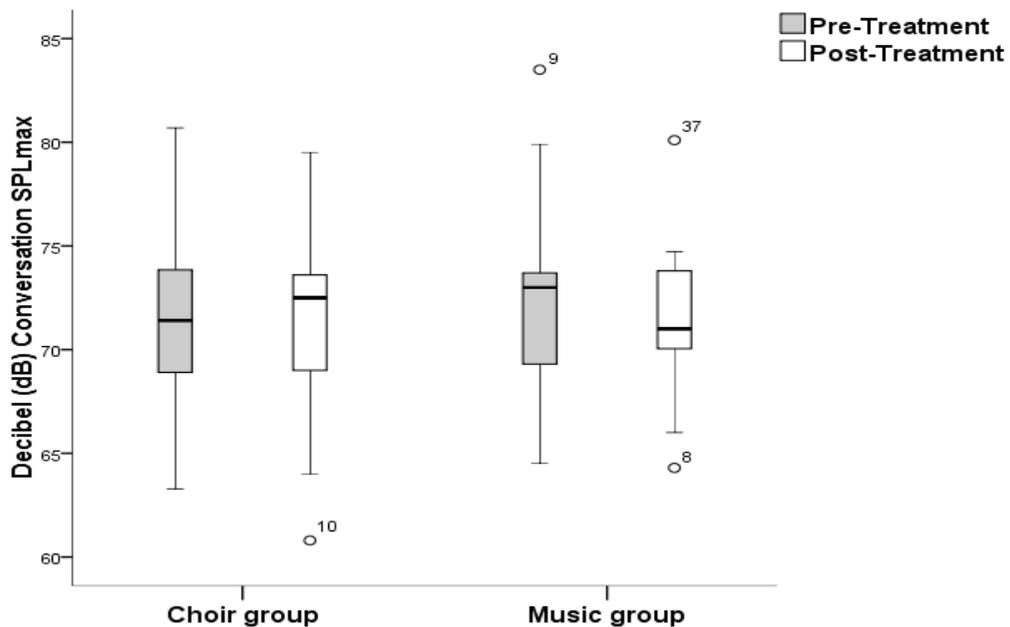
Task	Measure		Choir Group		Music Group	
			Mean	(SD)	Mean	(SD)
Reading	MeanF <sub>0</sub>	Pre	157.9	(34.7)	149.6	(31.9)
		Post	158.5	(31.8)	150.7	(30.4)
	SD	Pre	35.2	(8.6)	33.6	(9.3)
		Post	33.8	(11.3)	34.0	(9.7)
	vF <sub>0</sub>	Pre	0.23	(0.08)	0.22	(0.08)
		Post	0.21	(0.09)	0.23	(0.08)
	STR	Pre	23.1	(4.30)	24.5	(2.80)
		Post	23.3	(2.54)	22.3	(4.31)
SDSTR	Pre	3.32	(0.91)	3.16	(0.91)	
	Post	3.16	(1.09)	3.19	(0.91)	
Conversation	MeanF <sub>0</sub>	Pre	159.2	(42.0)	149.8	(31.7)
		Post	156.6	(35.6)	148.6	(31.8)
	SD	Pre	36.9	(14.5)	34.3	(12.8)
		Post	36.0	(14.6)	33.8	(9.9)
	vF <sub>0</sub>	Pre	0.24	(0.12)	0.22	(6.85)
		Post	0.23	(0.11)	0.25	(0.14)
	STR	Pre	19.6	(6.85)	20.5	(5.81)
		Post	20.5	(6.15)	21.6	(4.67)
SDSTR	Pre	3.44	(1.39)	3.40	(1.24)	
	Post	3.48	(1.56)	3.23	(0.93)	

Note. *p* values are shown for significant paired t-tests. \* Obtained from reading and dialogue (spontaneous conversation). MeanF<sub>0</sub> = Mean Fundamental Frequency, SD = Standard Deviation, vF<sub>0</sub> = Variance Fundamental Frequency, STR = Semitone Range, SDSTR = Standard Deviation Semitone Range

There were no significant pre-post treatment differences for SPLmax Reading and Conversation for either group (Figures 26 & 27).



*Figure 25.* Pre and post treatment means dB Reading SPLmax.



*Figure 26.* Pre and post treatment results for dB Conversation SPLmax.

There were significant within-group pre-post treatment differences for Reading and Conversation SPLavg for both groups (Table 42). A paired t-test of Reading and

Conversation SPLavg means indicates that for both groups SPL improved as they were both significantly louder at post-treatment.

Reading SPLavg (Figure 28) was significantly louder post-treatment ( $M = 68.2$ ,  $SD = 5.15$ ),  $t(19) = 3.14$ ,  $p = .005$ ,  $d = 0.70$ ) (3.9dB) than at pre-treatment ( $M = 64.3$ ,  $SD = 3.33$ ) for the Choir group and the Music group (Post:  $M = 66.4$ ,  $SD = 5.95$ ),  $t(14) = 3.49$ ,  $p = .004$ ,  $d = 0.90$ ) (2.8dB); Pre:  $M = 61.6$ ,  $SD = 2.80$ ).

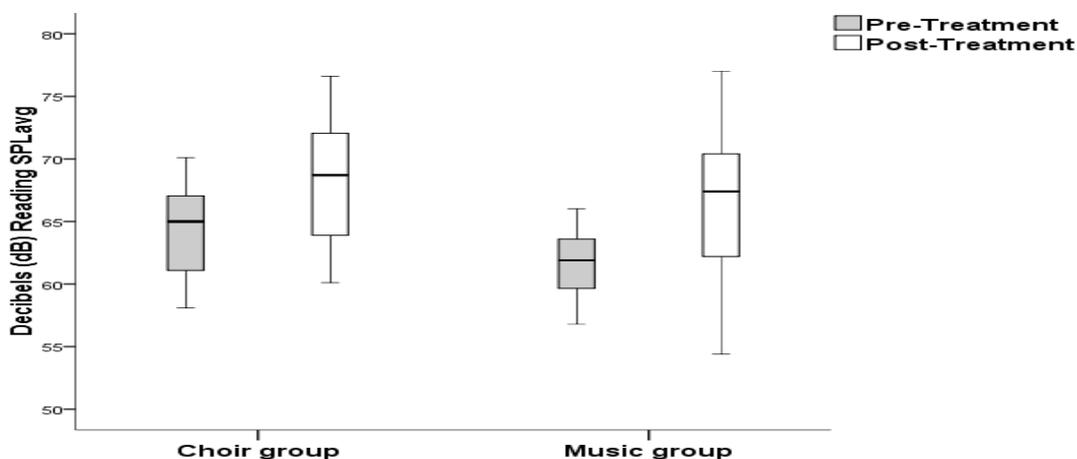
Conversation SPLavg (Figure 29) was significantly louder post-treatment ( $M = 64.4$ ,  $SD = 5.42$ ),  $t(34) = 5.17$ ,  $p = .001$ ,  $d = 0.87$ ) (6.1dB) than at pre-treatment ( $M = 58.3$ ,  $SD = 4.15$ ) for the Choir group and the Music group (Post:  $M = 61.6$ ,  $SD = 5.40$ ),  $t(14) = 2.40$ ,  $p = .031$ ,  $d = 0.62$ . (3.9dB); Pre: ( $M = 57.7$ ,  $SD = 4.00$ ).

**Table 42**

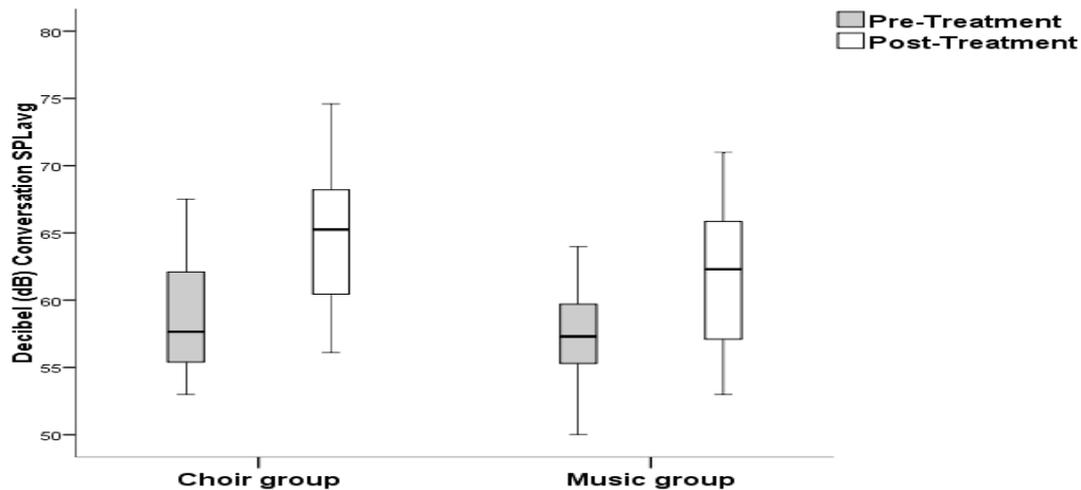
*Mean (SD) Maximum and Average reading and conversation Sound Pressure Levels (dB)*

Task	Measure		Choir Group		Music Group		
			Mean	(SD)	Sig	Mean (SD)	Sig
Reading	SPLmax (dB)	Pre	74.9	(3.62)		73.4 (3.73)	
		Post	74.9	(3.33)		73.1 (4.03)	
	SPLavg (dB)	Pre	64.3	(3.71)		61.6 (2.80)	
		Post	68.2	(5.15)	.005	66.4 (5.95)	.004
Conversation	SPLmax (dB)	Pre	71.5	(3.86)		72.6 (4.74)	
		Post	71.3	(4.63)		71.3 (3.99)	
	SPLavg (dB)	Pre	58.3	(4.15)		57.7 (5.40)	
		Post	64.4	(5.42)	.001	61.6 (5.40)	.031

Note.  $p$  values are shown for significant paired t-tests. dB = decibels.



**Figure 27.** Pre and post treatment means dB for Reading SPLavg.



*Figure 28* Pre and post treatment means dB for Conversation SPLavg.

## 8.8 Between Group Data Comparisons

### 8.8.1 Self-Report Measures

An independent samples t-test indicated no statistically significant between group differences for the DASS, PDQ-8, VHI-10 VHI-10P and Part I or Part II of the UPDRS. Between-group analysis using Mann Whitney U showed no statistically significant differences in the means for the total scores or of the five elements of the ACE-III.

### 8.8.2 Respiratory Measures

An independent samples t-test indicated no statistically significant between group differences for each of the vital capacity tasks of PEF and FEV.

### 8.8.3 Glottal Behaviour

An independent samples t-test indicates that there were no statistically significant between group differences for PAP (Table 43). There was a significant trend for PEF for the Choir group with post-treatment means significantly higher  $M = 0.90$ ,  $SD = 0.53$ ,  $t(33) = 1.99$ ,  $p = .055$ ,  $d = 0.44$ ) than the Music group ( $M = 0.77$ ,  $SD = 1.16$ ).

There was a statistically significant between-group difference for ARES. The Choir group post-treatment mean ( $M = 38.33$ ,  $SD = 16.83$ ),  $t(33) = 2.14$ ,  $p = .039$ ,  $d = 0.02$ ) was significantly better than the Music group ( $M = 28.88$ ,  $SD = 14.33$ ).

**Table 43**  
*Mean (SD) of Glottal Behaviour*

		Choir Group		<i>p</i> value	Music Group		
		Mean	(SD)		Mean	(SD)	
PAP cm/H <sub>2</sub> O	Pre	13.34	(4.21)	.055	14.51	(7.93)	
	Post	15.91	(7.05)		15.59	(11.87)	
PEF l/s	Pre	0.69	(0.50)		.039	0.69	(0.77)
	post	0.90	(0.53)			0.77	(1.16)
ARES cm/H <sub>2</sub> O/(l/s)	Pre	32.13	(10.62)		.039	35.24	(13.01)
	Post	38.33	(16.83)			28.88	(14.33)

Note. *p* values are shown for significant Independent t-tests. PAP = Peak Air pressure, PEF = Peak Air Flow, ARES = Aerodynamic Resistance.

#### 8.8.4 Voice

An independent samples t-test indicated no statistically significant between group differences in MSP for SPLavg and time in seconds. There was a statistically significant pre-treatment difference in SPLmax. The mean dB for the Music group ( $M = 100.8$ ,  $SD = 5.74$ ),  $t(35) = 2.68$ ,  $p = .011$ ,  $d = 0.44$ ) was louder compared to the Choir group ( $M = 96.4$ ,  $SD = 4.42$ ).

#### 8.8.5 Pitch Range

There were no statistically significant between-group differences for pitch range.

#### 8.8.6 Comfortable Sustained Phonation

An independent samples t-test indicated that there were no statistically significant between-group differences in CSP for Jitter %, RAP %, Shimmer %, NHR, VTI, SPLmax (dB) and SPLavg (dB). There was a statistically significant between-group difference in SPI. The Music group were lower at pre-treatment ( $M = 17.2$ ,  $SD = 4.01$ ),  $t(35) = 2.046$ ,  $p = .048$ ,  $d = 0.31$ ) compared to the Choir group ( $M = 25.6$ ,  $SD = 4.86$ ).

### 8.8.7 Reading and Conversation

There were no statistically significant between-group differences observed from spectral analysis of variables in the reading and conversation tasks. There was a significant pre-treatment between-group difference in SPLavg Reading. The Choir group were louder ( $M = 64.2, SD = 3.54$ ) than the Music group ( $M = 61.6, SD = 2.80$ ),  $t(35) = 2.37, p = .023, d = 0.31$ ). An independent t-test shows a statistically significant post-treatment between-group difference in SPLavg Conversation. The Choir group SPLavg was significantly louder following treatment ( $M = 64.8, SD = 5.42$ ),  $t(33) = 2.07, p = .046, d = 11.1$ ) compared to the Music group ( $M = 61.6, SD = 5.40$ ).

## **8.9 Repeated Measures ANOVA**

Effect size: Eta squared measures the proportion of the total variance in a dependent variable that is associated with the membership of the different groups defined by an independent variable. Partial eta squared is a similar measure in which the effects of other independent variables and interactions are partialled out (Richardson, 2011).

## **8.10 Self-Report Measures**

### **8.10.1 VHI-10**

There was a significant statistical main effect for Time ( $F(1,35) = 5.404, p = .026, \eta_p^2 = 0.13$ ) and a significant statistical interaction for Time \* Group ( $F(1,35) = 5.577, p = .024, \eta_p^2 = 0.14$ ) indicating that the Choir group perceived their voices to have improved following the 9 week treatment period.

### **8.10.2 VHI-10P**

There was a significant statistical main effect for Time ( $F(1,30) = 7.199, p = .012, \eta_p^2 = 0.19$ ). The partners of the Choir group and the Music group were in agreement with the outcomes reported by the people with PD completing the VHI-10.

### **8.10.3 PDQ-8**

There was a statistically significant effect of time for PDQ-8 ( $F(1,35) = 7.728, p = .011, \eta_p^2 = 0.17$ ). Both groups reported improved quality of life at post treatment.

### **8.10.4 DASS-21**

There was a significant statistical effect of time for Stress ( $F(1,35) = 8.049, p = .008, \eta_p^2 = 0.19$ ). There were no main or interaction effects for Depression or Anxiety.

### **8.10.5 UPDRS**

A repeated-measures ANOVA revealed no significant main or interaction effects for Part One or Part Two of the UPDRS.

## **8.11 Voice – Sound Pressure Level (SPL)**

### **8.11.1 Maximum sustained phonation (MSP)**

There was a significant statistical main effect for Group ( $F(1,35) = 6.967, p = .012, \eta_p^2 = 0.17$ ) for SPLmax.

There was also a significant statistical interaction effect between Time and Group ( $F(1,35) = 4.142, p = .050, \eta_p^2 = 0.109$ ) for SPLavg. The average volume (SPLavg) of the Choir group increased over the treatment period whereas it was seen to decrease for the Music group.

### **8.11.2 Comfortable Sustained Phonation (CSP)**

There were no significant statistical main or interaction effects for SPLmax. There was a significant statistical main effect for Time ( $F(1,35) = 13.437, p = .001, \eta_p^2 = 0.28$ ) for SPLavg.

### **8.11.3 Reading and Conversation**

There were no significant statistical main or interaction effects for reading and conversation SPLmax. There was a significant statistical main effect of Time ( $F(1,35) = 21.650, p < .001, \eta_p^2 = 0.38$ ) for reading SPLavg. There was a significant statistical main effect of Time ( $F(1,35) = 23.061, p < .001, \eta_p^2 = 0.40$ ) for conversation SPLavg.

### **8.11.4 Composite of MSP, CSP and Reading**

Cronbach's alpha ( $\alpha$ ) (Cronbach, 1951) reliability analysis indicated high inter-item agreement ( $\alpha = .812$ ) for the maximum and average SPL values for the MSP (two repeats), CSP and Reading tasks and hence a composite measure was derived by averaging these eight values together. There was a significant statistical main effect of Time ( $F(1,35) = 10.057, p = .003, \eta_p^2 = 0.22$ ) for composite SPL for MSP, CSP and Reading.

### **8.11.5 Composite Conversation**

Cronbach's alpha ( $\alpha$ ) reliability analysis indicated high inter-item agreement ( $\alpha = .813$ ) for the maximum and average SPL values obtained for the Conversation task and hence a composite measure was derived by averaging these two values together. There was a significant statistical main effect of Time ( $F(1,35) = 7.134, p = .010, \eta_p^2 = 0.17$ ) for composite SPL for Conversation.

### **8.12 Voice Quality**

#### **8.12.1 Perturbation - Comfortable Sustained Phonation (CSP)**

There was a statistical significant main effect of Time for Jitter ( $F(1,35) = 5.443, p = .026, \eta_p^2 = 0.13$ ); Shimmer ( $F(1,35) = 4.562, p = .040, \eta_p^2 = 0.11$ ) and NHR ( $F(1,35) = 291.9, p < .001, \eta_p^2 = 0.89$ ) indicating that these measures of noise presence (perturbation) in the voice sample improved for both groups.

There was a significant statistical main effect of Group for VTI ( $F(1,35) = 5.044, p = .031, \eta_p^2 = 0.13$ ). There was also a significant statistical interaction effect of Time\*Group for SPI ( $F(1,35) = 7.103, p = .012, \eta_p^2 = 0.169$ ), which, for the the Choir group, indicates that the high frequency harmonic SPI component had improved (reduced). The Music group deteriorated (increased) over the same period suggesting worsening (loosely adducting) vocal folds during phonation.

#### **8.12.2 Pitch Range**

There was a significant statistical effect of Time for Semitone Range (STR) ( $F(1,35) = 38.47, p < .001, \eta_p^2 = 0.52$ ) indicating that both groups improved following the intervention. There were no significant statistical main or interaction effects for Minimum Hz, Maximum Hz and Range Hz.

### **8.12.3 Reading and Conversation**

There were no significant statistical main or interaction effects for Mean  $F_0$ ,  $SD F_0$ ,  $vF_0$ , STR and SD STR. There were no significant statistical main or interaction effects for Mean  $F_0$ ,  $SD F_0$ ,  $vF_0$ , and SD. There was a significant statistical effect of Time for Semitone Range  $F(1,35) = 7.071, p = .012, \eta_p^2 = 0.73$ .

### **8.13 Glottal Behaviour**

There was a significant statistical main effect for Time\*Group ( $F(1,35) = 7.334, p = .010, \eta_p^2 = 0.17$ ) for ARES. ARES (sub-glottic pressure) increased for the Choir group over the treatment period and reduced for the Music group.

There were no significant statistical Time, Group or interaction effect of Time\*Group for PAP or PEF.

### **8.14 Respiration**

There was no significant statistical main effect for Time, Group or interaction effect of Time\*Group effect for PEF or FEV.

## Chapter Nine: Study Two Results - Participant Activities Evaluation

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All participants completed a questionnaire (Fogg & Talmage, 2011) at the end of the nine week treatment period to evaluate their experience of group participation and of perceptual changes owing to their particular group activity (Appendix 12). Using a Likert rating 5-point scale (1 representing strongly disagree and 5 representing strongly agree), the participants assessed the degree of agreement with a mix of 23 social and personal open ended questions relating to wellbeing associated with group participation (Figure 30).

Statistical analysis was undertaken using Mann Whitney U to ascertain significant between-group differences. The results from the evaluation (Table 51) show that there were significant between-group differences spread evenly across social and physical rehabilitative aspects of participation. Cronbach's alpha ( $\alpha$ ) (Cronbach, 1951) analysis of reliability indicated a high inter-item agreement ( $\alpha = .914$ ) for the 23 items of the questionnaire.

