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Comparing live to recorded music and stories using multiple psychoneuroendocrine and psychological measures

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Comparing live to recorded music and stories using multiple psychoneuroendocrine and psychological measures

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Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

i. incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution of higher education;

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Ronniet ORLANDO

Abstract

Listening to music brings health benefits, according to an expanding opus of empirical research. Studies to date cover a wide range of music interventions and outcome measures. Music has been applied to healthy participants, as well as clinical populations to target anxiety and pain. But little is known about whether live music is more effective than recorded music as an intervention for these common symptoms.

This exploratory study sought answers with the emerging science of saliva analysis, which focuses on biomarkers that indicate stress and immune function. In this case salivary cortisol, alpha-amylase, immunoglobulin-A, interleukin-1beta, and pH levels were measured. Saliva samples from 50 university students and 23 palliative care and surgical patients were compared before and after each participant listened to a live (ML), audiovisual (MAV) or audio recorded (MA) standardised program of classical music played on a solo violin, viola or cello. Live (SL) or audio (SA) story readings were added as interventions to control for psychosocial variables. Saliva's non-invasive, repeatable, objective psychoneuroendocrine (PNE) snapshots were supplemented with subjective visual analogue scales for anxiety (VASA) and pain (VASP), and self-report affect scales to rate liking, perceived and felt emotion, and absorption. Participants were also asked for a one-word summary of their listening experience.

It was anticipated that ML would reduce anxiety and pain, as well as boost the immune markers, more than MAV and MA, and that music overall would demonstrate stronger benefits than the story readings.

No single outcome measure provided sufficient data to draw conclusions, but trends in the melange of both objective and subjective instruments revealed that overall more positive health indicators arose from live music than recorded music, particularly in the clinical settings. Stories were also shown to have some

moderating effects on pain and anxiety. This study demonstrated the therapeutic values of music as well as story readings, and the superior benefits of live music and stories compared to audio recordings of the same presentations.

The PNE methodology had some limitations, particularly with the clinical population, resulting in gaps in the patients' biomarker data. Some differential results highlighted the value of using a kaleidoscope of both objective and subjective outcome measures to gain a fuller understanding of the complex cognitive, emotional, neural, hormonal, and biopsychosocial processes involved in music's beneficial effects.

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It may take a village to raise a child, but it takes a world
— and coffee — to create a PhD!

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Abbreviations

A	audio
AA	alpha-amylase
Aβ	beta-amyloid
ACTH	adrenal corticotrophin hormone
AD	Alzheimer's disease
AV	audiovisual
ANS	autonomic nervous system
BP	blood pressure
bpm	beats per minute
Ca	cancer (carcinoma)
CI	confidence interval
cm	centimetre
CNS	central nervous system
CS	clinical significance
CV	cardiovascular
CVD	cardiovascular disease
dB	decibels
dL	decilitre
EEG	electroencephalogram
ES	effect size
H	hydrogen
HPA	hypothalamic-pituitary-adrenal
HR	heart rate
hrs	hours
HRV	heart rate variability
IgA	immunoglobulin-A
IL-1β	interleukin-1β
IL-6	interleukin-6
MA	music audio
MAV	music audiovisual
MCID	minimum clinically important difference
MCSD	minimum clinically significant difference
MEG	magnetoencephalogram

μg	microgram
MID	minimum important difference
min	minute(s)
ML	music live
nm	nanometre
μL	microlitre
mL	millilitre
mm	millimetre
MP3	audio coding format for digital audio recording
MRI	magnetic resonance imaging
MT	music therapy
N	number of participants (in study)
n	number of participants (in group)
NRS	numerical rating scale
PC	palliative care
PET	positron emission tomography
pg	picogram
PNE	psychoneuroendocrine
PNI	psychoneuroimmune
PNS	parasympathetic nervous system
QOL	quality of life
RR	respiration rate
SA	stories audio
sAA	salivary α-amylase
SAM	sympathetic adrenomedullary
sC	salivary cortisol
SD	standard deviation
SE	standard error
sec	seconds
SEM	strong experiences in music
sIgA	salivary immunoglobulin-A
sIL-1β	salivary interleukin-1β
SL	stories live
SNS	sympathetic nervous system
spH	salivary pH
STAI	State-Trait Anxiety Index

U/mL	units per millilitre
VAS	visual analogue scale
VASA	visual analogue scale-anxiety
VASP	visual analogue scale-pain

Dedication

Pain was greedy; it demanded all of her attention.

(Morrison, 1973, p. 141)

This thesis is dedicated to my mother, Henriette Spyer-van Leeven (1924-2002), who inspired me through her example, resilience, intellect, courage, wisdom, and love.

Prelude

‘What would you like me to play, mum?’

With no music to read from, I mined the catalogue of scores coded in my neurones, infused in my muscles. Playing *sotto voce* beside her bed, my violin spoke of love’s sorrow through Fritz Kreisler’s *Liebesleid*, gently whispered lyrical Telemann, traced the ordered architecture of Bach, and joyfully exploded with exuberant Vivaldi.