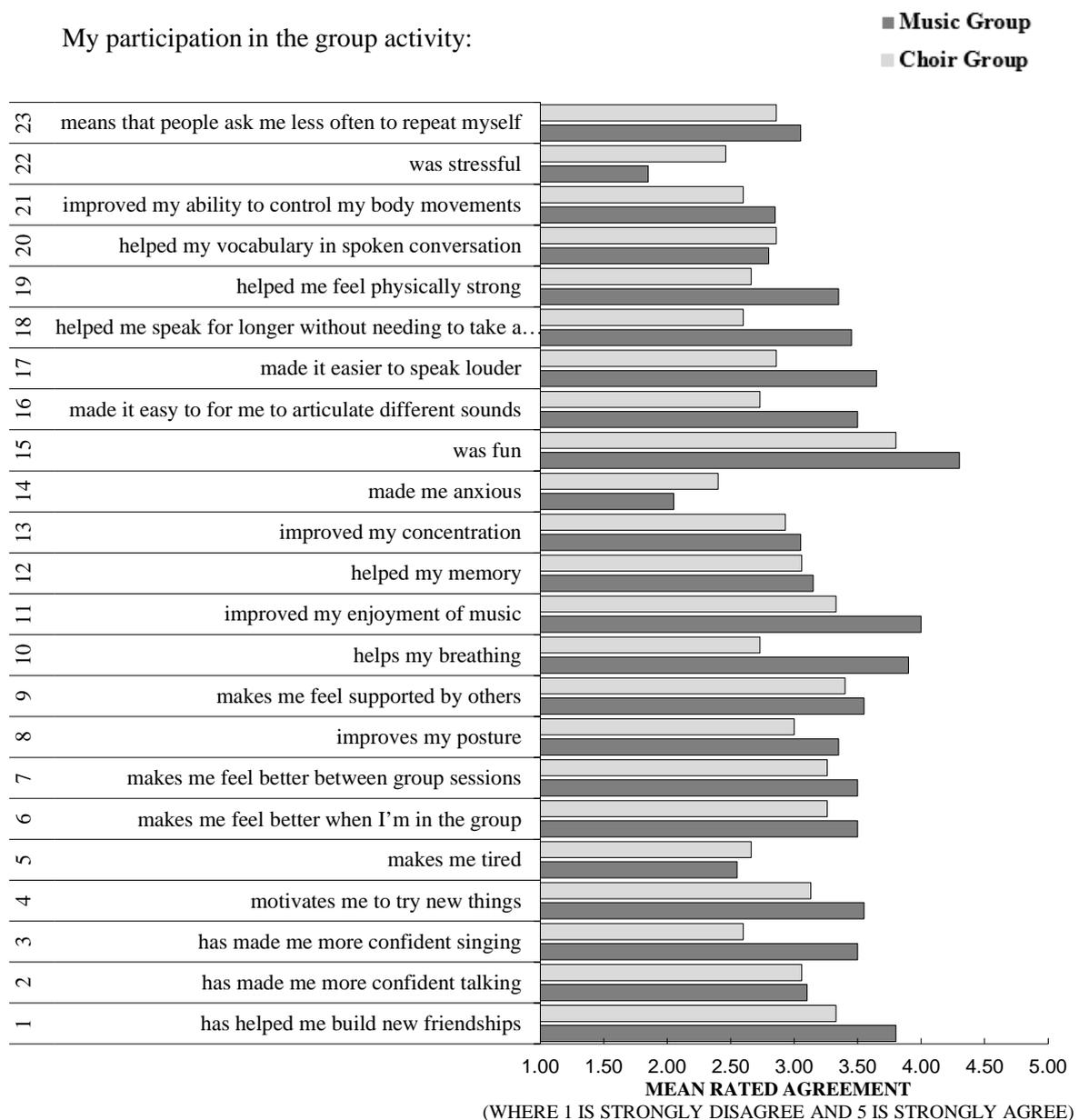
### 9.1 Social Aspects

There were significant statistical between-group differences across 7 of the social aspects of Choir group and Music group participation. In particular, the Choir group indicated significant social benefits following participation such as building new friendships Q1: ( $Mdn = 4$ ),  $U = 94.5$ ,  $p = .031$ ,  $r = 0.36$ ). The Choir group also felt more confident Q3: ( $Mdn = 4$ ),  $U = 83.0$ ,  $p = .017$ ,  $r = 0.40$ ). With that confidence, came a motivational trend for the Choir group to try new things Q4: ( $Mdn = 4$ ),  $U = 102.0$ ,  $p = .073$ ,  $r = 0.30$ ) and a statistical trend for improved enjoyment of music Q11: ( $Mdn = 4$ ),  $U = 101.0$ ,  $p = .063$ ,  $r = 0.31$ ).

Participation in the Choir group resulted in a significantly greater experience of fun Q15: ( $Mdn = 4$ ),  $U = 94.0$ ,  $p = .015$ ,  $r = 0.41$ ). Conversely, the Music group found participation stressful Q22: ( $Mdn = 2$ ),  $U = 83.0$ ,  $p = .014$ ,  $r = 0.42$ ) and were more anxious Q 14: ( $Mdn = 2$ ),  $U = 95.5$ ,  $p = .044$ ,  $r = 0.34$ ) compared to the Choir group.

## 9.2 Physical Aspects

Interestingly, there were significant statistical between-group differences across 6 of the physical aspects. The Choir group reported physical health benefits associated with their group activity with significantly high ratings given to improvement that included Q10: breathing ( $Mdn = 3$ ),  $U = 43.5$ ,  $p = .001$ ,  $r = 0.65$ ); Q16: ease of articulating different sounds ( $Mdn = 3$ ),  $U = 52.0$ ,  $p = .001$ ,  $r = 0.61$ ); Q17: speaking louder ( $Mdn = 3$ ),  $U = 80.5$ ,  $p = .012$ ,  $r = 0.43$ ) and Q18: being able to speak for longer between breaths ( $Mdn = 3$ ),  $U = 59.0$ ,  $p = .001$ ,  $r = 0.56$ ). There was also a statistical trend for the Choir group activity to help participants to feel physically strong ( $Mdn = 3$ ),  $U = 101.0$ ,  $p = .073$ ,  $r = 0.30$ ). There were no significant statistical results reported by the Music group.



**Figure 29.** Post-treatment mean rated agreement with statement my participation in the group activity from the Choir group and Music group.

Analysis of between group differences data in Table 44 shows that, except for question 20 (*helped my vocabulary in spoken conversation*) the Choir group rated positively across all of the statements relating to their group activity.

**Table 44**  
*Statistical Analysis of Perception of Group Participation*

Q	My participation in the group activity:	Choir	Music	Sig
		group	group	
		Mean	Mean	
		Rank	Rank	
1	<b>has helped me build new friendships</b>	21.03	14.41	$p = .031^*$
2	<b>has made me more confident talking</b>	18.58	17.31	
3	<b>has made me more confident singing</b>	21.63	13.69	$p = .017^*$
4	<b>motivates me to try new things</b>	20.63	14.88	$p = .0738$
5	makes me tired	16.79	19.44	
6	<b>makes me feel better when I'm in the group</b>	20.26	15.31	
7	<b>makes me feel better between group sessions</b>	19.32	16.44	
8	improves my posture	20.26	15.31	
9	<b>makes me feel supported by others</b>	19.82	15.84	
10	helps my breathing	23.71	11.22	$p = .001^*$
11	<b>improved my enjoyment of music</b>	20.68	14.81	$p = .0638$
12	helped my memory	18.42	17.50	
13	improved my concentration	18.71	17.16	
14	<b>made me anxious</b>	15.03	21.53	$p = .044^*$
15	<b>was fun</b>	21.05	14.38	$p = .015^*$
16	made it easy to for me to articulate different sounds	23.26	11.75	$p = .001^*$
17	made it easier to speak louder	21.76	13.53	$p = .012^*$
18	helped me speak for longer without taking a breath	22.89	12.19	$p = .001^*$
19	helped me feel physically strong	20.68	14.81	$p = .0738$
20	helped my vocabulary in spoken conversation	16.92	19.28	
21	improved my ability to control my body movements	18.95	16.88	
22	<b>was stressful</b>	14.37	22.31	$p = .014^*$
23	means that people ask me less often to repeat myself	19.21	16.56	

Note. Social statements in **bold**. Significant statistical effects ( $p < .05$ ) & statistical trends ( $p < .10$ ). Mann Whitney U. Bonferroni-adjusted p value of  $p < .002$  (.05/23).

### 9.3 Subjective Experiences

The questionnaire also enabled participants to describe, in their own words, their subjective experience of the group activity. The questionnaire was completed by 48% of the participants of which 59% were in the Choir group and 34% in the Music group.

A general inductive approach (Thomas, 2006) was used to capture and condense emergent themes within these data for analysis. A hierarchical framework was constructed consisting of summary themes identified from the narrative. The themes were examined further to establish lateral relationships. Categories were identified and coded - for example; experience of being in the group, physical/therapeutic benefits, confidence, belonging, special qualities

of music/singing, social connectedness and achievement. From evaluating these data through multiple readings and re-checking, four common themes emerged from the narrative – enjoyment of belonging to a group, friendships/connectedness, wellbeing and physical improvement are highlighted below.

## **9.4 Choir Group**

### **9.4.1 Group Enjoyment**

For the Choir group, enjoyment of group participation and singing was both intrinsic as well as extrinsic with references to inner feelings, satisfaction, pleasure and confidence alongside the social interaction and comradery.

0024 - *The comradery of the singing and the fact there is no criteria only enjoyment.*

0047 - *I feel there is more enjoyment for me singing as it releases good feelings and added self-confidence when singing with a group of people. You can also get satisfaction in the thought of entertaining people. I get more pleasure out of being part of the performance.*

0028 - *An inner feeling of satisfaction and pleasure in being able to get the words and music as right as you can, adding value to the greater group.*

0032 - *I love the social interaction with the other participants, the pleasure gained from group singing, and the benefits of voice control and volume gained from the programme.*

### **9.4.2 Friendships**

Having fun with ‘likeminded’ others in the choir whilst being ‘lost’ in singing was considered a spiritual experience. Sharing the singing experience with others was also regarded a great sense of belonging, achievement and pleasure across people with differing degrees of symptom severity.

0021 - *Making new friends and being lost in the music was for me quite spiritual.*

0017 - *There was wonderful comradery.*

0029 - *I enjoyed the meeting together of like-minded people and I enjoy their company.*

0037 - *I felt happy with a great sense of belonging and pleasure. A sense of achievement.*

0021 - *The purpose...to sing, to improve voice control etc is essentially a pathway to social interaction and friendships, also recognition of the commonality of areas of disease*

*means I recognise I am not alone!*

0040 - *For me - speech, respiratory exercise, voice strength and making new friends are of equal importance.*

### **9.4.3 Wellbeing**

There were references to wellbeing created from singing as a medicine. Not being set up to fail; independent but, part of the larger group was for some inspirational bringing wellbeing and happiness.

0039 - *I thought that singing created wellbeing among “fellow travellers” who may need a “medicine” to overcome an illness or loneliness or just a need to stop succumbing to an unhealthy attitude to life left for them.*

0040 - *There is a greater pleasure when one is both giver & receiver.*

0029 - *A warm sense of wellbeing and one of happiness and joy is what I will remember.*

0039 - *Each member is treated as equal, or better than you [researcher] as a “star performer”.*

0041 - *Singing without the need to worry about the quality of the output.*

0033 - *I was totally immersed in the songs, which are recalled from my younger days, so it made me feel happy*

0029 - *The fact that there is a group of people with a similar outlook and being part of a choir lets you have independence but being part of a group which makes you feel great.*

0033 - *Character building can be rekindled with such newly confronted commitment.*

0024 - *It was inspirational. I started off very nervous as I was afraid of what could possibly be ahead of me as someone with PD. The people a got to sing with got nothing short of 100% admiration for their attitude. I felt very blessed being part of the singing group.*

0033 - *Look harder and you will see the joy of singing.*

### **9.4.4 Physical**

As might be expected, references to voice and speech volume were common themes within the narrative of the Choir group. Perceived improvement was referred to as a ‘physical sensation’ with changes to strength, control, effort and commitment. Interestingly,

there were also references of how attending the singing group provided a sense of ownership and distraction and a way to assist delaying the decline.

0024 - *The physical sensation that I got from expanding my lungs and diaphragm and the realisation that my voice [audio volume] was actually getting louder was very satisfying for me.*

0029 – *I thought it gave me a way slow the Parkinson's.*

0047 - *A group activity that helped to make my voice stronger and let me forget myself.*

0041 - *I felt as if I could control my voice volume.*

0029 - *I feel that I honestly made every effort to attend every commitment made to the group's practices because I feel the improvement to my voice and breathing muscles.*

0033 - *For me [personally] the respiratory exercise is something I feel must be benefitting myself, plus keeping the memory going, not just with the words but also events associated with some of the songs.*

0024 - *Singing helps, in my case, particularly with my strength of volume.*

0037 - *I felt very positive when I sang and felt this is something I can do to really improve myself.*

## **9.5 Music Group**

### **9.5.1 Group Enjoyment**

For the Music group, enjoyment of group participation centred on inclusion and belonging to a group. A group in which, initially, they were disappointed to be in, but were content in being part of the bigger project.

0044 - *I felt I belonged to a special group. People were very welcoming and I felt no awkwardness. I could be myself.*

0004 - *I was disappointed I wasn't in the singing group as I felt that it might assist my speech or slow down deterioration in the future. I really enjoyed being part of the music appreciation group and being part of a bigger project.*

0034 - *I enjoyed the group meetings and listening to good music. I also felt part of something very important and wanted to do what I can to help.*

### **9.5.2 Friendships**

Making new friends and sharing with others with PD was seen as a benefit for the Music group.

0046 - *I enjoyed meeting new people and discovering their taste in music. I really enjoyed coming to my group each week and was sorry when it finished.*

0033 - *The social interactions and group ability to feel inclusive is invaluable for a person who has certain conditions. The fact that many are afflicted with the same condition makes it more relevant.*

0034 - *It was great making friends with people who are in the same boat as me and finding that actually we had lots in common and could share stuff.*

0044 - *Although I feel that I had missed something very special by not singing, I got a lot out of being in the music group and have made new friends.*

### **9.5.3 Wellbeing**

Establishing new friendships and the enjoyment of belonging to a group was not interpreted as feelings of wellbeing with few references in the narrative.

0004 - *I find it difficult to interact with people who are largely more challenged than I see myself. I function better in groups who are not challenged by illness. Being in this group made me realise and accept there are certain commonalities.*

0046 - *I thought as the group went on over the weeks there was a definite feeling of comradery especially with the music quiz which I thought cheered us up as lot.*

### **9.5.4 Physical**

With exercise not being part of the Music group protocol, understandably, there was little reference with relation to physical benefit from the Music group

0044 - *Coming to the group has given me renewed energy. I used to lack much of the incentive needed to do jobs around the house that are within my capability and I used to procrastinate.*

This personal, subjective, evaluation revealed that participants of the Choir group rated the social aspects of participation and the physical rehabilitative benefits roughly equally. With benefits recorded across nearly all dimensions shows that participation in the Choir group was viewed, broadly, as a positive experience. Conversely, although seemingly enjoying the experience as observed from the narrative, the Music group recorded increases in stress and anxiety; a result not reflected in the DASS-21 outcome, which showed (paired t-test) significantly less post-treatment depression and stress. The outcome of the participant activities questionnaire did not, however, affect compliance as the attendance of Music group participants was high (96.5%) with no withdrawals. This suggests that, although the Music group perceived group participation as stressful and made them anxious, the DASS-21 outcome reflects a broader perception in relation to everyday life in the week preceding the DASS- 21 assessment, which was not affected by group participation. The open ended nature of the questionnaire did not allow the participants to differentiate stress and anxiety at the beginning or over the nine week duration of the study.

Broadly, the outcome of the Choir group in this present study compare to those of a qualitative study by Stegemöller, Hurt, O'Connor, Camp, Green, Pattee, and Williams, (2018), who recorded and analysed the experiences of people with PD who engaged in a group singing intervention (GSI). The findings of their study revealed that participants regarded their involvement as mutually beneficial, fun and engaging. The participants were thankful for the fellowship with others with PD and the observed improvements in their abilities to breathe and speak better.

## Chapter Ten: Discussion and Conclusion

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### 10.1 Introduction

This chapter summarises the main outcomes of this thesis. It defines the implications, limitations and applications for clinical practice and concludes with suggestions for future research. To the best of my knowledge, this is the first RCT to examine the impact of a voice and singing intervention with a series of objective instrumental measures that include vocal loudness, voice quality, respiration and glottal behaviour as well as self-report measures of voice, QoL, stress, depression and symptom severity.

Chapter one described the progressive, degenerative nature of the motor and the non-motor characteristics of PD and how both impact significantly on general function of mobility, voice, respiration and, importantly, on the psychological wellbeing of the people with it. The symptomatological difficulties associated with ongoing, long-term pharmacological management of the condition were also explored. Also Chapter one discussed how complementary, non-pharmacological interventions like singing therapy could have a beneficial effect, providing opportunities for physical and emotional benefits and social engagement.

In Chapters two and four outcomes from the few studies in the literature that report on the benefits of group singing are discussed. All are varied, single group, non-RCT designs and include only limited assessment of the impact of group singing on functional communication and psychosocial wellbeing. None of the studies explored the potential for improvement in cognitive and motor function and were, in the main, voice - speech centric.

The aim of this present study was to investigate, using a range of objective (instrumental) and self-report measures, whether exposure to VCST (with a combined vocal pedagogy that emphasises vocal intensity) produces a positive change in voice and

respiration, and psychological and psychosocial wellbeing. The study posits questions for future research of how connectedness, derived from a collaborative community (VCST), could create awareness and opportunity for people with PD to enhance self-management of their PD symptoms and the capacity to control how they might interact with their environment. There are other important considerations relating to the economic benefits (financial and time) of group treatment with a strong community focus that provides opportunities for social and emotional support.

The enjoyable accommodation and therapeutic benefit proffered by a group activity for people with PD (at various stages of progression and with varying singing and musical abilities) aligns with the International Classification of Functioning, Disability and Health model (ICF; WHO, 2001) as it provides depersonalised self-expression whilst promoting empowerment to manage their own health and wellness (Clift & Hancox, 2001). Although in the current study adherence to treatment was not compared to other similar approaches, the high rate of attendance at therapy and assessment sessions in the current study suggests that an engaging singing group activity, outside the traditional healthcare setting, could improve compliance with therapeutic maintenance of voice in people with PD and, importantly, for long periods.

Analysis of variance (ANOVA) of the data indicated that, for many of the measures, both interventions were successful. The Choir group and the Music group improved across a range of measures. There were, however, specific significant benefits for the Choir group across five dependent variables, which are examined below.

## **10.2 Maximum Sustained Phonation (MSP) Sound Pressure Levels (SPL)**

The Choir had better maximum sustained phonation (MSP) sound pressure levels overall than the Music group, and showed differential improvement in the average sound pressure levels following the intervention.

The Choir group performed better than the Music group with an increase in both maximum and average SPL. A significant post-treatment improvement (+3.3dB) from 96.2dB to 99.5dB for Maximum SPL and a post-treatment improvement (+3.4dB) from 91.2dB to 94.6dB for Average SPL for the Choir group demonstrates that intensive weekly voice exercise and singing with emphasis on phonatory effort is capable of producing effective, medium term improvement in voice amplitude in people with PD. The important data is not the high SPL dB means, but the pre-post treatment differential. The high SPL means for the MSP task are the result the microphone placement, which for the PAS equipment was 16 cm distance from the participant's mouth. The SPL results for the other acoustic measures in this study have the SPL meter microphone placement at 50 cm from the participant's mouth. When comparing SPL outcomes across studies and instruments, microphone placement is an important consideration.

These data are consistent with those of Tanner, Rammage, and Liu (2016), who found that a group treatment that included singing and increased vocal effort improved MSP Maximum SPL from 45.7dB to 52.9dB (+7.1dB) after a six week treatment period. The improvement in MSP in this current study would appear modest when compared to the results achieved in the high intensity, high effort studies of the LSVT<sup>®</sup> and LSVT<sup>®</sup> programmes (Ramig et al., 2001; Spielman et al., 2007; Spielman et al., 2011; Wight and Miller, 2015; Halpern et al., 2012), however, a microphone placement at 30cm in these studies compared to a placement of 50cm of the present study could explain this difference. Despite this difference, the results of the current study support the efficacy of a high intensity approach to vocal and respiratory exercise when combined with high intensity singing.

When looked at in conjunction with a significant result for aerodynamic resistance and the other average sound pressure level results (discussed below), the data from the current study are compelling. Yinger and Lapointe (2012) noted that MSP is a widely used measure

of respiratory integrity and laryngeal valving efficiency. The improvement in MSP-SPL of the Choir group supports the notion that the high intensity approach integrated into VCST, adopted from the LSVT® and used with some success in the mixed approach explored by Tanner et al. (2016), is an important factor in improving laryngeal valving efficiency.

### **10.3 Maximum Sustained Phonation (MSP/s) (Seconds)**

Results of MSP/s were not significant, however both the Choir and Music groups maintained their phonation durations from 16.1 secs pre-treatment to 16.7 secs post treatment and 15.2secs to 15.2 secs post-treatment. These data compare with Tanner et al. (2016) who achieved a minimal increase: 14.0 to 15.1 seconds and Di Benedetto et al. (2009) who report a four second increase: 13.5 to 17.2 seconds. Greater vocal intensity encouraged during treatment significantly improved maximum and average MSP sound pressure levels for the Choir group without improving phonation time. A possible explanation comes from Tanner et al. (2016) who stated that louder phonation is associated with higher phonation flow rates and shorter phonation duration.

Normative data for MSP is 15-25 seconds (adult female) and 25-35 seconds (adult male) (Williamson, 2009). The increase in Maximum and Average MSP SPL (dB) for the Choir group did not translate into longer phonation times in the current study, suggesting that the other activities incorporated into the Choir repertoire maybe needed to change phonation times.

### **10.4 Reading and Conversation - SPL**

Average SPL improved for reading and conversation tasks for both groups. The improvement in Average SPL of Reading was (+3.9dB) for the Choir group and (+4.8dB) for the Music group. The average increase in SPL for Conversation was (+6.5dB) for the Choir group and (+3.9dB) for the Music group. The Reading SPLavg result is comparable with

results for LSVT<sup>®</sup> and LSVT-X<sup>®</sup>, which range from +6.7dB (Ramig & Dromey, 1996) to +9.1 dB (Halpern et al., 2012).

The +6.5dB increase in Conversation SPLavg for the Choir group is also comparable with the outcomes for LSVT<sup>®</sup> and LSVT-X<sup>®</sup>, which range from +5.5dB (Ramig & Dromey, 1996) to +8.5dB (Wight & Miller, 2015). The +6.5dB increase in Conversation SPLavg for Choir group's in this study is very similar to results of Spielman, Ramig, Mahler, Halpern, and Gavin, (2007), who reported an average SPL increase in Conversation SPLavg of +6.1dB after an LSVT-X<sup>®</sup> intervention with a 16 hour exposure to high intensity vowel prolongation, monologue and reading treatment. SPLavg for Conversation is the primary outcome of this study by Spielman et al., which I will be refer, along with treatment dosage, later in this discussion.

The improvement in SPL for both groups across all measures of SPL should contribute to improved communication related quality of life – this was supported by the questionnaire data. This lends credence to the view that positive daily affective experience (Weintraub, Cary, Stern, Taraborelli, & Katz, 2006) and reward-related behaviour theory (Ridderinkhof et al., 2012) does indeed have the potential to improve outcomes for people with PD. The results indicate that well organised and focused group activities, whether listening to music or singing, both engaged and stimulated people positively, as observed in SPL, respiration and voice quality improvements for the two different interventions.

### **10.5 Comfortable Sustained Phonation (CSP) SPL**

Both the Choir and the Music groups had better average sound pressure levels following the intervention. The average increase in SPL (dB) for CSP was +5.2dB for the Choir group and +4.4dB for the Music group. These results are similar to the SPL improvements evidenced for the other speech tasks.

### **10.5.1 Comfortable Sustained Phonation - Voice Quality (Perturbation)**

As discussed in Chapter six, rigidity and bradykinesia of the laryngeal and respiratory musculature are thought to be responsible for the soft, breathy, voices in people with PD (Ramig et al. 1995). Rigidity and bradykinesia of the muscles can increase with the clinical progression of PD and can present with restriction in pitch and a softer, breathier voice. The CSP data suggest that, for the Choir group, the voice characteristics related to bradykinesia and rigidity have the potential to improve following treatment.

Soft Phonation Index (SPI) is a component measured by the Sona-Speech II™ Voice Programme (MDVP) that provides an indication of vocal fold adduction (glottal closure) during phonation, SPI is not a measurement of noise, rather it reflects the harmonic structure of the voice spectrum (KayPENTAX - Issue F (2009)). SPI is an average ratio of the lower-frequency harmonic energy between 70-1600 Hertz and the higher frequency harmonic energy between 1600-4500 Hertz. KayPENTAX - Issue F (2009). High values of SPI are stated to correlate with incomplete vocal fold adduction and are thought to be a better indicator of breathiness than an electroglottograph (Mathew & Bhat, 2009) and consequently SPI is an important variable in this study.

SPI improved for the Choir group. In fact, while mean SPI reduced (improved) for the Choir group, it increased (worsened) in the Music group, which is suggestive of worsening vocal fold function. These SPI data compare with published normative data (non PD population), which range from 24.87 (Mathew & Bhat, 2009) to 1.79 - 14.14 (Di Nicola, Fiorella, Spinelli, & Fiorella, 2006), and hence although SPI worsened for the Music group, it was still in the normative range. There was a positive correlation for the Choir group between SPI and ARES ( $r = 0.426$ ,  $p = .039$ ), suggesting that the improvement in SPI is related to changes in subglottic pressure.

Bhuta, Patrick, and Garnett (2004) found that SPI was one of only a few acoustic parameters that correlated with perceptual voice ratings. Analysis of SPI and voice ratings using the VHI-10 and VHI-10P in this study showed no correlation in the current study, however. It is possible that the instrumental assessment of SPI is a more sensitive objective index of voice change than the perceptual ratings of participants and their partners, or voice ratings are based on a range of voice changes rather than just one aspect of voice.

Voice Turbulence Index (VTI) is the average ratio of the spectral inharmonic high frequency energy in the range 2800-5800 Hz to the spectral harmonic energy in the frequency range 70-4500 Hz which is the part of speech signal where the influences of the frequency and amplitude variations, voice breaks and sub-harmonic components are minimal. VTI measures the relative energy level of high frequency noise. It correlates primarily with the turbulence caused by incomplete or loose adduction of the vocal folds (Di Nicola et al., 2006).

The data show that VTI worsened for the Music group, which correlates with SPI data which also showed a significant pre-post worsening of SPI. This suggests a worsening or incomplete vocal fold adduction in the Music group, in contrast to the improved data for the Choir group, who were singing and doing exercises designed to improve vocal fold adduction.

When comparing the voice quality (perturbation) of the two groups, no significant difference in Jitter%, RAP%, Shimmer% and NHR were observed. Voice quality analysed using these variables improved for both groups over the treatment period. The Multi-Dimensional Voice Program (MDVP) (Kay Elemetrics, 2008) has a threshold of pathology of  $\leq 1.040\%$  for Jitter and  $\leq 3.810\%$  for Shimmer. Although the Choir group improved for these measures, their post-treatment scores are above these normative threshold figures, which is a sign of potential pathology (Kay Elemetrics, 2008).

Frequency perturbation is one of the correlates of perceived hoarseness (Baken & Orlikoff, 2000). The means of Jitter% - frequency perturbation and RAP% - Relative Average Perturbation, although not significantly different pre- versus post-treatment, are of interest because of the group differences for these two variables. The Choir group's pre-treatment results were higher (worse) than the Music group's and the Choir group's post-treatment results were lower (better) than the Music group suggesting a trend of worsening vocal stability in the Music group. This is consistent with the findings for SPI and VTI over the same period. For the Choir group the post-treatment result for vocal Jitter% moved within the normative range of  $< 1.04\%$ .

These outcomes, when combined with the Glottal Behaviour (ARES) data, are encouraging and, as discussed earlier, suggests that high intensity vocal and respiratory exercise combined with high intensity singing improved the aerodynamic resistance (subglottic pressure) of the Choir group. This result is consistent with findings of an earlier study that examined whether vocal function exercises would improve physiological parameters of vocal production in singers (Sabol, Lee, & Stemple, 1995). The exercises combining muscle action (isotonic) and tone (isometric) elements in the study by Sabol et al. (1995) were designed to strengthen the laryngeal musculature and facilitate efficient vocal fold vibration over a four week period. The primary physiological effects observed were higher phonation volumes and phonation times, as well as a reduction in airflow, which the authors interpreted as reflecting improved coordination of laryngeal function and vocal fold vibration.

### **10.6 Acoustic Measures: Reading and Conversation**

Spectral measures did not show differences in changes in prosody between the Choir group and Music group for Reading and Conversation. The Semitone Range (STR) of the Choir group was 23.4 for Reading and 20.5 for Conversation. The STR for the Music group

was 22.3 for Reading and 21.8 for Conversation. All these values fall outside the average range 24 - 36 semitones (2-3 octaves or doubling of fundamental frequency) for adults (Williamson, 2009).

The STR data in the current study are consistent with results of a similar study by Tanner et al. (2016), who report a higher post treatment STR of 25.19 in an investigation on how singing and vocal strengthening might improve vocal ability in people with PD.

$F_0$  and  $vF_0$  for both groups remained relatively stable over the course of the study, including the  $F_0$  values obtained for both Reading and Conversation. These results compare with a study on the effect of music therapy on people with PD ( $N = 72$ ) by Yinger and Lapointe (2012), which also found no significant pre and post-treatment differences in  $F_0$  and  $vF_0$ .

An earlier study by Di Benedetto et al. (2009) investigating VCST as a new treatment for people with PD recorded a pre-treatment average  $F_0$  of 94.3Hz and post-treatment  $F_0$  of 172.8Hz, indicating a higher overall  $F_0$ , post-treatment, a much less stable outcome than that obtained in the present study. Sundberg, Andersson, and Hultqvist, (1999) stated that higher  $F_0$  requires higher subglottal pressure. Vocal control involves manipulation of the vocal folds, larynx and the articulators (tongue and lips). Mechanistically,  $F_0$  is controlled by manipulating the tension and effective length or surface area of the vocal folds by contracting or relaxing the thyroarytenoid and cricothyroid muscles or increasing subglottal pressure (Pisanski, Cartei, McGettigan, Raine, & Reby, 2016). It is of interest, therefore, that there was no observed statistically significant post-treatment improvement in  $F_0$  for the Choir group during reading and conversation, although there were differences in sub-glottic pressure for the ARES task for the Choir group on the ARES measure.

### 10.6.1 Pitch Range

There were no differences or changes in pitch range (PR) for the Choir and Music groups consistent with the findings for the other acoustic measures (Mean  $F_0$ , STR and SDSTR) results. PR data captured from analysing the maximum phonational frequency range – the lowest sustainable tone to the highest comfortable falsetto tone and back again, showed minimal between-group change in PR range after treatment.

The trend for a change in overall PR for the Choir group reflected an increase in the higher register, whilst the lower register decreased. Sundberg et al. (1999) noted that higher  $F_0$  requires higher subglottal pressure. More recently Pisanski et al. (2016) reported that  $F_0$  is controlled by increasing subglottal pressure as well as manipulating tension and effective surface area of the vocal folds. The trend for an increase in overall PR and extension to (upper) Maximum PR suggests that the improvement in subglottic pressure (discussed below) may have impacted positively on vocal fold function for the Choir group.

There was a positive post-treatment correlation for the Choir group between PR and mean  $F_0$  for Reading ( $r = 0.630, p = .003$ ) and mean  $F_0$  for Conversation ( $r = 0.489, p = .029$ ). Thus higher fundamental frequency was associated with a larger pitch range for these tasks. There was also a positive (modest) post-treatment correlation ( $r = 0.452, p = .045$ ) for the Choir group between PR and UPDRS (Part 2 motor experiences of daily living), suggesting a link between voice changes and other motor symptoms associated with PD.

### 10.7 Glottal Behaviour - Aerodynamic Resistance (ARES)

Central to this study and to the Choir group intervention is sub-glottic pressure. The phonatory, respiratory and resonatory elements within the vocal tract interact and the action of one elicits a direct effect on another (Herbst, 2017). These subsystems, Herbst suggests, create a model of voice interaction involving vocal tract adjustments that influence the behaviour of the voice source. These interactions involve how the degree of vocal fold

adduction controls the expiratory airflow rate and how tracheal pull, caused by the respiratory system, affects laryngeal excursion and thus vocal tract resonances.

Aerodynamic studies show that laryngeal function can change due to typical aging unrelated to pathology (Martins, Gonçalves, Pessin, & Branco, 2014; Ramig & Ringel, 1983). The literature also describes how people with PD present with insufficient vocal intensity necessary for their speech because of difficulty sustaining expiratory pressures to maintain subglottic pressure (Matheron, Stathopoulos, Huber, & Sussman, 2017).

Leanderson, Sundberg, and Von Euler (1987) studied the differences in pressure dynamics of speech and singing tasks and found that insufficient accuracy in subglottal pressure regulation will lead to errors in voice fundamental frequency. They found that the demands made on the breathing apparatus are much greater in singing than in speech, suggesting that singing requires greater subglottal pressure than speech. Therefore, a core interest of this study was the investigation of how group singing for people with PD might provide an opportunity to exercise the respiratory and laryngeal system to improve subglottic pressure and thus improve vocal fold vibration. This should make voice production less effortful at a self-selected comfortable intensity.

The Glottal Behaviour data in this study were significant for the Choir group and suggest that the valving characteristics of the vocal folds within the Choir group improved following the nine week treatment period of high intensity singing, exercise and a home voice maintenance programme.

Aerodynamic resistance, which is a ratio of air pressure over airflow and a measure of glottal resistance, improved for the Choir group from  $M = 32.13 \text{ cm/H}_2\text{O}/(\text{lt/s})$  to  $M = 38.33 \text{ cm/H}_2\text{O}/(\text{lt/s})$  and fell within the normative range of 32 - 45  $\text{cm/H}_2\text{O}/(\text{lt/s})$  (Holmberg, Hillman, & Perkell, 1989). It was hypothesised that the high intensity singing and exercise,

which also included exercises to improve glottic valving and respiration would improve aerodynamic resistance; this was supported by the data.

These data for ARES measurements are encouraging and compare with a study of laryngeal somatosensory deficits in people with PD receiving no voice therapy by Hammer and Barlow (2009) which investigated the effect of asymmetric laryngeal somatosensory on impairment of speech respiratory and phonatory control. Hammer and Barlow found that the PD participants ( $N = 19$ ) exhibited laryngeal somatosensory deficits compared with controls and exhibited decreased subglottal air pressure, peak air flow and laryngeal resistance and found that speech related deficits in PD are related to abnormal laryngeal somatosensory function, and that this function may degrade as a function of disease severity. The aerodynamic resistance data of the PD participants in their study compare with the results of the current study with a mean ARES 43.35 cm/H<sub>2</sub>O/(lt/s). Their data show group differences, but did not show change over time. In contrast ARES for the Music group was worse after treatment. Means reduced from  $M = 35.24$  cm/H<sub>2</sub>O/(lt/s) to 28.88 cm/H<sub>2</sub>O/(lt/s), falling outside of the normative band.

Although not significant, PAP (peak air pressure) showed a trend for an increase for the Choir group  $M = 13.34$  cm/H<sub>2</sub>O to  $M = 15.91$  cm/H<sub>2</sub>O (+2.57cm/H<sub>2</sub>O an 18.5% increase). Hammer and Barlow (2009) recorded much lower subglottal air pressure of 6.45 cm/H<sub>2</sub>O. There was no significant main effect for group for PEF in the current study, although PEF increased (+0.21 lt/s) for the Choir groups ( $M = 0.69$  lt/s) to ( $M = 0.90$  lt/s) and the Music group ( $M = 0.69$  lt/s) to ( $M = 0.77$  lt/s) (+0.08 lt/s).

Rosenthal, Lowell and Colton (2014), who examined aerodynamic and acoustic features of vocal effort, found that when participants increased their level of vocal effort, both airflow and subglottal pressure increased significantly and observed that a decrease or minimal change in subglottal pressure with an increase in airflow would be associated with a

breathy voice quality. The improvement in measures of subglottic pressure are consistent with the SPL changes indicating greater vocal effect.

### **10.8 Vital Capacity – Peak Expiratory Airflow (PEF), Forced Expiratory Volume (FEV)**

The results for PEF (l/s) were not significant however, there was a trend for improvement observed in both groups. FEV is a measure of the maximum amount of air potentially available for use in respiration or phonation and not the total volume of air contained in the lungs. Interestingly, FEV reduced for both groups over the same period. This was not a statistically significant change. Di Benedetto et al. (2009), similarly found no significant change in pre-post maximum expiratory pressure (MEP). In contrast Stegemöller, Radig, Hibbing, Wingate, and Sapienza (2016), found a significant pre-post testing difference for MEP following a high or low dosage singing intervention for people with PD. The participants in Di Benedetto et al.'s (2009) study underwent 20 hours of speech therapy, two sessions of one hour every week, and 26 hours of choral singing, one session of two hours every week over a period of 26 weeks. Stegemöller et al.'s participants were selected to participate in either a group that met for a one hour session of group singing once a week for eight weeks (low dosage) and a group that met for a one hour session of group singing twice a week (high dosage).

Taken together, the aerodynamic and PEF data observed in this study suggest that the post treatment aerodynamic changes for the Choir group have improved. These compare to data published by Matheron et al. (2017), whose study on laryngeal aerodynamics in healthy older adults and adults with PD showed increases in SGP, SPL and PEF when differences were measured between (comfortable) speech in quiet condition compared to (increased vocal intensity) speech in noise condition using multi-talker background noise.

## 10.9 VHI-10 and VHI-10P

The Choir group's results for the VHI-10 in this study are of interest. The Choir group scored themselves significantly lower (better) post-treatment thus perceiving that, after treatment, aspects of their voice had improved. For the Choir group, the score reduced from pre-treatment mean score of 14.91 to a post-treatment mean score of 11.25. As might be expected, and in line with the voice quality results, the Music group did not perceive improvement in their voice and scored themselves higher (worse) after treatment with a pre-treatment mean score of 12.66 compared to 13.06 at post-treatment.

These data differ from published studies. Of the PD and singing studies completed thus far, two (Elefant, Baker, Lotan, Lagesen, & Skeie, 2012; Shih et al., 2012) used the VHI (long form) for which neither study found a significant post-treatment outcome.

The VHI-10 is a short form version of the VHI and has been validated (Rosen et al., 2004). The 10 most robust VHI items were selected using item analysis and clinical consensus. Irrespective of diagnosis, there was a high correlation between the VHI and VHI-10. Results actually suggested that the VHI-10 was more robust than the VHI (Morzaria & Damrose, 2012).

A number of LSVT® studies and one LSVT-X® study (Halpern et al., 2012; Spielman et al., 2007; Wight & Miller, 2015) investigating intensive voice treatment for PD have used the VHI to measure participant voice evaluation and all report post-treatment improvement. This current study is the first study to use both the VHI-10 (short form) to measure voice perception of someone with PD and the VHI-10P (Zraick et al., 2007) to measure their partner's perception. A study investigating laryngeal somatosensory deficits in PD (Hammer & Barlow, 2010) used the VHI and also asked spouses of participants to evaluate the participants' voices using the Voice Handicap Index-Partner (VHI-P). The participant's assessment of their voice ( $M = 37.59$ ) was compared with the (VHI-P)

assessment by their spouse and the spouses rated voice severity as significantly higher by ( $M = 20.86$ ). Hammer & Barlow's (2010) VHI-10P data contrast with the current study, which showed a trend for pre-treatment means to be higher ( $M = 15.5$ ) than post-treatment ( $M = 11.2$ ) means indicating that partners of Choir group participants were generally in agreement with their spouses. This agreement between people with voice difficulties and their partners was also seen in a study by Morzaria and Damrose, (2012), who found a high correlation ( $r = 0.860$ ,  $p < .001$ ) between the VHI-10 and VHI-10P.

### **10.10 Self-Report Measures**

Using the UPDRS to track the progression of PD, much of the literature suggests that the course of PD is inexorably progressive; is not linear and that there is great variability in the rate of motor progression (Jankovic, 2008). For the PD population, day to day variability in symptom severity is also well documented (Weintraub et al., 2006). Reasons for this variability are wide ranging, and might include medication timing errors, and non-motor symptoms that include sleep and autonomic disturbances (Buetow, Henshaw, Bryant, & O'Sullivan, 2010; Xia & Mao, 2012).

Great care was taken to ensure all pre- and post-treatment assessment was done whilst participants were in an ON state and done on the same day of the week and at the same time on each test occasion. That notwithstanding, within subject variability will have contributed to the results for different tasks revealed in the data.

There were no significant between-group differences for a number of self-report measures in the current study. There are no between-group comparisons of data with other published singing and PD studies as, currently, these have generally been single group repeated measure design studies and not RCTs.

There were significant within-group pre and post-treatment differences with improvement in the DASS-21 Depression and Stress scales for both the Choir and Music groups following intervention.

The quality of life measure, PDQ-8, improved for the Choir group. Although not using the PDQ-8, two previous studies using QoL measures found contrasting results. Stegemöller et al. (2016), using Voice QoL and WHQoL, found a significant pre-post difference, whereas Evans, Canavan, Foy, Langford, and Proctor (2012) using the PDQ-39 found no significant change for any subscale. Thus, the selection of QoL measure may be critical for demonstrating the benefit of singing therapies for people with PD

The significant improvement in QoL for the Choir group reported in this study is consistent with outcomes of similar studies of group singing (Abell, Baird, & Chalmers, 2017; Evans et al., 2012; Fogg-Rogers et al., 2016; Stegemöller et al., 2016), supporting the notion that social interaction within a mutually supportive group of people with similar PD symptom related stresses may have contributed to the improvement in QoL. Stegemöller et al. (2016) noted that speech and language therapy approaches have traditionally focused on the impairment (such as the voice disorder) often neglecting the NMS impact beyond the impairment. The current study supports Stegemöller et al.'s (2016) finding that singing groups can provide an additional treatment strategy complementing traditional speech therapy treatment and enhancing the QoL for people with PD. The improvement in QoL was seen in both physical and social dimensions and, interestingly, is consistent with the improvement seen in post treatment non-motor symptom severity scored in Part 2 of the UPDRS. These results are in marked contrast to the Music group, who showed no significant improvement in QoL.