Mum’s tension melted with the notes. She quietly mused with her visitor, immersed in her meal now marinated in melodies. Her Parkinsonian mask made it hard to decipher her pleasure, but she clearly emanated a new aura of peace and dignity.

It was her last meal.

‘Immer schmerzen’, she moaned.

‘I don’t know what she is saying’, the nurse announced, looking hopefully to me for a translation. But I couldn’t help her. Not speaking in our native Dutch, she had reverted to German, the language of her grandmother.

The look on Dad’s face when he entered the room required no translating.

Immer schmerzen: always pain, always suffering.

When she finally let go, a few days later, mum was again at peace. Still the mask-like face, skin like tissue paper: echoing Kreisler’s sorrow, Telemann’s poetry, Bach’s dignity ... but no more Vivaldi’s joy.

Overture

'Every note is important,' she said, 'every sound says something. . . .
Every piece tells a story,' she concluded.

(Goldsworthy, 2011, p. 9)

Music is everywhere. We dance to it. We cry to it. It accompanies us on long car rides. Music is present in films, in gyms, in shops, on transport. It is central to ceremonies, rituals, and spiritual gatherings. Music infuses every aspect of human life. But mostly it is taken for granted, without listeners' conscious awareness of its presence and ubiquity, and its power to shape their moods and behaviours.

In Western cultures listeners prefer to engage with this art form live in the same space as the musicians (Brown & Krause, 2016; North, Hargreaves, & Hargreaves, 2004), but more commonly experience music in audiovisual formats on television, in film, or on a computer screen or hand-held device. The most consumed manifestation of music though is as audio sound, via earphones from a playback or digital streaming device, or broadcast in living and working spaces, as well as when encountered during leisure and incidental activities such as travel and shopping time.

The story shared in the Prelude tells how this study came to be. The profound personal experience led to my thinking about why live music appeared to settle my mother so quickly and effectively where recorded music previously had not. Obviously there were close relationship factors at play, but some of the recordings she listened to were of my live performances. There was something else going on and I needed to find out what it was.

So I launched into personally unchartered waters of biomedical sciences to try and unravel the mysteries of what occurs at the physiological level when people engage with music. Half a decade of delving into this fascinating field has culminated in the realisation that there is no single clear answer, but a better understanding of the processes has emerged.

Specifically, I was interested to discover if there were any physiological and psychological differences for listeners of live music compared to those exposed to recorded music, in both audiovisual (AV) and audio formats. The non-musical intervention of listening to stories would provide a control condition for the psychosocial factors inherent in any intervention involving a human element.

Differential results, both of the interventions and the outcome measures themselves, vindicated the decision to employ multiple physiological and psychological measures. Whilst overall there were benefits demonstrated of live music over recorded music, these were not clear cut. In addition, the choice of stories as a control for the music interventions delivered some unexpected positive responses to this alternative passive listening intervention.

A traditional thesis structure was chosen to tell the story of this research project. Chapter 1: *Thematic Exposition* reviews the literature on the history and development of music as a therapeutic tool; explores the difficulties of defining the word *music* and the resulting implications for researchers; explains the properties and characteristics of music; examines how music can be applied in different clinical settings to address anxiety and pain; and briefly discusses music for general health and wellbeing.

Chapter 2: *Bridge* outlines the conceptual framework for the project. This chapter examines anxiety and stress through the lenses of the rationalist and somatic biomedical model, the head and heart cognitive-emotional model, and the broader biopsychosocial model. The integrated psychoneuroendocrine (PNE) approach is then introduced and the reasons offered for applying this methodology to the study. The chapter concludes with a summary of the empirical evidence for the impact of music on health and wellness in general, and anxiety, pain and immune function in particular, as well as a consideration of what gaps exist in the literature. The two-fold aims of this exploratory research project are then announced: firstly to establish the possible difference between live music and recorded music in addressing anxiety and pain in a clinical setting; and secondly to test the feasibility and practicality of PNE methodology using saliva samples, initially on a student population and subsequently with patients.

Potential methodology is explored in Chapter 3: *Development,* which includes options for the study design, outcome measures, and data analysis. A

particular focus of this chapter is an extensive explanation of PNE processes and specific biomarkers. Possible subjective outcome measures are also introduced.

Chapter 4: *Two-part Invention* details the study design and methods chosen to collect and work with the data. The reader is informed about how the music and stories, presenters and participants, and objective and subjective outcome measures were selected; the processes of converting live presentations to AV and audio formats; protocols for the interventions and data gathering; collection, storage and laboratory preparation and assaying of saliva samples; and statistical and non-statistical data processing.

The results are presented and discussed in Chapter 5: *Recapitulation*. Differential results, both between interventions and across outcome measures, are outlined and considered. Reasons are offered for why live experiences were more likely to show clinically significant results for patients, why there were gaps in the biomarker data set for the clinical cohort, why the subjective data was more consistent than the biomarker results, and why stories emerged as an effective intervention for some participants.

The final Chapter 6: *Coda* offers some concluding thoughts on the implications of this research project, such as who might benefit most from music interventions, how to consider the needs of presenters in clinical settings, the importance of using a medley of outcome measures to gain a more rounded understanding of the complex PNE and psychosocial processes involved in music listening, as well as suggestions for future research. The study highlights the importance of a reconnection between the arts and sciences as a means of exploring this sometimes enigmatic field of investigation.