Clift et al. (2010) and Clift and Hancox (2010) found gender differences in emotional sensitivity and expressiveness. Women and men in their studies experienced similar gains,

but women expressed themselves more strongly. Clift and colleagues suggested that choral singing should attract more women than men, but found that men were actively involved. Although the men endorsed the wellbeing benefits, other factors such as the value placed on music or the opportunity to socialise, they suggest, may have been stronger motivators for their involvement.

Participation in this present study involved 20 males and 15 females however, unlike the studies by Clift and colleagues, an ANOVA analysis of the self-report measures showed no statistically significant main or interaction effects for gender hence findings were similar for men and women. This may reflect differences in study design as Clift and colleagues have mainly used qualitative study designs.

#### **10.11 Participants' Evaluation of Activities**

Analysis of the participants' evaluations (Appendix 19) of their group activity provided an interesting insight into the perceived benefits of group membership. Subjective evaluation derived from the questionnaire revealed that the experience for the Choir group was positive, rating the social aspects and physical rehabilitative benefits equally. Conversely, the Music group were less positive about participation.

When the two groups were asked to describe, in their own words, their subjective experience of the group activity, expectations and experiences within the narrative began to converge. Understandably, there were few references in the narrative from Music group participants relating to perceived therapeutic benefits associated with speech, breathing, voice or voice amplitude. That said, only 48% of the participants completed this portion of the written questionnaire; 59% of the Choir group and 34% of the Music group, therefore these data may not be an accurate representation of all the participants' experiences. The narrative of both groups contained words such as: *friendship, fun, uplift, pleasure, energising and*

*enjoyment*, all positive affirmations suggesting across-group perceived acknowledgement of the psychosocial and psychological wellbeing associated with group activity.

These written comments support the quantitative data suggesting that singing groups and group activities in general may, provide additional treatment options complementing traditional speech therapy treatment while enhancing the psychosocial and psychological wellbeing in people with PD (Collis & Bloch, 2012; Stegemöller et al., 2016).

### **10.12 Attendance**

The literature suggests that, for a number of reasons, compliance and maintaining regular attendance at therapy sessions and exercise for people with PD can be a challenge. Anxiety, apathy, daily variability of symptom severity and other, outside, commitments are cited as reasons for poor attendance (Allen et al., 2012; Johnston & Chu 2010).

Social factors play an important role in human health outcomes. Activities, such as those involving music are known to foster feelings of social connection, specifically interpersonal trust and bonding (Uchino, 2006). I highlight this point because the key to the success of singing therapy (and the Music group) in the present study involving people of varying age, disease severity and years with PD may be in part the participant's excellent engagement in the therapy. Poor attendance was not an issue with a 96.9% attendance for the Choir group and 96.5% attendance for the Music group. This suggests that participants from both groups found the nature and format of the activities enjoyable and worthwhile, and reflects the attendance success that I have personally observed as a clinician running a large PD choir for the last seven years. Indeed, the participant's comments about group singing as a therapy suggests that their high attendance and compliance, owes much to the mutually supportive environment in which the singing group operates and the bonds and friendships that are formed within the singing group.

The outcomes of participation in this present study are consistent with those obtained in a qualitative study of an eight week group singing intervention (GSI) for people with PD by Stegemöller et al. (2017). In this study the participants described being enthusiastic about the study and motivated to take part in all sessions with one participant characterising the GSI as more like a social event or a support group and less like a research study.

These experiences relate well to the outcomes of the participants' group activities evaluation in which the Choir group highlighted (Q15) *fun* and (Q1) *helping build new friends*. The Choir group viewed their participation broadly as a positive experience. This was also described in other studies (Beck, Cesario, Yousefi, & Enamoto, 2000; Bento-Allpress, 2013; Unwin, Kenny, & Davis, 2002), which have found that singing positively influenced subjective emotional states and enhanced the immune defense system.

A study by Kreutz, Bongard, Rohrmann, Hodapp, and Grebe, (2004) of a non-PD population also demonstrated psychophysiological effects of choral singing and listening to choral music. They found that singing in a choir influenced positive emotions as well as immune functions in humans. Measuring secretory immunoglobulin A (S-IgA) and cortisol, they found different patterns of changes for S-IgA and cortisol and participants' emotional state with respect to the two experimental conditions: choral singing and listening to choral music. Singing led to a decrease in negative mood and an increase in positive mood and S-IgA, but did not affect cortisol responses, whilst listening to choral music was associated with an increase in negative mood, a decrease in cortisol, and no significant changes in positive mood and S-IgA.

The Music group in the current study reported enjoying their experience, but the participation questionnaire data indicated they were less positive about participation and they made references to experiences of stress and anxiety over the nine week treatment period. This outcome, however, did not compare with the Depression, Anxiety and Stress Scale

(DASS-21) self-report results, which showed an improvement in post-treatment stress levels for the Music group. This disparate outcome for the DASS-21 and the qualitative comments made by the Music group may be the result of these data collections capturing different aspects of the participants' experiences. Perhaps the Music group was lacking the connectivity and creativity associated with the group singing. However, despite some negative results, the Music group enjoyed a high attendance with no withdrawals supporting the view that, even with no singing, group collaboration and social interaction (whilst listening to music) is important and thus should be an important consideration when developing future PD therapy programmes. The willingness of both groups to attend for each of the nine weeks of this study suggests that, for people with PD, there is perhaps power and benefit in belonging to any activity group in which a new social identity can be nurtured that is defined not by their impairment but by membership of the group. This view is supported by Weintraub et al. (2006) who examined the daily affective experiences of ( $N = 23$ ) people with PD to determine their association with daily events and motor symptom severity. Their specific intention was to determine if people with PD (even in the absence of depression) have an inability to feel pleasure in normally pleasurable activities (anhedonia). They found that people with PD do not experience anhedonia (inability to feel pleasure in normally pleasurable activities), and they concluded that there is value in interventions that emphasise daily engagement with positive experiences. An enjoyable group activity approach to therapy, therefore, has the potential to alleviate some of the issues surrounding PD symptoms like stress and anxiety. Other investigations into the positive effects of group singing on psychological wellbeing and QoL have also suggested that anxiety and depression could, similarly, be affected positively using behavioural or group singing therapy as found by Uitti, (2012) and Di Benedetto et al. (2009).

Group intervention, Gupta, Scholl, and Toynton (2008) suggest, can provide opportunities for people with PD to interact with new people and, by doing so, gain confidence to practise and improve their voice in a meaningful context and learn to generalise the gains that intervention provides outside of the group environment. This could, for example, explain the positive effects of both the Music and Choir group for measures of vocal loudness in the current study. Another possible benefit of group singing is that it could create a condition in which members are encouraged to explore ongoing active self-management. Positive daily affective experience as, described by Weintraub et al. (2006), and the reward related behaviour theory developed by Ridderinkhof et al. (2012) suggest that lead to reward. If this is the basis for ongoing involvement in therapy then it is important that the therapy provides rewards such as voice improvement and better QoL, as was observed for the Choir group in the current study.

As they have a progressive disease, it is important that people with PD are empowered to self-manage their symptoms to some extent because with limited resources available to healthcare providers, labour-intensive treatment programmes are unlikely to be sustained or afforded or consistently available (Allen et al., 2012). The studies summarised in previous chapters suggest the positive experience gained from a group activity has the potential to affect how members manage some of the NMS of PD, and affect how they might better interact with their environment; an outcome that could improve compliance and attendance for voice therapy for people with PD.

Group therapy, including group singing may overcome compliance and maintenance issues that affect regular attendance to therapy and exercise for people with PD. The non-motor symptoms associated with PD that include anxiety and apathy as well as the daily variability of symptom severity are often cited as reasons affecting regular attendance, but there are other barriers affecting participation in therapy for people with PD that include

availability, mobility and, importantly, geographical location. There have been a number of recent studies investigating the technological infrastructure and procedures for telehealth and the role and opportunities for speech and language therapy to provide effective telehealth practice. There is growing evidence supporting the application of this technology in speech and language therapy and therapists are now engaged in a number of telehealth activities providing the same quality of services via telehealth as they would be face to face (Keck & Doarn, 2014). A study by Barbour et al. (2016) of telehealth intervention on ( $N = 16$ ) for people with PD in continuous care facilities found that the use of telehealth removed barriers hindering care provided in the traditional paradigm and improved access that might otherwise not have been available. Barbour and colleagues found telehealth to be a sustainable and efficient care delivery method for patients with PD, although the study's focus appeared to centre on assessment rather than delivering therapy. A study that investigated the feasibility and effectiveness of using an online LSVT® voice treatment on ( $N = 10$ ) people with PD in Australia, who were excluded from usual treatment because of their geographical location, found significant increases in SPL for sustained phonation, reading and conversational speech (Theodoros et al., 2016). This study raises questions about the methodology and robustness of the data capture process, but it provides an important contribution to the ongoing investigation into the feasibility of online tele-rehabilitation applications for people with PD, which could potentially include singing therapies. This approach might provide people with PD some opportunity to self-manage their symptoms using the resources available to them as well as introducing an online social interaction not previously available. There was a high participant satisfaction rate with the online treatment in Theodoros et al.'s (2016) study, but whether the online social factor plays as large a role in health outcomes for activities like group singing could be an interesting area of further investigation.

### **10.13 Home Voice Maintenance Programme (HVMP)**

The Home Voice Maintenance Programme (HVMP) is an important element of the current study. The high intensity approach integrated into the VCST Choir group singing sessions and the daily voice homework were adapted from the LSVT<sup>®</sup>. Similarly to the LSVT-X<sup>®</sup>, to maintain and generalise SPL gains, the Choir group were required to complete the HVMP for six days each week for 20 minutes. They were asked to abstain from the HVMP on Choir group days. Compliance was monitored using a self-report HVMP homework diary. Analysis of the Choir group homework diary data at the end of the nine week treatment period showed that all participants complied with the required exercise regime on 89% of a possible 54 days. Further analysis indicated that there was a narrow range in the data making it difficult to see if there was a differential effect between those who completed more home practice than those that didn't. These were self-report and thus there is the possibility of over/under reporting. Thus, it is feasible to add a homework element to group singing activities; this may be key to therapy effectiveness but the relative contribution of the HVMP cannot be determined in the current study.

### **10.14 Summary**

In summary, vocal exercise is proposed to favour glottic closure, increase subglottic pressure and voice intensity, stabilise vocal quality and fundamental frequency, and provide global improvement in the speech functional system (Martins et al., 2014). This study supports the notion that singing can be beneficial for people with PD as observed in three statistically significant changes in vocal function – MSP: maximum and average SPL (dB), SPI and ARES, as well as a clinically significant change in participant's perceived improvement in voice measure using the VHI-10.

Two different interventions were compared and contrasted in this study. Improvements were observed for in both approaches, suggesting that group participation is

beneficial for people with PD. The Music group intervention controlled for the effect of social group participation, and resulted in an improvement in voice volume (SPL). This happened without participation in the vocal exercise and singing, which is an interesting outcome, and suggests that the conversational aspects of the activity were beneficial.

In a study investigating the impact of an exercise programme on physical, emotional, and social aspects on quality of life of individuals with Parkinson's disease, de Paula et al. (2006) noted that it is important to consider the potentially powerful Hawthorne effects of receiving positive and unaccustomed treatment. It is likely, they also state, that their training programme increased energy levels and that group classes provided positive socialisation opportunities. They confirmed that enjoyment and socialisation are recognised key components of successful programmes with good compliance. Hence the music group could have had positive outcomes for some measures through these kinds of effects.

### **10.15 Implications, Limitations and Future Direction**

The participants were volunteers and had decided independently to join this study, which may have contributed to a subject bias. Their decision to participate was based on an expectation that doing so might improve their voice and, if the experience of participation was a pleasant one, there is a possibility that self-confidence and satisfaction were enhanced and these perceptions might influence the way some tasks were performed (de Paula et al., 2006). The participants who were assigned to the Music group (control) may have had a different experience and differing influence on performance outcomes.

A positive daily affective experience (Weintraub et al., 2006) and reward related behaviour (Ridderinkhof et al., 2012) may have affected the outcome for the Music group positively, despite the lack of direct vocal intervention. Post-treatment evaluation of the Music group experience of participation highlights a positive affirmation across four themes of enjoyment, friendships, wellbeing and physical. References to belonging to a special

group, being part of an important or “big project” and feelings of “renewed energy” along with the observed positive interactions between the participants and the test procedures may explain the SPL changes seen for the Music group. This is one reason why there was a Music control group, to see if these factors alone could produce the same improvements as choral singing. The Hawthorn or placebo effect can occur with repeat testing, task familiarity and a growing familiarity with the research assistant and increased expectation of positive outcomes.

Although denied by all Music group members, there is also the added possibility that weekly participation and exposure to music may have inspired them to sing at home or when in the car, which may have improved respiratory and phonatory function and in doing so affected SPL. Interestingly, other than voice SPL measures, which participant expectation has the potential to affect, the dependent variables that are not easily influenced – SPI and ARES were observed to worsen for the Music group. Other potential limitations of this study are the relatively small heterogeneous sample and the variable symptomatological nature of PD. Problems related to NMS management or medication timing errors can lead to within and between-subject variability, which is a common observed outcome in people with PD undergoing clinical tasks (Tanner et al., 2016).

As well as the limitations relating to participant heterogeneity, another inherent difficulty in recruiting participants to this type of study, which could have a biasing effect on the data, is the problem of engaging with non-singers. Future studies might consider encouraging participation of non-singers as their participation in future voice and wellbeing intervention studies would enable a more representative sample of the PD population (Yinger & Lapointe, 2012). Achieving this would require researchers to explain thoroughly the theory, rationale and aims with regard to why an inhibited singer or non-singer would be an important contributor to the study. It will also require sensitivities on behalf of the researcher

to the possibility that such individuals may require support in overcoming any emotional barriers associated with joining a singing group.

This study was designed to compare the effect of group singing with a music appreciation group in order to control for the group socialising effect. Future researchers might consider a three armed study comparing and contrasting the benefits of participation in a PD choir with two controls of music appreciation group and a group receiving no treatment activity. This would further our understanding of the impact of group participation on voice and wellbeing. In part, the current study was a response to Shih et al. (2012) who, after their inconclusive study on a singing intervention (SING-PD) for people with PD, suggested that (novel) group singing based interventions should continue because access to LSVT<sup>®</sup> therapy, they say, remains limited for many people. This is a reality recognised by those behind the LSVT programme who aware of the “realities of scheduling and reimbursement in the clinical world.... evaluated whether the LSVT could be implemented with more flexibility than has been previously reported” (Spielman et al., 2007 p.97). The outcome of that re-evaluation was the LSVT-X<sup>®</sup>, an extended form of the LSVT<sup>®</sup> with an administration of two 1-hour clinic sessions a week for 8 weeks (16 hours) as opposed to four 1-hour LSVT clinic sessions a week for 4 weeks.

The present study measured pre and post-treatment outcomes of one 1.5 hour session a week over a nine week period (16 hours), thus participants received comparable numbers of therapy hours and distribution of hours as involved in LSVT-X<sup>®</sup>. The treatment period of nine weeks for this present study, however, may not have been sufficient to effect positive respiration changes. Future studies should explore the effectiveness of different treatment intensities as well as the frequency and duration of the intervention to establish whether it can be effective as a time restricted programmes as well as an ongoing weekly social voice intervention. Designs that attempt to isolate the potential causal effect using two Choir group

interventions, one of singing with exercise and the other of just singing would also be of interest, since there could be a synergistic effect of singing combined with exercise if there are positive effects of exercise on respiration and wellbeing.

Fox, Morrison, Ramig, and Sapir, (2002) noted that long term retention of improved voice is an ongoing problem for all voice therapies for PD. A six month post treatment follow-up was considered when designing the present study, but was excluded because of the potential difficulties blinding the assessment process and the time constraints of the study. Now that the study is complete, a number of the Choir group and Music group participants have since joined an established choirs and attend regularly and hence they could participate in a longer term follow-up assessment to see whether their outcomes differ from participants who did not go on to attend choir regularly. Outside the context of a research study, group singing as an intervention does not necessarily need to be thought of in terms of limitations to dosage, but rather, as an ongoing weekly opportunity for people to self-manage through engagement in an expressive activity of singing within a mutually supportive community.

The post-treatment activity questionnaire used in this study did not obtain the views of participants' partners. Future studies would benefit from gathering information from partners. This would allow for a differential analysis of perceived changes observed by the partners relating to the physical/therapeutic benefits, confidence, belonging, social connectedness and achievement associated with group participation. It is possible that partners would perceive benefits that the people with PD are not able to see themselves. The qualitative data captured from the questionnaire was not generated from informal discussion, and instead was from a written account "in their own words." Although this approach did not devalue the content, had the narrative been captured by way of an informal or 'relaxed' open discussion, it may have produced a spontaneous and detailed personal representation of participants' and partner's experience of the activity and provide comparative insight and analysis of partner

agreement with the person with PD. This semi structured interview approach may also have provided a richer account of the impact of the two types of group therapy employed in the study.

### **10.16 Conclusion**

This study compared the effect of group singing on people with PD and a non-singing music appreciation group for people with PD to control for the effect of being in a group to see if group activity alone could produce the same improvements. Both groups improved on a number of self-report and instrumental measures suggesting that group participation is an important and beneficial intervention for people with PD and compares with similar studies found in the literature. Many of the outcomes are comparable across both groups, but some are unique to the Choir group.

Both groups were observed to have improved across a range of instrumental voice and respiratory measures. However, the results for MSP, ARES and SPI measures for the Choir group are compelling and suggest that (when combined with voice and respiratory exercise and a simple daily voice maintenance programme) high intensity group singing improves the voice problems associated with PD.

High intensity singing, vocal exercises and simple daily maintenance can be an enjoyable as well as time and cost effective means of improving voice in people with PD. Importantly, this approach has the capacity to maintain regular attendance and improve compliance with therapy for people with PD. However, further large RCT studies are essential to contribute to the evidence for the benefits of singing on voice in people with PD. In particular, evidence is required to establish the significance of the frequency and intensity of such an intervention. The writer suggests two questions for consideration; does intervention need to be a time restricted, similar to that of the LSVT programme, or can it be an ongoing weekly social voice intervention with sustained benefits. In support of the latter

view, there is neurochemical evidence for the beneficial effects of music on reward, motivation, pleasure, stress, arousal, and social affiliation (Chanda & Levitin, 2013; Kreutz et al., 2004; Clift & Hancox, 2010). There is also the suggestion in the literature that group singing can be an ongoing distraction for people with PD by providing a context of connectedness, collaboration and social identity (Buetow et al., 2013). This, combined with new evidence provided here for voice improvement, suggests the group singing has the potential to help individuals with PD find their voice both literally and metaphorically.

## Appendices

### APPENDIX 1 - Modified Hoehn and Yahr Staging

#### Modified Hoehn and Yahr Staging

STAGE 0 = No signs of disease.

STAGE 1 = Unilateral disease.

1. Signs and symptoms on one side only
2. Symptoms mild
3. Symptoms inconvenient but not disabling
4. Usually presents with tremor of one limb
5. Friends have noticed changes in posture, locomotion and facial expression

STAGE 1.5 = Unilateral plus axial involvement.

STAGE 2 = Bilateral disease, without impairment of balance.

1. Symptoms are bilateral
2. Minimal disability
3. Posture and gait affected

STAGE 2.5 = Mild bilateral disease, with recovery on pull test.

STAGE 3 = Mild to moderate bilateral disease; some postural instability; physically independent.

1. Significant slowing of body movements
2. Early impairment of equilibrium on walking or standing
3. Generalized dysfunction that is moderately severe

STAGE 4 = Severe disability; still able to walk or stand unassisted.

1. Severe symptoms
2. Can still walk to a limited extent
3. Rigidity and bradykinesia
4. No longer able to live alone
5. Tremor may be less than earlier stages

STAGE 5 = Wheelchair bound or bedridden unless aided

1. Cachectic stage
2. Invalidism complete
3. Cannot stand or walk
4. Requires constant nursing care

(Goetz et al., 2008)

## **APPENDIX 2 - Diagnostic criteria for PD-MCI (Yarnall, Rochester, & Burn, 2013).**

### **Inclusion criteria**

Diagnosis of PD

Cognitive decline, in context of established PD, reported by patient/carer/ treating physician

Cognitive deficits on either formal neuropsychological testing or a scale global cognitive abilities

Cognitive deficits not severe enough to interfere with functional independence, although subtle impairments may be present

### **Exclusion criteria**

PDD

Other primary explanation for cognitive impairment (e.g. stroke, major depression, delirium)

Other PD-associated comorbid conditions (e.g. motor impairment, severe anxiety, psychosis) that may significantly influence cognitive testing

Specific guidelines for PD-MCI level I and level II categories

#### **Level I (abbreviated assessment)**

Impairment on a scale of global cognitive abilities validated for use in PD (MoCA, SCOPA-COG, PD CRS, MDRS) or

Impairment on at least two tests, when a limited battery of neuropsychological tests is Performed

#### **Level II (comprehensive assessment)**

Neuropsychological testing that includes two tests within each of the five cognitive domains (*attention and working memory, executive, language, memory and visuospatial*)

Impairment on  $\geq 2$  neuropsychological tests (either two impaired tests in one cognitive domain or one impaired test in two different cognitive domains)

Impairment on neuropsychological tests may be demonstrated by: Performance 1–2 SDs below appropriate norms or

Significant decline demonstrated on serial cognitive testing or Significant decline from estimated premorbid levels

Subtype classification for PD-MCI (optional, requires two tests for each of the five cognitive domains assessed)

PD-MCI single-domain—abnormalities on two tests within a single cognitive domain (specify the domain), with other domains unimpaired *or*

PD-MCI multiple-domain—abnormalities on at least one test in two or more cognitive domains (specify the domains)

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Note. MoCA Montreal Cognitive Assessment; SCOPA-COG Scales for Outcomes of Parkinson's disease Cognition; PD CRS PD Cognitive Rating Scale; MDRS Mattis Dementia Rating Scale.

## APPENDIX 3 - Ethics approval Study One



Health and Disability Ethics Committees  
Ministry of Health Freyberg Building 20 Aitken Street  
PO Box 5013  
Wellington  
6011

0800 4 ETHICS  
hdec@moh.govt.nz

A - 15/NTA/80 – Approval of Application – 30 June 2015  
30 June 2015

Mr Robin Martin  
Matthews  
Tauranga 3112

Dear Mr Matthews

**Ethics ref:** 15/NTA/80

**Study title:** The pilot study that forms the basis of this ethics application is part of a larger planned RCT parallel study which will be entitled: Acoustic, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease receiving different approaches to treatment.

I am pleased to advise that this application has been approved by the Northern A Health and Disability Ethics Committee. This decision was made through the HDEC-Expedited Review pathway.

### Conditions of HDEC approval

HDEC approval for this study is subject to the following conditions being met prior to the commencement of the study in New Zealand. It is your responsibility, and that of the study's sponsor, to ensure that these conditions are met. No further review by the Northern A Health and Disability Ethics Committee is required.

#### Standard conditions:

Before the study commences at *any* locality in New Zealand, all relevant regulatory approvals must be obtained.

Before the study commences at *a given* locality in New Zealand, it must be authorised by that locality in Online Forms. Locality authorisation confirms that the locality is suitable for the safe and effective conduct of the study, and that local research governance issues have been addressed.

#### Non-standard conditions:

##### Summary of ethical issues (outstanding)

The main ethical issues considered by the Committee and which require addressing by the Researcher are as follows.

- Please note that approval has been made by the Northern A Health and Disability Ethics Committee in the Participant Information Sheet.
- Please clarify in the PIS that audio recordings will be made and state how they stored confidentially.
- Data is being used for future research and this data should be de-identified. Please clarify that study IDs will be used and names of patients kept on a register to ensure confidentiality.

Please submit your non-standard conditions by email to HDEC@moh.govt.nz

Please note HDEC review is not required for non-standard conditions however they must be completed prior to commencing your study. Do not submit non-standard conditions as a post approval form (PAF).

For information on non-standard conditions please see section 128 and 129 of the Standard Operating Procedures at <http://ethics.health.govt.nz/home>.

After HDEC review

Please refer to the *Standard Operating Procedures for Health and Disability Ethics Committees* (available on [www.ethics.health.govt.nz](http://www.ethics.health.govt.nz)) for HDEC requirements relating to amendments and other post-approval processes.

Your **next progress report** is due by **29 June 2016**.

Participant access to ACC

The Northern A Health and Disability Ethics Committee is satisfied that your study is not a clinical trial that is to be conducted principally for the benefit of the manufacturer or distributor of the medicine or item being trialled. Participants injured as a result of treatment received as part of your study may therefore be eligible for publicly-funded compensation through the Accident Compensation Corporation (ACC).

Please don't hesitate to contact the HDEC secretariat for further information. We wish you all the best for your study.

Yours sincerely,

Dr Brian Fergus  
Chairperson  
Northern A Health and Disability Ethics Committee

Encl: appendix A: documents submitted  
appendix B: statement of compliance and list of members

A - 15/NTA/80 – Approval of Application – 30 June 2015

**Appendix A  
Documents  
submitted**

<i>Document</i>	<i>Version</i>	<i>Date</i>
CV for CI: CV 2015	v1	14 June 2015
Evidence of scientific review: Scientific Review Letter	v1	14 June 2015
CVs for other Investigators: Suzanne Purdy CV May 2015	001	15 June 2015
Survey/questionnaire: Dass-21	001	15 June 2015
Survey/questionnaire: ACE-111	001	15 June 2015
Survey/questionnaire: MDS-UPDRS	001	15 June 2015
Survey/questionnaire: PDQ-8	001	15 June 2015
Survey/questionnaire: VHI-10	001	15 June 2015
Covering Letter: Covering letter	001	15 June 2015
PIS/CF: Participant Information Sheet	001	15 June 2015
Protocol: Study Protocol	001	15 June 2015
Covering Letter: Letter from Head of Maori Health BOPDHB	001	17 June 2015
Survey/questionnaire: Probe questions for participants and their carers	001	17 June 2015

Covering Letter: BOPDHB clinical School research approval application form.	001	17 June 2015
Application		17 June 2015

A - 15/NTA/80 – Approval of Application – 30 June 2015

## Appendix B

### Statement of compliance and list of members

#### Statement of compliance

The Northern A Health and Disability Ethics Committee:

- is constituted in accordance with its Terms of Reference
- operates in accordance with the *Standard Operating Procedures for Health and Disability Ethics Committees*, and with the principles of international good clinical practice (GCP)
- is approved by the Health Research Council of New Zealand’s Ethics Committee for the purposes of section 25(1)(c) of the Health Research Council Act 1990
- is registered (number 00008714) with the US Department of Health and Human Services’ Office for Human Research Protection (OHRP).

<i>Name</i>	<i>Category</i>	<i>Appointed</i>	<i>Term Expires</i>
Dr Brian Fergus	Lay (consumer/community perspectives)	01/07/2012	01/07/2015
Dr Karen Bartholomew	Non-lay (intervention studies)	01/07/2013	01/07/2016
Ms Susan Buckland	Lay (consumer/community perspectives)	01/07/2012	01/07/2015
Ms Shamim Chagani	Non-lay (health/disability service provision)	01/07/2012	01/07/2015
Dr Christine Crooks	Non-lay (intervention studies)	01/07/2013	01/07/2015
Mr Kerry Hiini	Lay (consumer/community perspectives)	01/07/2012	01/07/2015
Mr Mark Smith	Non-lay (intervention studies)	01/09/2014	01/09/2015
Ms Michele Stanton	Lay (the law)	01/07/2012	01/07/2015

#### List of members

<http://www.ethics.health.govt.nz>

## APPENDIX 4 – Study 1: Participant Information Sheet and Consent

DEPARTMENT OF PSYCHOLOGY (Speech Science)



Tamaki Campus, 261 Morrin Road  
Glen Innes 1072  
The University of Auckland  
Private Bag 92019  
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Telephone 07 579 8783  
Mobile: 027 326 1464  
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[rsmatthews@kinect.co.nz](mailto:rsmatthews@kinect.co.nz)

### PARTICIPATION INFORMATION SHEET

#### Research title:

**Acceptability of measures of voice and quality of life with Parkinson's disease**

#### Researcher:

My name is Robin Matthews. I am a speech and language therapist at Tauranga Hospital and undertaking a PhD – Speech Science research thesis at The University of Auckland.

#### Supervising Researchers:

Professor Suzanne Purdy

Associate Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor and a lecturer in neuropsychology at The University of Auckland.

#### Contact details:

Robin Matthews (7) 579 8783

email:

[rmat107@aucklanduni.ac.nz](mailto:rmat107@aucklanduni.ac.nz)

Suzanne Purdy (9) 373 7599

email: [sc.purdy@auckland.ac.nz](mailto:sc.purdy@auckland.ac.nz)

Lynette Tippett (9) 373 7599

email: [l.tippett@auckland.ac.nz](mailto:l.tippett@auckland.ac.nz)

The Northern A Health and Disability Ethics Committee (HDEC) have approved this pilot study - **Ethics ref: 15/NTA/80**

This information sheet will give you information about the study and may help you decide if you would like to take part. I am happy to answer any questions you have.

#### Why are we doing this pilot study?

I plan to compare the effectiveness of two different methods of therapy for people

with Parkinson's disease. These are singing and choir participation and a mainstream voice treatment programme. Before doing this I need to test whether the outcome measures I plan to use to compare these two treatments are suitable and acceptable to people with Parkinson's disease. In this study I am asking you to help me test the acceptability and suitability of a range of patient self-reported outcome measures. This pilot study will provide important preliminary data that will support the planned research.

### **Who will be in this pilot study?**

We are looking for about twenty volunteers who have had a diagnosis of Parkinson's disease of more than two years. As someone with Parkinson's you are invited to take part in this pilot study.

### **Where will it happen and what will I have to do?**

You will be visited in your home. I will help you complete short questionnaires that will ask you how you feel about your voice, quality of life, your experience of Parkinson's, a short task involving thinking abilities, such as naming and a short interview where I will ask you about your experience as a pilot study participant. You will also be given one more self-assessment questionnaires, which you can complete over the following week, after which I will visit you again to collect them.

### **Do I have to take part in this pilot study?**

No. Participation is voluntary. You can choose if you want to take part in the study. If you do take part, you can change your mind at any time. You do not have to give a reason.

### **Can I think about it?**

Yes. You can take time to think about whether you want to take part in this study. You might like to discuss it with your partner or whanau.

### **Will I have to give up my usual therapy if I take part in the study?**

No. If you choose to take part in the study you can carry on with your usual therapy e.g. exercise group or singing in a choir.

### **Will being a participant in this pilot study affect the service I currently receive from the BOPDHB?**

No. Your participation or nonparticipation will not affect the service provided to you by the BOPDHB

### **What will happen to all the data that you collect from me?**

All the collected data is confidential and will be kept in your clinical file.

Your file is kept in a locked cabinet in the hospital. You can have a copy of the data if you wish. All the information will be destroyed after ten years.

Audio recordings will be made of interviews for easy transcription. The recorded audio files will be stored confidentially in password protected files on a password protected computer at the Bay of Plenty District Health Board.

You can request a summary of all the results at the end of the study in 2017.

### **Can I stop taking part in the study?**

You can stop at any time, but should you stop before the study is complete your data cannot be used.

### **What are the benefits of taking part in the study?**

*Benefits for you* - You might find it helpful to talk about your experiences of Parkinson's and activities such as singing in a choir.

*Benefits for others* -Your participation in this pilot study will help the international community of speech and language therapists understand better how to improve the effectiveness of therapy approaches for people with Parkinson's.

### **What are the risks in taking part in this study?**

There should not be any risk to you. You may find the appointment tiring. We will do our best to accommodate the assessment times around your schedule.

### **What will happen if an unknown problem is identified?**

Unexpected findings, if identified, will be discussed with you and should you consent, a referral will be made to your GP or consultant geriatrician at the BOPDHB movement disorder clinic.

### **Where can I find out more information?**

If you want more information please contact Robin Matthews, Lynette Tippett or Suzanne Purdy.

### **Your rights as a participant?**

If you have any queries or concerns about your rights as a participant in this study, you can contact an independent health and disability advocate:

Health and Disability Commissioner



0800 555 050



[advocacy@hdc.org.nz](mailto:advocacy@hdc.org.nz) - <http://www.hdc.org.nz/>

## CONSENT FORM

THIS FORM WILL BE HELD FOR A PERIOD OF 10 YEARS

### Research title:

### Acceptability of measures of voice and quality of life with Parkinson's disease

### Researcher:

My name is Robin Matthews. I am a speech and language therapist at Tauranga Hospital and undertaking a PhD – Speech Science research thesis at The University of Auckland.

Supervisors: My supervisors are: Professor Suzanne Purdy  
Associate Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor and a lecturer in neuropsychology at The University of Auckland.

### Contact details:

Robin Matthews	(7) 579 8783	email:	
rmat107@aucklanduni.ac.nz			
Suzanne Purdy	(9) 373 7599	email:	sc.purdy@auckland.ac.nz
Lynette Tippett	(9) 373 7599	email:	l.tippett@auckland.ac.nz

---

I have read and I understand the Participant Information Sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I have been given sufficient time to consider whether or not to participate in this study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
--	------------------------------	-----------------------------

---

I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without this affecting my medical care.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I consent to the research staff collecting and processing my information, including information about my health.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
--	------------------------------	-----------------------------

---

If I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I consent to my GP or current provider being informed about my participation in the study and of any significant abnormal results obtained during the study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
--	------------------------------	-----------------------------

---

I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study. Yes  No

---

I know who to contact if I have any questions about the study in general. Yes  No

---

I understand my responsibilities as a study participant. Yes  No

---

I wish to receive a summary of the results from the study. Yes  No

---

Name \_\_\_\_\_ Signature \_\_\_\_\_

Date \_\_\_\_\_

**About you**

Please indicate if you are male or female (circle)

**M**                      **F**

Please tell us your age in years \_\_\_\_\_

Please indicate the age of onset of your condition \_\_\_\_\_

Please indicate your ethnic identity (please tick)

NZ European

NZ Maori

Pacific peoples

Asian

European

Other

Please indicate

## APPENDIX 5 – Study 1: Participant Partner Information Sheet and Consent



DEPARTMENT OF PSYCHOLOGY (Speech Science)

Tamaki Campus, 261 Morrin Road  
Glen Innes 1072  
The University of Auckland  
Private Bag 92019  
Auckland Mail Centre 1142  
Telephone 07 579 8783  
Mobile: 027 326 1464  
email: [rmat107@aucklanduni.ac.nz](mailto:rmat107@aucklanduni.ac.nz)

### PARTNER'S PARTICIPATION INFORMATION SHEET and CONSENT

**Research title:**

**Acceptability of measures of voice and quality of life with Parkinson's disease**

**Researcher:**

My name is Robin Matthews. I am a speech and language therapist at Tauranga Hospital and undertaking a PhD – Speech Science research thesis at The University of Auckland.

**Supervising Researchers:**

Professor Suzanne Purdy

Associate Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor and a lecturer in neuropsychology at The University of Auckland.

Contact details:

Robin Matthews (7) 579 8783  
[rmat107@aucklanduni.ac.nz](mailto:rmat107@aucklanduni.ac.nz)

email:

Suzanne Purdy (9) 373 7599

email: [sc.purdy@auckland.ac.nz](mailto:sc.purdy@auckland.ac.nz)

Lynette Tippett (9) 373 7599

email: [l.tippett@auckland.ac.nz](mailto:l.tippett@auckland.ac.nz)

The Northern A Health and Disability Ethics Committee (HDEC) have approved this pilot study - **Ethics ref: 15/NTA/80**

This information sheet will give you information about the study and may help you decide if you would like to take part. I am happy to answer any questions you have.

#### **Why are we doing this pilot study?**

I plan to compare the effectiveness of two different methods of therapy for people with Parkinson's disease. These are singing and choir participation and a mainstream voice treatment programme. Before doing this I need to test whether the

outcome measures I plan to use to compare these two treatments are suitable and acceptable to people with Parkinson's disease. In this study I am asking you to help me test the acceptability and suitability of a range of patient self-reported outcome measures. This pilot study will provide important preliminary data that will support the planned research.

### **Who will be in this pilot study?**

As a partner of someone with Parkinson's you are invited to take part in this study too. We are looking for about forty volunteers who are partners of someone with a diagnosis of Parkinson's disease.

### **Where will it happen and what will I have to do?**

Your partner will receive through the post four short de-identified questionnaires that he/she will be asked to complete. The questionnaires will ask how they feel about their voice, quality of life, anxiety and experience of Parkinson's.

We would also like you to complete a short questionnaire, which will be included with your Partner's, asking about how you perceive the quality of your partner's voice. Completing your questionnaire will take no more than five minutes. It is very important that you complete the questionnaire independently and do not collude with your partner.

After you and your partner have completed your questionnaires, return them to me in the prepaid envelope that will be provided.

### **Do I have to take part in this pilot study?**

No. Participation is voluntary. You can choose if you want to take part in the study. If you do take part, you can change your mind at any time. You do not have to give a reason.

### **Can I think about it?**

Yes. You can take time to think about whether you want to take part in this study. You might like to discuss it with your partner or whanau.

### **Will being a participant in this pilot study affect the service I currently receive from the BOPDHB?**

No. Your participation or nonparticipation will not affect the service provided to you by the BOPDHB

### **What will happen to all the data that you collect from me?**

All the collected data is confidential and will be kept in your clinical file.

Your file is kept in a locked cabinet in the hospital. You can have a copy of the data if you wish. All the information will be destroyed after ten years.

Audio recordings will be made of interviews for easy transcription. The recorded audio files will be stored confidentially in password protected files on a password protected computer at the Bay of Plenty District Health Board.

You can request a summary of all the results at the end of the study in 2017.

### **Can I stop taking part in the study?**

You can stop at any time, but should you stop before the study is complete your data cannot be used.

### **What are the benefits of taking part in the study?**

*Benefits for you* - You might find it helpful to talk about your experiences of Parkinson's and activities such as singing in a choir.

*Benefits for others* -Your participation in this pilot study will help the international community of speech and language therapists understand better how to improve the effectiveness of therapy approaches for people with Parkinson's.

### **What are the risks in taking part in this study?**

There should not be any risk to you. You may find the appointment tiring. We will do our best to accommodate the assessment times around your schedule.

### **Where can I find out more information?**

If you want more information please contact Robin Matthews, Lynette Tippett or Suzanne Purdy.

### **Your rights as a participant?**

If you have any queries or concerns about your rights as a participant in this study, you can contact an independent health and disability advocate:

Health and Disability Commissioner



0800 555 050



[advocasy@hdc.org.nz](mailto:advocasy@hdc.org.nz) - <http://www.hdc.org.nz/>

## CONSENT FORM

THIS FORM WILL BE HELD FOR A PERIOD OF 10 YEARS

### Research title:

### Acceptability of measures of voice and quality of life with Parkinson's disease

### Researcher:

My name is Robin Matthews. I am a speech and language therapist at Tauranga Hospital and undertaking a PhD – Speech Science research thesis at The University of Auckland.

Supervisors: My supervisors are: Professor Suzanne Purdy  
Associate Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor and a lecturer in neuropsychology at The University of Auckland.

### Contact details:

Robin Matthews	(7) 579 8783	email:	
rmat107@aucklanduni.ac.nz			
Suzanne Purdy	(9) 373 7599	email:	sc.purdy@auckland.ac.nz
Lynette Tippett	(9) 373 7599	email:	l.tippett@auckland.ac.nz

---

I have read and I understand the Participant Information Sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I have been given sufficient time to consider whether or not to participate in this study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
--	------------------------------	-----------------------------

---

I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without this affecting my medical care.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I consent to the research staff collecting and processing my information, including information about my health.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
--	------------------------------	-----------------------------

---

If I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I know who to contact if I have any questions about the study in general.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I understand my responsibilities as a study participant.

Yes

No

---

I wish to receive a summary of the results from the study.

Yes

No

Name \_\_\_\_\_ Signature

\_\_\_\_\_

Date \_\_\_\_\_

**About you**

**Please indicate if you are male or female (circle)**

**M**

**F**

Please tell us your age in years \_\_\_\_\_

Please indicate the age of onset of your condition \_\_\_\_\_

Please indicate your ethnic identity (please tick)

NZ European

NZ Maori

Pacific peoples

Asian

European

Other

Please indicate

## APPENDIX 6 – Probe questions for participants and carers

### Probe questions for participants and carers

Participants and their significant others will be interviewed at baseline and final to determine their views on the measures and participation. These questions will not be shown to the participants and will be used as a guide by the interviewer.

Introduction	Tell me about yourself and your (health condition)?	How do you think your health has been over the past month? How does your (health condition) affect you and your life?
Communication abilities	Tell me about your voice and your communication with others	Tell me about your voice and your speech now Tell me about your communication with others now Are there things that help your voice or your communication? What things do you do to help your communication abilities? Has anything changed over the past months? Is there anything new that you have found in the past month to help your voice?
Medical care	Tell me about the care you receive from your doctor and other health professionals?	What advice has your health professional given you about your voice or wellbeing? Have you ever asked your doctor about health issues that concern you? Has anything changed with your medical care over the past month?
General wellbeing	Can you tell me anything else about how your health affects your everyday life?	Do you have any problems in areas such as sleep, relationships and mood? Do you feel you can influence and change your health? Tell me about any changes you have seen in your overall health?
General perception of the study 1	Tell me about your decision to participate in this pilot study?	Have you ever undertaken a study like this before? What was your motivation for wanting to take part in this study?
General perception of the study 2	Tell me about any potential problems you feel could be encountered whilst undertaking this pilot study?	What do you think of the location? What do you think of the timing?

<p>General perception of the study 3</p>	<p>What did you think of the questionnaires?</p>	<p>Tell me about your experience of doing the questionnaires?  Were there any surprises when doing the questionnaires?  Were you able to complete the questionnaires comfortably?</p>
<p>General perception of the study 4</p>	<p>Tell me about any specific observations made about the individual questionnaires that you completed</p>	<p>Tell me about the different tasks  Were there any questions that you did not understand?  Tell me about the length of time it took to complete the questionnaires?  Did you find the questions were relevant to your needs?  What did you think about the appropriacy or acceptability of the questionnaires?  What do you think about the appropriacy or acceptability of the questions?  Did you find answering the questions tiring?</p>
<p>General perception of the questionnaire process</p>	<p>What are your expectations of the study process?</p>	<p>Tell me how we could have improved your experience of doing the questionnaires?  Tell me how we could have improved the overall process?  Tell me, is there anything you hope to learn from participating in this study?</p>

## APPENDIX 7 – Ethics approval Study Two



**Health and Disability Ethics Committees**  
Ministry of Health Freyberg Building 20 Aitken Street  
PO Box 5013  
Wellington 6011  
0800 4 ETHICS  
hdec@moh.govt.nz

A - 16/NTA/53 – Approval of Application – 23 May 2016

23 May 2016

Mr Robin Martin Matthews



Tauranga 3112

Dear Mr Matthews

**Ethics 16/NTA/53**

Re:

**ref:**

Study title:

Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease receiving voice and choral singing group therapy or music appreciation activity

I am pleased to advise that this application has been *approved* by the Northern A Health and Disability Ethics Committee. This decision was made through the HDEC-Expedited Review pathway.

Conditions of HDEC approval

HDEC approval for this study is subject to the following conditions being met prior to the commencement of the study in New Zealand. It is your responsibility, and that of the study's sponsor, to ensure that these conditions are met. No further review by the Northern A Health and Disability Ethics Committee is required.

Standard conditions:

Before the study commences at *any* locality in New Zealand, all relevant regulatory approvals must be obtained.

Before the study commences at *any* locality in New Zealand, it must be registered in a clinical trials registry. This should be a WHO-approved (such as the Australia New Zealand Clinical Trials Registry, [www.anzctr.org.au](http://www.anzctr.org.au)). However <https://clinicaltrials.gov/> is acceptable provided registration occurs prior to the study commencing at *any* locality in New Zealand.

Before the study commences at *a given* locality in New Zealand, it must be authorised by that locality in Online Forms. Locality authorisation confirms that the locality is suitable for the safe and effective conduct of the study, and that local research governance issues have been addressed.

Non-standard conditions:

Please ensure the Consent Form has yes/no boxes against only the truly optional statements.

In your Consent Form please use Statistics New Zealand's ethnicity classifications when collecting ethnicity data to ensure the options available are suitable for New Zealand participants. These classifications are: New Zealand European, Maori, Samoan, Cook Islands Maori, Tongan, Niuean, Chinese, Indian, Other (such as Dutch, Japanese, Tokelauan) please state.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by HDEC before commencing your study.

If you would like an acknowledgement of completion of your non-standard conditions letter you may submit a post approval form amendment. Please clearly identify in the amendment that the changes relate to non-standard conditions and ensure that supporting documents (if requested) are tracked/highlighted with changes.

For information on non-standard conditions please see section 128 and 129 of the Standard Operating Procedures at <http://ethics.health.govt.nz/home>.

After HDEC review

Please refer to the *Standard Operating Procedures for Health and Disability Ethics Committees* (available on [www.ethics.health.govt.nz](http://www.ethics.health.govt.nz)) for HDEC requirements relating to amendments and other post-approval processes.

Your **next progress report** is due by **22 May 2017**.

## Participant access to ACC

The Northern A Health and Disability Ethics Committee is satisfied that your study is not a clinical trial that is to be conducted principally for the benefit of the manufacturer or distributor of the medicine or item being trialled. Participants injured as a result of treatment received as part of your study may therefore be eligible for publicly-funded compensation through the Accident Compensation Corporation (ACC).

Please don't hesitate to contact the HDEC secretariat for further information. We wish you all the best for your study.

Yours sincerely,

Dr Brian Fergus

Chairperson

Northern A Health and Disability Ethics Committee

Encl: appendix A: documents submitted, appendix B: statement of compliance and list of members

## Appendix A

<b>Documents submitted</b> <i>Document</i>	<i>V</i>	<i>Date</i>
Survey/questionnaire: VHI-10	001	20 April 2016
Survey/questionnaire: PDQ-8	001	20 April 2016
Survey/questionnaire: MDS-UPDRS	001	20 April 2016
Survey/questionnaire: DASS-21	001	20 April 2016
Survey/questionnaire: ACE-III Administration NZ	001	20 April 2016
PIS/CF: PIC/CF	001	20 April 2016
CV for CI: CI CV	001	20 April 2016
CVs for other Investigators: CV for other Investigator	001	20 April 2016
Evidence of scientific review: Scientific review	001	20 April 2016
Protocol: Study Protocol	003	20 April 2016
Covering Letter: BOPDHB clinical School research approval application form.	001	20 April 2016
Covering Letter: Maori Health	001	17 June 2015
Covering Letter: Parkinsonism Tauranga support letter	001	19 August 2015
Survey/questionnaire: Questionnaire	001	20 April 2016
Covering Letter: Covering letter	001	20 April 2016
<b>Application</b>		
PIS/CF: amended PIS	005	11 May 2016
Protocol: amended protocol	004	04 May 2016
PIS/CF: Participant's partner PIS	001	11 May 2016
HDEC response 001Responses to further requested information	001	11 May 2016
PIS/CF: Participant Information Sheet v.6_Highlighted	6.0	13 May 2016
Protocol: Study Protocol v.6.Tracked	6.0	13 May 2016

## Appendix B

### Statement of compliance and list of members

Statement of compliance

The Northern A Health and Disability Ethics Committee:

is constituted in accordance with its Terms of Reference

operates in accordance with the *Standard Operating Procedures for Health and Disability Ethics Committees*, and with the principles of international good clinical practice (GCP)

is approved by the Health Research Council of New Zealand's Ethics Committee for the purposes of section 25(1)(c) of the Health Research Council Act 1990

is registered (number 00008714) with the US Department of Health and Human Services' Office for Human Research Protection (OHRP).

<b>List of members</b> <i>Name</i>	<i>Category</i>	<i>Appointed</i>	<i>Term Expires</i>
Dr Brian Fergus	Lay (consumer/community perspectives)	11/11/2015	11/11/2018
Ms Rosemary Abbott	Lay (the law)	15/03/2016	15/03/2019
Dr Karen Bartholomew	Non-lay (intervention studies)	13/05/2016	13/05/2019
Dr Charis Brown	Non-lay (intervention studies)	11/11/2015	11/11/2018
Ms Susan Buckland	Lay (consumer/community perspectives)	11/11/2015	11/11/2016
Ms Shamim Chagani	Non-lay (health/disability service provision)	11/11/2015	11/11/2016
Dr Christine Crooks	Non-lay (intervention studies)	11/11/2015	11/11/2018
Dr Kate Parker	Lay (consumer/community perspectives)	11/11/2015	11/11/2018

## Parkinson's?

Have you or your partner noticed  
your voice getting quieter?



Would you like to participate in new research  
that explores ways to improve voice  
in people with parkinson's?

A survey of 500 New Zealanders with Parkinson's disease found that fewer than 24% had seen a speech and language therapist, despite up to 90% developing voice related communication difficulties. **Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease receiving voice and choral singing group therapy or music appreciation activity.**

Thank you for your interest in this doctoral research project.

Researching how singing can improve voice and wellbeing will provide important information on future community based therapy for people with Parkinson's across New Zealand and around the world.

Participation is voluntary and will involve joining one of two group activities: voice exercise and singing or an activity that includes thinking and talking about music. It will take just two hours a week for nine weeks.

If you are interested in volunteering, or simply want to find out more, contact Robin Matthews MSc by phone on 027 326 1464 or by email on [rmat107@aucklanduni.ac.nz](mailto:rmat107@aucklanduni.ac.nz)

Health and Disability Ethics Committee Ethics approved– ref: 16/NTA/53  
Research approved by Parkinson's New Zealand



## APPENDIX 9 – Study 2: Participant Information Sheet and Consent

DEPARTMENT OF PSYCHOLOGY (Speech Science)



Tamaki Campus, 261 Morrin Road  
Glen Innes 1072  
The University of Auckland  
Private Bag 92019  
Auckland Mail Centre 1142  
Telephone 07 579 8783  
Mobile: 027 326 1464  
email: [rmat107@aucklanduni.ac.nz](mailto:rmat107@aucklanduni.ac.nz)  
[rsmatthews@kinect.co.nz](mailto:rsmatthews@kinect.co.nz)

### PARTICIPATION INFORMATION SHEET

**Research title:**

**Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson’s disease receiving voice and choral singing group therapy or music appreciation activity.**

**Researcher:**

Robin Matthews - speech and language therapist and PhD doctoral candidate – undertaking a Speech Science research thesis at The University of Auckland.

**Supervising Researchers:** Professor Suzanne Purdy  
Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor of psychology and lecturer in neuropsychology at The University of Auckland.

**Contact details:**

Robin Matthews	(7) 579 8783	email: <a href="mailto:rmat107@aucklanduni.ac.nz">rmat107@aucklanduni.ac.nz</a>
Suzanne Purdy	(9) 373 7599	email: <a href="mailto:sc.purdy@auckland.ac.nz">sc.purdy@auckland.ac.nz</a>
Lynette Tippett	(9) 373 7599	email: <a href="mailto:l.tippett@auckland.ac.nz">l.tippett@auckland.ac.nz</a>

The Northern A Health and Disability Ethics Committee (HDEC) have approved this study - **Ethics ref: 16/NTA/53**

You are invited to take part in a study that will evaluate how singing and music activities improve voice and wellbeing in people who have Parkinson’s disease.

This information sheet will give you information about the study and may help you decide if you would like to take part. It tells you why we are doing the study, what your participation will involve and what the benefit and risks might be. Please take

time to read and think about the information provided. I am happy to answer any questions you have.

### **Why are we doing this study?**

The purpose of this study is to evaluate how singing and music maintains or improves voice and wellbeing in people who have been diagnosed with Parkinson's disease. We will compare the effectiveness of two activities: singing in a choir and an activity that includes talking and thinking about music.

### **Who will be in this study?**

We are looking for about forty volunteers who have a diagnosis of Parkinson's disease. As someone with Parkinson's you are invited to take part in this study.

### **Where will it happen and what will I have to do?**

You will be assigned to one of two group activities: singing in a choir or an activity that includes thinking and talking about music. The decision regarding which of these activities you will be offered happens by chance, like a toss of a coin. This is the best way to work out which activity works the best.

Before the two group activities begin, you will receive through the post four short de-identified questionnaires that you will be asked to complete. The questionnaires will ask you how you feel about your voice, quality of life, anxiety and your experience of Parkinson's. Your partner will also be asked to complete a short questionnaire about their perception of the quality of your voice.

After you have completed the questionnaires a research assistant will make an initial visit to see you in your home at a time that is most convenient for you to collect them and to help with any queries that you might have. Also, at that time the research assistant will administer with you a short task involving thinking abilities, such as naming and memory. Completing the questionnaires will take approximately 30 minutes.

Depending on where you live, you will also be invited to attend either the clinical school at the BOPDHB, Tauranga or the offices of Parkinson's New Zealand in Hamilton, where the research assistant will record your voice for volume, intensity and quality and measure for aerodynamic resistance, which will take around 60 minutes. This will occur twice; before the study begins and again just after it has finished.

### **How long will the group activities last?**

The group activities will occur each week for nine weeks. Each session will last for 90 minutes - including tea and biscuits. Each group will be led by an experienced facilitator.

After nine weeks, when the group activities are completed you will be asked to complete the same questionnaires that you did at the start of the study with the

addition of a short questionnaire asking you about your experience as a study participant. The research assistant will visit you once again to repeat the measures that were done at the start

Information from the study will be used to see whether the activity that you participated in – singing or music appreciation – has made a difference to your voice and wellbeing.

**Do I have to take part in this study?**

No. Participation is voluntary. You can choose if you want to take part in the study. If you do take part, there is no obligation and you can change your mind at any time. You do not have to give a reason.

**Can I think about it?**

Yes. You can take time to think about whether you want to take part in this study. You might like to discuss it with your partner.

**Will I have to give up my usual therapy if I take part in the study?**

No. If you choose to take part in the study you can carry on with your usual therapy.

**Will being a participant in this study affect the service I currently receive from my local District Health Board (DHB)?**

No. Your participation or nonparticipation will not affect the service provided to you by your DHB.

**What will happen to all the data that you collect from me?**

All the collected data is strictly confidential, anonymous and coded by number not your name. It will be kept securely stored and kept under lock and key for 10 years. You can have a copy of your data if you wish.

Audio recordings will be made of your voice. The recorded audio files will be stored confidentially in password protected files on a password protected computer at the University of Auckland.

Any future publications or presentations relating to this study will not contain any information that could identify you.

You can request a summary of all the results at the end of the study in 2017.

**Can I stop taking part in the study?**

You can stop at any time, but should you stop before the study is complete your data cannot be used.

### **What are the benefits of taking part in the study?**

*Benefits for you* - You might find it helpful talking about your experiences of Parkinson's and the activities and you might also benefit directly from being involved in the study as the social involvement is usually fun.

*Benefits for others* -Your participation in this study will help the international community of speech and language therapists understand better how to improve the effectiveness of voice therapy for people with Parkinson's.

### **What are the risks in taking part in this study?**

There should not be any risk to you. However, as your participation is required over a number of weeks you could become tired during the task activities. We will do our best to accommodate the assessment times around your schedule and, as experience clinicians, we will monitor for tiredness and ensure there are adequate breaks for rest throughout the weekly activities.

### **What will happen if an unknown problem is identified?**

Unexpected findings, if identified, will be discussed with you and should you consent, a referral will be made to your GP or consultant geriatrician at your DHB movement disorder clinic.

### **Will I have to pay?**

No, taking part in this study will not cost you anything. It will require a certain amount of time and commitment from you to attend the weekly activities

### **Where can I find out more information?**

If you want more information please contact Robin Matthews, Lynette Tippett or Suzanne Purdy.

### **What do I need to do if I am interested in participating?**

If you would like to participate, complete and sign the attached consent form and return to the researcher in the pre-paid envelope provided.

### **Your rights as a participant?**

If you have any queries or concerns about your rights as a participant in this study, you can contact an independent health and disability advocate:

Health and Disability Commissioner:

Phone: 0800 555 050

email: [advocacy@hdc.org.nz](mailto:advocacy@hdc.org.nz) - <http://www.hdc.org.nz>

You can also contact the health and disability ethics committee (HDEC) that approved this study:

Phone: 0800 4 ETHICS email: [hdec@moh.govt.nz](mailto:hdec@moh.govt.nz)

## CONSENT FORM

THIS FORM WILL BE HELD FOR A PERIOD OF 10 YEARS

### Research title:

**Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease receiving voice and choral singing group therapy or music appreciation activity.**

### Researcher:

My name is Robin Matthews. I am a speech and language therapist at Tauranga Hospital and undertaking a PhD – Speech Science research thesis at The University of Auckland.

Supervisors: My supervisors are: Professor Suzanne Purdy

Associate Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor and a lecturer in neuropsychology at The University of Auckland.

### Contact details:

Robin Matthews	(7) 579 8783	email:	rmat107@aucklanduni.ac.nz
Suzanne Purdy	(9) 373 7599	email:	sc.purdy@auckland.ac.nz
Lynette Tippett	(9) 373 7599	email:	l.tippett@auckland.ac.nz

I have read and I understand the Participant Information Sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
I have been given sufficient time to consider whether or not to participate in this study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without this affecting my medical care.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
I consent to the research staff collecting and processing my information, including information about my health.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
If I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
I consent to my GP or current provider being informed about my participation in the study and of any significant abnormal results obtained during the study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>

---

I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study. Yes  No

---

I know who to contact if I have any questions about the study in general. Yes  No

---

I understand my responsibilities as a study participant. Yes  No

---

I wish to receive a summary of the results from the study. Yes  No

---

Name \_\_\_\_\_ Signature \_\_\_\_\_

Date \_\_\_\_\_

<p><b>About you</b></p> <p><b>Please indicate if you are male or female (circle)</b></p> <p style="text-align: center;"><b>M</b>                      <b>F</b></p> <p>Please tell us your age in years _____</p> <p>Please indicate the age of onset of your condition _____</p> <p>Please indicate your ethnic identity (please tick)</p> <p>New Zealand European <input type="checkbox"/></p> <p>Maori <input type="checkbox"/></p> <p>Samoan <input type="checkbox"/></p> <p>Cook Islands Maori <input type="checkbox"/></p> <p>Tongan <input type="checkbox"/></p> <p>Niuean <input type="checkbox"/></p> <p>Chinese <input type="checkbox"/></p> <p>Indian <input type="checkbox"/></p> <p>Other (such as Dutch, Japanese, Tokelauan) <input type="checkbox"/> please state _____</p>
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## APPENDIX 10 – Study 2: Participant Partner Information Sheet and Consent



DEPARTMENT OF PSYCHOLOGY (Speech Science)

Tamaki Campus, 261 Morrin Road  
Glen Innes 1072  
The University of Auckland  
Private Bag 92019  
Auckland Mail Centre 1142  
Telephone 07 579 8783  
Mobile: 027 326 1464  
email: [rmat107@aucklanduni.ac.nz](mailto:rmat107@aucklanduni.ac.nz)

### PARTNER'S PARTICIPATION INFORMATION SHEET and CONSENT

**Research title:**

**Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease receiving voice and choral singing group therapy or music appreciation activity.**

**Researcher:**

Robin Matthews - speech and language therapist and PhD doctoral candidate – undertaking a Speech Science research thesis at The University of Auckland.

**Supervising Researchers:** Professor Suzanne Purdy  
Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor of Psychology and lecturer in neuropsychology at The University of Auckland.

**Contact details:**

Robin Matthews	(7) 579 8783	email: <a href="mailto:rmat107@aucklanduni.ac.nz">rmat107@aucklanduni.ac.nz</a>
Suzanne Purdy	(9) 373 7599	email: <a href="mailto:sc.purdy@auckland.ac.nz">sc.purdy@auckland.ac.nz</a>
Lynette Tippett	(9) 373 7599	email: <a href="mailto:l.tippett@auckland.ac.nz">l.tippett@auckland.ac.nz</a>

The Northern A Health and Disability Ethics Committee (HDEC) have approved this study - **Ethics ref: 16/NTA/53**

You are invited to take part in a study that will evaluate whether singing and music activities improve voice and wellbeing in people who have Parkinson's disease.

This information sheet will give you information about the study and may help you decide if you would like to take part. It tells you why we are doing the study, what your participation will involve and what the benefit and risks might be. Please take time to read and think about the information provided. I am happy to answer any questions you have.

### **Why are we doing this study?**

The purpose of this study is to evaluate whether singing and music maintains or improves voice and wellbeing in people who have been diagnosed with Parkinson's disease. We will compare the effectiveness of two group activities: singing in a choir and an activity that includes talking and thinking about music.

### **Who will be in this study?**

As a partner of someone with Parkinson's you are invited to take part in this study too. We are looking for about forty volunteers who are partners of someone with a diagnosis of Parkinson's disease.

### **Where will it happen and what will I have to do?**

Before the start of the group activities that your partner volunteered for, he/she will receive through the post four short de-identified questionnaires that he/she will be asked to complete. The questionnaires will ask how they feel about their voice, quality of life, anxiety and experience of Parkinson's.

Included with your partner's questionnaires will be one for you to complete. We would like you to complete a short questionnaire about how you perceive the quality of your partner's voice. Completing your questionnaire will take no more than five minutes. It is very important that you complete the questionnaire independently and do not collude with your partner.

After you and your partner have completed your questionnaires, return them to me in the prepaid envelope that will be provided.

### **How long will the group activities last?**

The group activity that your partner has volunteered for will occur each week for nine weeks. After nine weeks, when the group activities are completed you and your partner will be asked to complete the same questionnaire that you did at the start of the study. Your partner will be given one further short questionnaire asking about his/her experience as a study participant. The research assistant will visit you and your partner once again to collect the completed questionnaires and help with any queries that you may have.

Information from the study will be used to see whether the activity that your partner has participated in – singing or music appreciation – has made a difference to his/her voice and wellbeing.

### **Do I have to take part in this study?**

No. Participation is voluntary. You can choose if you want to take part in the study. If you do take part, there is no obligation and you can change your mind at any time. You do not have to give a reason.

**Can I think about it?**

Yes. You can take time to think about whether you want to take part in this study. You might like to discuss it with your partner.

**Will being a participant in this study affect the service I receive from my local District Health Board (DHB)?**

No. Your participation or nonparticipation will not affect the service provided to you by your DHB.

**What will happen to the data that you collect from me?**

The collected data is strictly confidential, anonymous and coded by number not your name. It will be kept securely stored and kept under lock and key for 10 years. You can have a copy of your data if you wish.

Any future publications or presentations relating to this study will not contain any information that could identify you.

You can request a summary of all the results at the end of the study in 2017.

**Can I stop taking part in the study?**

You can stop, but should you stop before the study is complete your data cannot be used.

**What are the benefits of taking part in the study?**

*Benefits for you* – It is unlikely that taking part will benefit you particularly, but it might help your understanding of voice problems experienced by people with Parkinson's.

*Benefits for others* -Your participation in this study will help the international community of speech and language therapists understand better how to improve the effectiveness of voice therapy for people with Parkinson's.

**What are the risks in taking part in this study?**

There should not be any risk to you.

**What will happen if an unknown problem is identified?**

It is very unlikely that you will identify any unexpected findings through participating in this study.

**Will I have to pay?**

Taking part in this study will not cost you anything.

**Where can I find out more information?**

If you want more information please contact Robin Matthews, Lynette Tippett or Suzanne Purdy.

**What do I need to do if I am interested in participating?**

If you would like to participate, complete and sign the attached consent form and return to the researcher in the pre-paid envelope provided.

**Your rights as a participant?**

If you have any queries or concerns about your rights as a participant in this study, you can contact an independent health and disability advocate:

Health and Disability Commissioner:

Phone: 0800 555 050

email: [advocacy@hdc.org.nz](mailto:advocacy@hdc.org.nz) - <http://www.hdc.org.nz>

You can also contact the health and disability ethics committee (HDEC) that approved this study: Phone: 0800 4 ETHICS email: [hdecs@moh.govt.nz](mailto:hdecs@moh.govt.nz)

## CONSENT FORM

THIS FORM WILL BE HELD FOR A PERIOD OF 10 YEARS

### Research title:

**Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease receiving voice and choral singing group therapy or music appreciation activity.**

### Researcher:

My name is Robin Matthews. I am a speech and language therapist at Tauranga Hospital and undertaking a PhD – Speech Science research thesis at The University of Auckland.

Supervisors: My supervisors are: Professor Suzanne Purdy

Associate Professor Lynette Tippett

Suzanne is Head of Speech Science and a lecturer at The University of Auckland.

Lynette is a Doctor and a lecturer in neuropsychology at The University of Auckland.

### Contact details:

Robin Matthews	(7) 579 8783	email:	rmat107@aucklanduni.ac.nz
Suzanne Purdy	(9) 373 7599	email:	sc.purdy@auckland.ac.nz
Lynette Tippett	(9) 373 7599	email:	l.tippett@auckland.ac.nz

---

I have read and I understand the Participant Information Sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I have been given sufficient time to consider whether or not to participate in this study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
--	------------------------------	-----------------------------

---

I am satisfied with the answers I have been given regarding the study and I have a copy of this consent form and information sheet.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without this affecting my medical care.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

If I decide to withdraw from the study, I agree that the information collected about me up to the point when I withdraw may continue to be processed.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I understand that my participation in this study is confidential and that no material, which could identify me personally, will be used in any reports on this study.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I know who to contact if I have any questions about the study in general.	Yes <input type="checkbox"/>	No <input type="checkbox"/>
---	------------------------------	-----------------------------

---

I understand my responsibilities as a study participant. Yes  No

---

I wish to receive a summary of the results from the study. Yes  No

Name \_\_\_\_\_ Signature \_\_\_\_\_

Date \_\_\_\_\_

**About you**

**Please indicate if you are male or female (circle) Male Female**

**Please tell us your age in years \_\_\_\_\_**

**Please indicate your ethnic identity (please tick)**

New Zealand European

Maori

Samoan

Cook Islands Maori

Tongan

Niuean

Chinese

Indian

Other (such as Dutch, Japanese, Tokelauan)  please state \_\_\_\_\_

## **APPENDIX 11 - The Rainbow Passage**

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colours. These take the shape of a long, round arch, with its path high above and its two ends apparently beyond the horizon.

There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. When a man looks for something beyond his reach, his friends say he is looking for the pot of gold at the end of the rainbow. Throughout the centuries men have explained the rainbow in various ways. Some have accepted it as a miracle without physical explanation. The Greeks used to imagine that it was a sign from the gods to foretell war or heavy rain. The Norsemen considered the rainbow as a bridge over which the gods passed from earth to their home in the sky. Other men have tried to explain the phenomenon physically. Aristotle thought that the rainbow was caused by reflection of the sun's rays by the rain. Since then, physicists have found that it is not reflection, but refraction by the raindrops, which causes the rainbow. Many complicated ideas about the rainbow have been formed. The difference in the rainbow depends considerably upon the size of the water drops, where the width of the coloured band increases as the size of the drops increase. The actual primary rainbow observed is said to be the effect of superposition of a number of bows. If the red of the second bow falls upon the green of the first, the result is to give a bow with abnormally wide yellow band, since red and green lights when mixed form yellow. This is a very common type of bow, one showing mainly red and yellow, with little or no green or blue.

## APPENDIX 12 - Home Voice Maintenance Programme (HVMP) Pilot questionnaire



DEPARTMENT OF PSYCHOLOGY (Speech Science) v001

Tamaki Campus, 261 Morrin Road  
 Glen Innes 1072  
 The University of Auckland  
 Private Bag 92019  
 Auckland Mail Centre 1142  
 Telephone 07 579 8783  
 Mobile: 027 326 1464  
 email: [rmat107@aucklanduni.ac.nz](mailto:rmat107@aucklanduni.ac.nz)

### QUESTIONNAIRE

Please circle the number that best represents how you feel about your Voice Maintenance Homework Programme

My participation in the homework activity:		Disagree			Neither agree nor disagree			Agree		
1	The exercises were too hard	1			2			3		
2	The exercises were too easy	1			2			3		
3	The exercises were suitable	1			2			3		
4	I understand the need to do the exercises	1			2			3		
5	The time taken to do the exercises was acceptable	1			2			3		
7	The exercises improved your voice	1			2			3		
8	The exercises maintained the volume of your voice	1			2			3		
9	The exercises were completed each day as required	1			2			3		
10	If not, how many times a week did you do them	1	2	3	4	5	6	7		
11	In your opinion how many times a week would be practical	1	2	3	4	5	6	7		

## APPENDIX 13 - Home Voice Maintenance Programme (HVMP)



### Facial:

*Always exaggerated and stretch facial movements*

- Screw up face - close eyes tight – open suddenly and raise eyebrows with a big look of surprise x 6
- Puff cheeks out – (hold 5 secs) – relax x 4
- Open mouth/jaw as wide as you can as if at the dentist and bring your lips together as if to say “oh” with jaw still open (hold 5 secs)

### Voice:

*Always fill your lungs and make a loud voice* **NEVER STRAIN YOUR VOICE**

Days of the week – from a whisper getting **louder**

Breathe in

**Monday**

**Tuesday**

**Wednesday**

**Thursday**

**Friday**

**Saturday**

**Sunday**

**Sing 4 times going up half an octave (four notes)**

Oo<sup>oo</sup> oo ah ah ah ah ah

Oo<sup>oo</sup> oo ah ah ah ah ah

**Sing 8 times going down a full octave (8 notes)**

Meeooow Meeooooow Meeooow

1. Sustained /ah/ for 15 seconds (loud without straining)
2. Sustained /ah/ for 15 seconds (loud without straining)

Breathe in and sing each line going up and then down a scale

**Breathe in** - 1 2 3 4 **5** 4 3 2 1

**Breathe in** - 1 2 3 4 5 **6** 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 **7** 6 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 7 **8** 7 6 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 7 8 **9** 8 7 6 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 7 8 9 **10** 9 8 7 6 5 4 3 2 1

1. Sustained /ah/ for 15 seconds (loud without straining)
2. Sustained /ah/ for 15 seconds (loud without straining)

Days of the week – getting **louder**

Breathe in

**Monday**

**Tuesday**

**Wednesday**

**Thursday**

**Friday**

**Saturday**

**Sunday**

Days of the week – keep **loud**

Breathe in

**Monday**

**Tuesday**

**Wednesday**

**Thursday**

**Friday**

**Saturday**

**Sunday**

## Songs to sing at the same volume as /ah/ above

### **Now is the hour**

Now is the hour when we must say goodbye  
Soon you'll be sailing far across the sea

While you're away, Oh please remember me  
When you return you'll find me waiting here

Now is the hour when we must say goodbye  
Soon you'll be sailing far across the sea

While you're away, oh please remember me.  
When you return you'll find me waiting here.

### **CRUISING DOWN THE RIVER (On a Sunday Afternoon)**

Cruising down the river on a Sunday afternoon  
With one you love, the sun above waiting for the moon  
The old accordian playing a sentimental tune  
Cruising down the river on a Sunday afternoon

The birds above all sing of love, a gentle sweet refrain  
The winds around all make a sound like softly falling rain

Just two of us together, we'll plan a honeymoon  
Cruising down the river on a Sunday afternoon.

## APPENDIX 14 - Weekly Exercise Undertaken by the Singing Group

### Exercises

- Arms stretch high - release in a long aaaah
- Tighten and relax face x 4
- Tighten RIGHT side face x 2
- Tighten LEFT side face x 2
- Push tongue in right cheek
- Push tongue in left cheek
- Turn your head gently and slowly to your left as far as you can comfortably then return slowly to midline before turning your head to the right.
- Wrinkle nose x 4
- Close eyes tight – open suddenly and raise eyebrows with a big look of surprise x 6
- Blow a raspberry
- Trill
- Whistle
- Puff cheeks out - hold 5 secs - relax
- Open mouth/jaw as wide as you can as if at the dentist and bring your lips together as if to say “oh” with jaw still open
- Big smile

Days of the week – starting with a whisper getting louder

Breathe in

**Monday Tuesday Wednesday Thursday Friday Saturday Sunday**

Days of the week – starting loud getting softer to a whisper

Breathe in

**Sunday Saturday Friday Thursday Wednesday Tuesday Monday**

Tee ta tay tee ta tay tee ta tay tee ta tay (x 8 full octave)

Oo<sup>oo</sup> oo ah ah ah ah ah Oo<sup>oo</sup> oo ah ah ah ah ah

Boom<sup>boom</sup> boom Boom<sup>ba</sup> boom boom boom (x4)

Meeooow Meeooow Meeooow (x 8 full octave)

Sustained /ah/ for 15 seconds (loud without straining)

Sustained /ah/ for 15 seconds (loud without straining)

Breathe in and sing each line going up and then down a scale

**Breathe in** - 1 2 3 4 **5** 4 3 2 1

**Breathe in** - 1 2 3 4 5 **6** 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 **7** 6 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 7 **8** 7 6 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 7 8 **9** 8 7 6 5 4 3 2 1

**Breathe in** - 1 2 3 4 5 6 7 8 9 **10** 9 8 7 6 5 4 3 2 1

Sustained /ah/ for 15 seconds (loud without straining)

Sustained /ah/ for 15 seconds (loud without straining)

Days of the week – starting with a whisper getting louder

Breathe in

**Monday Tuesday Wednesday Thursday Friday Saturday Sunday**

Days of the week – keep loud

Breathe in

**Monday**

**Tuesday**

**Wednesday**

**Thursday**

**Friday**

**Saturday**

**Sunday**

**APPENDIX 15 - Home Voice Maintenance Programme Diary**

**Home Voice Maintenance Programme Diary**

<b>September 2016</b>							
<b>Wk</b>	<b>Sun</b>	<b>Mon</b>	<b>Tue</b>	<b>Wed</b>	<b>Thu</b>	<b>Fri</b>	<b>Sat</b>
					1	2	3
	4	5	6	7	8	9	10
<b>1</b>	11	12	<b>13</b>	14	15	16	17
<b>2</b>	18	19	<b>20</b>	21	22	23	24
<b>3</b>	25	26	<b>27</b>	28	29	30	

<b>October 2016</b>							
<b>Wk</b>	<b>Sun</b>	<b>Mon</b>	<b>Tue</b>	<b>Wed</b>	<b>Thu</b>	<b>Fri</b>	<b>Sat</b>
							1
<b>4</b>	2	3	<b>4</b>	5	6	7	8
<b>5</b>	9	10	<b>11</b>	12	13	14	15
<b>6</b>	16	17	<b>18</b>	19	20	21	22
<b>7</b>	23	24	<b>25</b>	26	27	28	29
	30	31					

<b>November 2016</b>							
<b>Wk</b>	<b>Sun</b>	<b>Mon</b>	<b>Tue</b>	<b>Wed</b>	<b>Thu</b>	<b>Fri</b>	<b>Sat</b>
<b>8</b>			<b>1</b>	2	3	4	5
<b>9</b>	6	7	<b>8</b>	9	10	11	12
	13	14	15	16	17	18	19
	20	21	22	23	24	25	26
	27	28	29	30			

Please  the days that you have done your Home Voice Maintenance Program or put a cross through the date if you have not been able to.  
 Please bring this diary with you when you see Laura at your final assessment at the end of the nine weeks.

## APPENDIX 16 - Table of transformed data

Table showing dependent variables for each group, raw data marked in Red indicating those that were not normally distributed, the transform applied and the Shapiro-Wilk transformed data – using paired t-test. Other dependent variables highlighted in yellow were unable to be transformed and were analysed using Wilcoxon.

Dependent variable	Group	Shapiro Wilk Value untransformed	Transform Applied	Shapiro Wilk Value transformed data
preVitCapPEA	Tauranga choir	0.205		
	Tauranga music	0.683		
	Hamilton choir	0.025	Log	.560
	Hamilton music	0.254		
preVitCapEV	Tauranga choir	0.350		
	Tauranga music	0.725		
	Hamilton choir	0.546		
	Hamilton music	0.465		
preSGPPAP	Tauranga choir	0.013	log	.542
	Tauranga music	0.247		
	Hamilton choir	0.005		
	Hamilton music	0.371		
preSGPPEA	Tauranga choir	0.000	log	.596
	Tauranga music	0.125		
	Hamilton choir	0.216		
	Hamilton music	0.017		
preSGPAPOW	Tauranga choir	0.002	log	.796
	Tauranga music	0.006	log	.940
	Hamilton choir	0.002	log	.838
	Hamilton music	0.001	log	.792
preSGPAeroRes	Tauranga choir	0.295		
	Tauranga music	0.634		
	Hamilton choir	0.613		
	Hamilton music	0.296		
preMPT1sec	Tauranga choir	0.764		
	Tauranga music	0.390		
	Hamilton choir	0.390		
	Hamilton music	0.712		
preMPT1Lmax	Tauranga choir	0.461		
	Tauranga music	0.815		
	Hamilton choir	0.272		
	Hamilton music	0.546		
preMPT1Lavg	Tauranga choir	0.786		
	Tauranga music	0.142		
	Hamilton choir	0.033	Log	.589
	Hamilton music	0.335		
preMPT2sec	Tauranga choir	0.648		

	Tauranga music	0.152		
	Hamilton choir	0.652		
	Hamilton music	0.380		
preMPT2Lmx	Tauranga choir	0.911		
	Tauranga music	0.600		
	Hamilton choir	0.241		
	Hamilton music	0.067		
preMPT2Lavq	Tauranga choir	0.577		
	Tauranga music	0.248		
	Hamilton choir	0.920		
	Hamilton music	0.683		
prePitchRangeMin	Tauranga choir	0.351		
	Tauranga music	0.274		
	Hamilton choir	0.413		
	Hamilton music	0.021	Log	.099
prePitchRangeMax	Tauranga choir	0.010	Sqrt	.693
	Tauranga music	0.139		
	Hamilton choir	0.011	Sqrt	.522
	Hamilton music	0.396		
prePitchRangeSTR	Tauranga choir	0.000	Sqrt	.760
	Tauranga music	0.276		
	Hamilton choir	0.087		
	Hamilton music	0.847		
prePitchRangeHz	Tauranga choir	0.426		
	Tauranga music	0.754		
	Hamilton choir	0.207		
	Hamilton music	0.204		
preSponahJitt	Tauranga choir	0.694		
	Tauranga music	0.056		
	Hamilton choir	0.000	Sqrt	.111
	Hamilton music	0.114		
preSponahRap	Tauranga choir	0.847		
	Tauranga music	0.055		
	Hamilton choir	0.001	Sqrt	.113
	Hamilton music	0.018	Sqrt	.408
preSponahShim	Tauranga choir	0.351		
	Tauranga music	0.281		
	Hamilton choir	0.041	Log	.201
	Hamilton music	0.505		
preSponahNHR	Tauranga choir	0.000	Sqrt	.302
	Tauranga music	0.000	Sqrt	.394
	Hamilton choir	0.810		
	Hamilton music	0.316		
preSponahVTI	Tauranga choir	0.379		

	Tauranga music	0.556		
	Hamilton choir	0.341		
	Hamilton music	0.598		
preSponahSPI	Tauranga choir	0.459		
	Tauranga music	0.185		
	Hamilton choir	0.063		
	Hamilton music	0.278		
preSponahLmx	Tauranga choir	0.511		
	Tauranga music	0.238		
	Hamilton choir	0.974		
	Hamilton music	0.645		
preSponahLavg	Tauranga choir	0.402		
	Tauranga music	0.091		
	Hamilton choir	0.051		
	Hamilton music	0.521		
preReadMeanFo	Tauranga choir	0.678		
	Tauranga music	0.872		
	Hamilton choir	0.058		
	Hamilton music	0.122		
preReadSD	Tauranga choir	0.814		
	Tauranga music	0.626		
	Hamilton choir	0.070		
	Hamilton music	0.844		
preReadvFo	Tauranga choir	0.714		
	Tauranga music	0.641		
	Hamilton choir	0.667		
	Hamilton music	0.122		
preReadSemitRange	Tauranga choir	0.790		
	Tauranga music	0.241		
	Hamilton choir	0.003	Sqrt	.663
	Hamilton music	0.135		
preReadSDSemit	Tauranga choir	0.741		
	Tauranga music	0.578		
	Hamilton choir	0.393		
	Hamilton music	0.303		
preReadLmx	Tauranga choir	0.764		
	Tauranga music	0.341		
	Hamilton choir	0.203		
	Hamilton music	0.357		
preReadLavg	Tauranga choir	0.508		
	Tauranga music	0.573		
	Hamilton choir	0.864		
	Hamilton music	0.393		
preConMeanFo	Tauranga choir	0.291		

	Tauranga music	0.162		
	Hamilton choir	0.173		
	Hamilton music	0.383		
preConSD	Tauranga choir	0.117		
	Tauranga music	0.648		
	Hamilton choir	0.982		
	Hamilton music	0.897		
preConvFo	Tauranga choir	0.771		
	Tauranga music	0.688		
	Hamilton choir	0.105		
	Hamilton music	0.756		
preConSemitRange	Tauranga choir	0.076		
	Tauranga music	0.396		
	Hamilton choir	0.039	Sqrt	.169
	Hamilton music	0.715		
preConSDSemit	Tauranga choir	0.529		
	Tauranga music	0.823		
	Hamilton choir	0.708		
	Hamilton music	0.512		
preConLmx	Tauranga choir	0.880		
	Tauranga music	0.080		
	Hamilton choir	0.700		
	Hamilton music	0.999		
preConLavg	Tauranga choir	0.627		
	Tauranga music	0.842		
	Hamilton choir	0.132		
	Hamilton music	0.715		
preACEIIIITotal	Tauranga choir	0.828		
	Tauranga music	0.023	Power	.364
	Hamilton choir	0.825		
	Hamilton music	0.133		
preACEIIIAtt	Tauranga choir	0.001	n/a	
	Tauranga music	0.063		
	Hamilton choir	0.028	n/a	
	Hamilton music	0.505		
preACEIIIMem	Tauranga choir	0.865		
	Tauranga music	0.226		
	Hamilton choir	0.077		
	Hamilton music	0.610		
preACEIIIFlu	Tauranga choir	0.140		
	Tauranga music	0.081		
	Hamilton choir	0.440		
	Hamilton music	0.389		
preACEIIILan	Tauranga choir	0.019	n/a	

	Tauranga music	0.002	n/a	
	Hamilton choir	0.181		
	Hamilton music	0.033	n/a	
preACEIIIVis	Tauranga choir	0.000	n/a	
	Tauranga music	0.408		
	Hamilton choir	0.011	n/a	
	Hamilton music	0.051		
preDASSDep	Tauranga choir	0.104		
	Tauranga music	0.085		
	Hamilton choir	0.036	Sqrt	.164
	Hamilton music	0.839		
preDASSAnx	Tauranga choir	0.025	Sqrt	.495
	Tauranga music	0.130		
	Hamilton choir	0.440		
	Hamilton music	0.099		
preDASSStr	Tauranga choir	0.015	Sqrt	.653
	Tauranga music	0.386		
	Hamilton choir	0.143		
	Hamilton music	0.548		
prePDQ8Total	Tauranga choir	0.799		
	Tauranga music	0.500		
	Hamilton choir	0.065		
	Hamilton music	0.680		
preVHI10Total	Tauranga choir	0.021	Sqrt	.115
	Tauranga music	0.051		
	Hamilton choir	0.602		
	Hamilton music	0.977		
preVHI10PTotal	Tauranga choir	0.056	Sqrt	.129
	Tauranga music	0.415		
	Hamilton choir	0.491		
	Hamilton music	0.904		
preUPDRSPart1Total	Tauranga choir	0.407		
	Tauranga music	0.113		
	Hamilton choir	0.984		
	Hamilton music	0.853		
preUPDRSPart2Total	Tauranga choir	0.593		
	Tauranga music	0.149		
	Hamilton choir	0.781		
	Hamilton music	0.557		

Note. Dependent variables marked as n/a were those unable to be transformed so were analysed using Wilcoxon.

## APPENDIX 17 - Independent t-tests Baseline Intervention Comparison

		Independent Samples Test								
		Levene's Test for Equality of Variances				t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Err Difference	95% Conf Int of the Difference	
									Lower	Upper
preVitCapPEALT	Equal variances assumed	.629	.433	.191	35	.850	.016230	.084943	-.156214	.188674
	Equal variances not assumed			.186	27.249	.854	.016230	.087326	-.162872	.195333
preVitCapEV	Equal variances assumed	2.293	.139	-.090	35	.929	-.028455	.316051	-.670072	.613163
	Equal variances not assumed			-.086	25.156	.932	-.028455	.331366	-.710700	.653791
preVitCapAirflowSecsLT	Equal variances assumed	1.674	.204	-.348	35	.730	-.022312	.064193	-.152631	.108007
	Equal variances not assumed			-.362	33.786	.720	-.022312	.061709	-.147750	.103125
preSGPPAPLT	Equal variances assumed	7.652	.099	-.039	35	.969	.002136	.055022	-.113837	.109564
	Equal variances not assumed			-.035	20.331	.972	-.002136	.060718	-.128660	.124388
preSGPPEALT	Equal variances assumed	2.878	.099	1.113	35	.273	.169548	.152319	-.139676	.478773
	Equal variances not assumed			1.001	19.701	.329	.169548	.169393	-.184143	.523240
preSGPAPOWLT	Equal variances assumed	6.369	.016	1.286	35	.207	.228827	.177896	-.132322	.589976
	Equal variances not assumed			1.174	20.934	.254	.228827	.194924	-.176617	.634272
preSGPAirResLT	Equal variances assumed	.504	.482	-.497	35	.622	-.026652	.053612	-.135490	.082187
	Equal variances not assumed			-.484	27.273	.632	-.026652	.055104	-.139663	.086360
preMPTBest	Equal variances assumed	.001	.970	.081	35	.936	.211636	2.601680	-5.070054	5.493327
	Equal variances not assumed			.081	30.105	.936	.211636	2.604776	-5.107247	5.530520
preMPTLmaxBest	Equal variances assumed	.530	.471	-2.684	35	.011	-4.487121	1.671880	-7.881218	-1.093025
	Equal variances not assumed			-2.553	24.878	.017	-4.487121	1.757607	-8.107882	-.866360
preMPTLavgBest	Equal variances assumed	1.803	.188	-1.801	35	.080	-2.935273	1.629571	-6.243478	.372933

	Equal variances not assumed			-1.735	26.201	.094	-2.935273	1.691686	-6.411283	.540738
prePitchrangeminLT	Equal variances assumed	.278	.601	-1.183	35	.245	-.050852	.042968	-.138081	.036378
	Equal variances not assumed			-1.175	29.429	.250	-.050852	.043293	-.139341	.037638
prePitchRangeMax	Equal variances assumed	3.272	.079	-.404	35	.689	-7.430576	18.410959	-44.806810	29.945658
	Equal variances not assumed			-.414	32.695	.682	-7.430576	17.949477	-43.962011	29.100859
prePitchRangeSTRQS	Equal variances assumed	.413	.525	-1.190	35	.242	-.096871	.081399	-.262120	.068377
	Equal variances not assumed			-1.177	29.037	.249	-.096871	.082314	-.265213	.071471
prePitchRangeHz	Equal variances assumed	1.355	.252	.719	35	.477	14.215636	19.766305	-25.912095	54.343368
	Equal variances not assumed			.737	32.570	.467	14.215636	19.298443	-25.067028	53.498301
preSponahJittSQ	Equal variances assumed	.537	.469	.773	35	.445	.110818	.143432	-.180365	.402001
	Equal variances not assumed			.780	31.250	.441	.110818	.142013	-.178725	.400361
preSponahRapSQ	Equal variances assumed	.148	.703	.587	35	.561	.063621	.108461	-.156566	.283809
	Equal variances not assumed			.581	29.284	.565	.063621	.109430	-.160095	.287337
preSponahShimLT	Equal variances assumed	.002	.968	-.346	35	.732	-.022570	.065256	-.155047	.109908
	Equal variances not assumed			-.341	28.830	.735	-.022570	.066117	-.157829	.112690
preSponahNHRSQ	Equal variances assumed	.001	.970	-.388	35	.700	-.060857	.156800	-.379178	.257464
	Equal variances not assumed			-.383	28.756	.705	-.060857	.158977	-.386122	.264407
preSponahVTIExp	Equal variances assumed	2.558	.119	-2.735	35	.060	-.011379	.004160	-.019824	-.002933
	Equal variances not assumed			-2.879	34.469	.057	-.011379	.003952	-.019406	-.003351
preSponahSPISQ	Equal variances assumed	1.614	.212	2.046	35	.348	.859100	.419880	.006698	1.711502
	Equal variances not assumed			2.140	34.125	.340	.859100	.401482	.043300	1.674900
preSponahLmx	Equal variances assumed	1.389	.246	1.476	35	.149	2.491212	1.688085	-.935782	5.918207
	Equal variances not assumed			1.408	25.193	.171	2.491212	1.769266	-1.151247	6.133671
preSponahLavg	Equal variances assumed	.002	.962	1.168	35	.251	2.547576	2.181192	-1.880480	6.975631
	Equal variances not assumed			1.167	30.173	.252	2.547576	2.182390	-1.908390	7.003542
preReadMeanFo	Equal variances assumed	.082	.776	.502	35	.619	5.615242	11.178499	-17.078318	28.308803
	Equal variances not assumed			.510	31.693	.614	5.615242	11.017998	-16.836208	28.066693

preReadSD	Equal variances assumed	.276	.603	.377	35	.708	1.110485	2.944125	-4.866407	7.087377
	Equal variances not assumed			.371	28.324	.714	1.110485	2.996916	-5.025262	7.246232
preReadvFo	Equal variances assumed	.029	.865	.056	35	.956	.001455	.026042	-.051414	.054323
	Equal variances not assumed			.055	29.448	.956	.001455	.026235	-.052166	.055075
preReadSemitRangeSQ	Equal variances assumed	1.381	.248	-.997	35	.326	-.131924	.132322	-.400553	.136704
	Equal variances not assumed			-1.082	34.907	.287	-.131924	.121942	-.379503	.115654
preReadSDSemit	Equal variances assumed	.090	.766	.424	35	.674	.126242	.297655	-.478030	.730515
	Equal variances not assumed			.421	29.418	.677	.126242	.299942	-.486830	.739315
preReadLmx	Equal variances assumed	.172	.681	1.185	35	.244	1.416667	1.195339	-1.010001	3.843334
	Equal variances not assumed			1.167	28.589	.253	1.416667	1.213799	-1.067382	3.900715
preReadLavg	Equal variances assumed	1.180	.285	2.375	35	.023	2.598485	1.093962	.377624	4.819346
	Equal variances not assumed			2.483	34.108	.018	2.598485	1.046318	.472359	4.724611
preConMeanFo	Equal variances assumed	.350	.558	.504	35	.617	6.358424	12.616378	-19.254185	31.971034
	Equal variances not assumed			.530	34.390	.600	6.358424	12.005185	-18.028863	30.745711
preConSD	Equal variances assumed	.317	.577	.685	35	.498	3.255121	4.755021	-6.398084	12.908326
	Equal variances not assumed			.706	33.177	.485	3.255121	4.608947	-6.119950	12.630192
preConvFo	Equal variances assumed	1.494	.230	.505	35	.617	.019182	.038003	-.057969	.096332
	Equal variances not assumed			.527	33.988	.602	.019182	.036420	-.054833	.093196
preConSemitRangeQS	Equal variances assumed	.459	.502	-.491	35	.626	-.126024	.256514	-.646776	.394727
	Equal variances not assumed			-.508	33.279	.615	-.126024	.248313	-.631060	.379012
preConSDSemit	Equal variances assumed	.398	.532	.304	35	.763	.140909	.463027	-.799085	1.080903
	Equal variances not assumed			.314	33.199	.755	.140909	.448680	-.771729	1.053547
preConLmx	Equal variances assumed	.316	.577	-.900	35	.374	-1.266061	1.407275	-4.122980	1.590859
	Equal variances not assumed			-.862	25.670	.397	-1.266061	1.468250	-4.285981	1.753859
preConLavg	Equal variances assumed	.203	.655	.577	35	.568	.806061	1.397984	-2.031998	3.644119
	Equal variances not assumed			.584	31.570	.563	.806061	1.379658	-2.005712	3.617833
preACEIIIITotal	Equal variances assumed	1.160	.289	.724	35	.474	1.657576	2.290868	-2.993135	6.308286

	Equal variances not assumed			.676	23.051	.506	1.657576	2.452745	-3.415686	6.730838
preACEIIIAtt	Equal variances assumed	12.921	.001	1.401	35	.170	.700000	.499550	-.314140	1.714140
	Equal variances not assumed			1.257	19.536	.223	.700000	.556699	-.463025	1.863025
preACEIIIMem	Equal variances assumed	5.855	.021	.762	35	.451	.821212	1.077895	-1.367031	3.009455
	Equal variances not assumed			.669	17.933	.512	.821212	1.227365	-1.758080	3.400504
preACEIIIFlu	Equal variances assumed	.238	.629	-.428	35	.671	-.315152	.735802	-1.808909	1.178606
	Equal variances not assumed			-.424	29.185	.675	-.315152	.743057	-1.834455	1.204152
preACEIIILan	Equal variances assumed	.003	.956	-.561	35	.578	-.354545	.631669	-1.636902	.927811
	Equal variances not assumed			-.558	29.621	.581	-.354545	.635315	-1.652728	.943637
preACEIIIVis	Equal variances assumed	.082	.776	1.009	35	.320	.578788	.573548	-.585576	1.743151
	Equal variances not assumed			.991	28.292	.330	.578788	.584000	-.616925	1.774501
preDASSDepSQ	Equal variances assumed	.036	.851	-1.110	35	.275	-.360603	.324856	-1.020096	.298890
	Equal variances not assumed			-1.096	28.853	.282	-.360603	.329072	-1.033780	.312574
preDASSAnxSQ	Equal variances assumed	1.284	.265	-.925	35	.361	-.198830	.214996	-.635296	.237636
	Equal variances not assumed			-.982	34.799	.333	-.198830	.202516	-.610045	.212385
preDASSStrSQ	Equal variances assumed	.131	.720	-1.132	35	.265	-.298773	.263880	-.834477	.236932
	Equal variances not assumed			-1.169	33.243	.251	-.298773	.255562	-.818573	.221027
prePDQ8Total	Equal variances assumed	.524	.474	-.534	35	.597	-.884848	1.656148	-4.247007	2.477310
	Equal variances not assumed			-.525	28.312	.604	-.884848	1.686030	-4.336813	2.567116
preVHI10TotalSQ	Equal variances assumed	.043	.836	.746	35	.461	.397021	.532143	-.683287	1.477330
	Equal variances not assumed			.732	28.155	.470	.397021	.542527	-.714019	1.508062
preVHI10PTotalSQ	Equal variances assumed	.289	.595	.419	32	.678	.255557	.610590	-.988174	1.499288
	Equal variances not assumed			.427	29.961	.672	.255557	.598598	-.967009	1.478124
preUPDRSPart1TotalSQ	Equal variances assumed	1.228	.275	.446	35	.658	.111142	.249297	-.394957	.617242
	Equal variances not assumed			.482	34.975	.633	.111142	.230698	-.357212	.579497
preUPDRSPart2TotalSQ	Equal variances assumed	2.009	.165	.598	35	.554	.194739	.325840	-.466751	.856230
	Equal variances not assumed			.650	34.866	.520	.194739	.299758	-.413885	.803364

## APPENDIX 18 – Independent t-tests Baseline Location Comparison

		Independent Samples Test								
		Levene's Test for Equality of Variances			t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Err Difference	95% Conf Int of the Difference	
									Lower	Upper
preVitCapPEALT	Equal variances assumed	.002	.966	.108	35	.914	.009068	.083714	-.160882	.179017
	Equal variances not assumed			.109	34.930	.913	.009068	.082869	-.159178	.177313
preVitCapEV	Equal variances assumed	.517	.477	-.837	35	.408	-.258088	.308334	-.884039	.367863
	Equal variances not assumed			-.851	34.950	.400	-.258088	.303169	-.873587	.357410
preVitCapAirflow SecsLT	Equal variances assumed	.778	.384	.632	35	.531	.039829	.062993	-.088052	.167711
	Equal variances not assumed			.625	32.051	.536	.039829	.063721	-.089958	.169617
preSGPPAPLT	Equal variances assumed	.311	.581	-1.806	35	.079	-.093653	.051845	-.198904	.011598
	Equal variances not assumed			-1.779	31.268	.085	-.093653	.052635	-.200965	.013659
preSGPPEALT	Equal variances assumed	3.917	.056	1.291	35	.205	.192626	.149184	-.110233	.495486
	Equal variances not assumed			1.235	23.934	.229	.192626	.156022	-.129434	.514687
preSGPAPOWLT	Equal variances assumed	3.428	.073	.815	35	.421	.144824	.177677	-.215880	.505527
	Equal variances not assumed			.794	28.476	.434	.144824	.182491	-.228712	.518359
preSGPAirResLT	Equal variances assumed	1.477	.232	-1.137	35	.263	-.059171	.052052	-.164841	.046500
	Equal variances not assumed			-1.114	30.092	.274	-.059171	.053113	-.167627	.049286
preMPTBest	Equal variances assumed	.063	.804	-1.176	35	.248	-2.956382	2.514195	-8.060470	2.147705
	Equal variances not assumed			-1.179	34.347	.247	-2.956382	2.508009	-8.051373	2.138609
preMPTLmaxBest	Equal variances assumed	.028	.869	.464	35	.646	.836529	1.803142	-2.824044	4.497103
	Equal variances not assumed			.464	34.167	.645	.836529	1.801438	-2.823773	4.496832
preMPTLavgBest	Equal variances assumed	.868	.358	-.286	35	.777	-.479265	1.676235	-3.882202	2.923673
	Equal variances not assumed			-.280	29.725	.782	-.479265	1.712997	-3.979026	3.020497
prePitchrangeminLT	Equal variances assumed	.793	.379	1.531	35	.135	.063994	.041793	-.020850	.148838
	Equal variances not assumed			1.554	34.993	.129	.063994	.041172	-.019590	.147579

prePitchRangeMaxQS	Equal variances assumed	.078	.781	-.327	35	.746	-374094853583.02	1144260391767.99	-2697066946893.76	1948877239727.72
	Equal variances not assumed			-.326	33.537	.747	-374094853583.02	1148248920101.69	-2708804871750.65	1960615164584.61
prePitchRangeSTRQS	Equal variances assumed	.967	.332	1.563	35	.127	.123637	.079085	-.036913	.284188
	Equal variances not assumed			1.590	34.953	.121	.123637	.077768	-.034248	.281522
prePitchRangeHz	Equal variances assumed	.475	.495	-.279	35	.782	-5.457588	19.595112	-45.237781	34.322605
	Equal variances not assumed			-.277	33.489	.783	-5.457588	19.669248	-45.452774	34.537598
preSponahJittSQ	Equal variances assumed	.233	.632	2.881	35	.007	.369147	.128120	.109049	.629245
	Equal variances not assumed			2.871	33.517	.007	.369147	.128583	.107696	.630598
preSponahRapSQ	Equal variances assumed	.834	.368	3.479	35	.001	.321982	.092563	.134069	.509896
	Equal variances not assumed			3.525	34.998	.001	.321982	.091355	.136522	.507442
preSponahShimLT	Equal variances assumed	1.876	.180	1.824	35	.077	.112276	.061539	-.012655	.237208
	Equal variances not assumed			1.794	30.847	.083	.112276	.062593	-.015408	.239961
preSponahNHR SQ	Equal variances assumed	1.262	.269	1.713	35	.096	.254696	.148702	-.047185	.556578
	Equal variances not assumed			1.690	31.686	.101	.254696	.150681	-.052351	.561744
preSponahVTIExp	Equal variances assumed	.274	.604	.844	35	.405	.003771	.004470	-.005304	.012845
	Equal variances not assumed			.854	34.978	.399	.003771	.004418	-.005198	.012739
preSponahSPISQ	Equal variances assumed	.000	.985	.173	35	.864	.075597	.437513	-.812602	.963796
	Equal variances not assumed			.173	34.416	.863	.075597	.436159	-.810391	.961585
preSponahLmx	Equal variances assumed	1.451	.236	.854	35	.399	1.448235	1.696466	-1.995773	4.892244
	Equal variances not assumed			.868	34.957	.391	1.448235	1.668448	-1.939044	4.835514
preSponahLavg	Equal variances assumed	5.028	.031	.081	35	.936	.178235	2.190146	-4.267998	4.624469
	Equal variances not assumed			.084	32.252	.933	.178235	2.110565	-4.119528	4.475998
preReadMeanFo	Equal variances assumed	2.043	.162	.516	35	.609	5.681765	11.010705	-16.671154	28.034684
	Equal variances not assumed			.504	29.392	.618	5.681765	11.267522	-17.349566	28.713095
preReadSD	Equal variances assumed	.004	.947	.243	35	.809	.707088	2.903937	-5.188216	6.602393
	Equal variances not assumed			.242	32.710	.811	.707088	2.927825	-5.251620	6.665797
preReadvFo	Equal variances assumed	2.243	.143	-.456	35	.651	-.011676	.025581	-.063609	.040256



	Equal variances not assumed			1.490	34.715	.145	.726471	.487511	-263519	1.716460
preACEIIIIMem	Equal variances assumed	1.820	.186	-1.185	35	.244	-1.244118	1.049839	-3.375405	.887170
	Equal variances not assumed			-1.236	31.116	.226	-1.244118	1.006901	-3.297396	.809161
preACEIIIIFlu	Equal variances assumed	.097	.757	.162	35	.872	.117647	.726526	-1.357279	1.592573
	Equal variances not assumed			.163	34.814	.871	.117647	.720865	-1.346066	1.581360
preACEIIILan	Equal variances assumed	.009	.924	1.286	35	.207	.785294	.610849	-4.454796	2.025384
	Equal variances not assumed			1.285	34.009	.207	.785294	.611018	-4.456432	2.027021
preACEIIIVis	Equal variances assumed	.095	.759	.339	35	.736	.194118	.572272	-967656	1.355891
	Equal variances not assumed			.335	32.023	.740	.194118	.578969	-985170	1.373406
preDASSDepSQ	Equal variances assumed	.000	.997	-1.419	35	.165	-.449232	.316651	-1.092068	.193603
	Equal variances not assumed			-1.422	34.332	.164	-.449232	.315915	-1.091020	.192556
preDASSAnxSQ	Equal variances assumed	1.298	.262	-1.709	35	.096	-.351921	.205965	-.770053	.066211
	Equal variances not assumed			-1.676	30.361	.104	-.351921	.209927	-.780434	.076593
preDASSStrSQ	Equal variances assumed	1.499	.229	-1.347	35	.187	-.347694	.258081	-.871627	.176239
	Equal variances not assumed			-1.326	31.067	.195	-.347694	.262246	-.882502	.187114
prePDQ8Total	Equal variances assumed	.078	.782	-.656	35	.516	-1.067647	1.628281	-4.373232	2.237938
	Equal variances not assumed			-.657	34.292	.516	-1.067647	1.625054	-4.369116	2.233822
preVHI10TotalSQ	Equal variances assumed	1.237	.274	-1.714	35	.095	-.870153	.507529	-1.900491	.160186
	Equal variances not assumed			-1.746	34.901	.090	-.870153	.498418	-1.882098	.141792
preVHI10PTotalSQ	Equal variances assumed	.620	.437	-.544	32	.590	-.328421	.604081	-1.558894	.902052
	Equal variances not assumed			-.542	29.781	.592	-.328421	.606186	-1.566800	.909958
preUPDRSPart1TotalSQ	Equal variances assumed	.078	.782	.598	35	.554	.146582	.245050	-3.350896	.644061
	Equal variances not assumed			.598	34.037	.554	.146582	.245066	-3.351432	.644597
preUPDRSPart2TotalSQ	Equal variances assumed	.622	.436	-1.199	35	.239	-.379085	.316220	-1.021045	.262875
	Equal variances not assumed			-1.216	34.999	.232	-.379085	.311772	-1.012017	.253847

## APPENDIX 19 – Participation Questionnaire

DEPARTMENT OF PSYCHOLOGY (Speech Science) V001  
Participant No:



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## QUESTIONNAIRE

Please  the number that best represents how you feel about your participation in the group

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
1 My participation in the group activity: has helped me build new friendships	1	2	3	4	5
2 has made me more confident talking	1	2	3	4	5
3 has made me more confident singing	1	2	3	4	5
4 motivates me to try new things	1	2	3	4	5
5 makes me tired	1	2	3	4	5
6 makes me feel better when I'm in the group	1	2	3	4	5
7 makes me feel better between group sessions	1	2	3	4	5
8 improves my posture	1	2	3	4	5
9 makes me feel supported by others	1	2	3	4	5
10 helps my breathing	1	2	3	4	5

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
11 improved my enjoyment of music	1	2	3	4	5
12 helped my memory	1	2	3	4	5
13 improved my concentration	1	2	3	4	5
14 made me anxious	1	2	3	4	5
15 was fun	1	2	3	4	5
16 made it easy to for me to articulate different sounds	1	2	3	4	5
17 made it easier to speak louder	1	2	3	4	5
18 helped me speak for longer without needing to take a breath	1	2	3	4	5
19 helped me feel physically strong	1	2	3	4	5
20 helped my vocabulary in spoken conversation	1	2	3	4	5
21 improved my ability to control my body movements	1	2	3	4	5
22 was stressful	1	2	3	4	5
23 means that people ask me less often to repeat myself	1	2	3	4	5

In your own words tell me about your experience of the group activity:

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