Chapter 1: THEMATIC EXPOSITION - A Review of the Literature

> *Music, uniquely among the arts, is both completely abstract and profoundly emotional. It has no power to represent anything particular or external, but it has the unique power to express inner states or feelings. Music can pierce the heart directly; it needs no mediation. One does not have to know anything about Dido and Aeneas to be moved by her lament to him; anyone who has ever lost someone knows what Dido is expressing. And there is, finally, a deep and mysterious paradox here, for while such music makes one experience pain and grief more intensely, it brings solace and consolation at the same time.*
>
> (Sacks, 2007, p. 300)

This literature review explores how music may be used therapeutically in both clinical and non-clinical settings. In order to understand music's potential benefits for health and wellness, it is important to define what we mean by music, and what characteristics form the building blocks of what we call music (Elliot & Silverman, 2012; Fancourt, Ockelford, & Belai, 2014).

The effects of how listeners engage with music, and whether it is live or recorded music, with or without lyrics, are also discussed. Specific applications of music for tackling pain and anxiety in palliative care and surgical settings are explored, including issues surrounding measurement of these constructs.

The final section of the review is a discussion of how research with non-clinical populations, such as tertiary students, may contribute to understanding the processes involved in the psychological and physiological benefits that are claimed to flow from engagement with music.

Music and the arts as therapeutic tools

I don't know anyone that can really explain music, what it does to the brain or what it does to the heart, but it does something that we need, everybody needs.

Bruce Springsteen (Rice, 2013)

The drive to creative expression and communication is central to what defines us as humans. This evolutionary gift has been woven into the complex tapestry of human existence, across all cultures, from the time of our earliest ancestors (Mithen, 2005). Many living things, large and small, make musical sounds. But humans are unique in their need to create infinite sounds and patterns, both with and without the technology of musical instruments (Williamson, 2014). Whilst some cultures lack writing, or even visual arts, music is ubiquitous. It appears to be present in one form or another in all societies (Ball, 2010). Throughout human history, and across all cultures, music has been important for comfort, imagination, social cohesion, and enriching lives (Metzner, 2012).

Music in history

The therapeutic benefits of music were recognised by the Hellenic Greeks, who formulated specific music treatments for mental and physical illnesses (Kreutz, Bongard, Rohrmann, Hodapp, & Grebe, 2004). Music was integrated into their social fabric: their ceremonies, celebrations, rituals, exercise, work, education and healing (Elliot & Silverman, 2012). This is still the case today in some cultures, where song and dance are inextricably linked, to the extent that in some languages they share the same word (Levitin, 2006). Central to the social cohesion and wellbeing of these communities, music and dance are natural daily activities for all members, rather than being the exclusive domain of specialist practitioners. Differentiation between music makers and listeners is not a worldwide phenomenon, but more a product of the Western approach to specialisation (Ball, 2010). Such compartmentalisation has also occurred in other discrete areas of knowledge and creativity.

Arts and science

In past eras arts and science were integrated, with the same individuals contributing to both domains (Chémali, 2010). Pythagoras, Socrates and Plato were all associated with both music and mathematics in the 5th and 6th centuries BCE. Much later, at the turn of the 6th century CE, Roman philosopher Boethius still placed music in the domain of mathematics, giving it the same relevance as arithmetic, geometry and astronomy (Heller-Roazen, 2011). During the Renaissance, Leonardo da Vinci was a prolific inventor as well as artist. The 19th century composers Berlioz, Borodin, and Saint-Saens were respectively a physician, chemist and amateur astronomer. The more recent trend to overspecialisation has cleaved the arts and sciences into separate, largely non-collaborating disciplines (Chémali, 2010). Although many practitioners may slot into more than one such category, their roles are still discrete. Whilst science cannot explain all the processes associated with interacting with the arts, there is a growing drive amongst researchers to explore what happens when humans engage with creative works, especially music (Chémali, 2010).

Engagement with the creative arts

> *Art is the thing that allows all of us to join the highest achievements of the human imagination. [It] restores the soul, uplifts the spirit, inspires us to share what we love, and continues to remind us how lucky we are to be illuminated by that light.*
>
> (Robertson, 2016)

Evidence suggests that observing the creative efforts of others can enhance mood, impact positively on physiology (Stuckey & Nobel, 2010), and can even lead to better health and survival rates in the broader population. A Swedish longitudinal study of over 9000 adults aged 25 to 74 years found that frequent attendees of cinema, theatre, art galleries, live music performances and museums were around three times less likely to die of cancer in the 12 year follow-up period than rare and moderate attendees (Bygren et al., 2009). The same research group had earlier reported a positive link between attending cultural events and self-reported health status (Johansson, Konlaan, & Bygren, 2001).

.

A recent study, assessing subjective wellbeing of 702 Western Australian adults, asked participants via telephone survey about the amount of time they were engaged in the arts over the previous twelve months (Davies et al., 2016). After adjusting for demographics, socioeconomic factors, education, recreational and religious activities, the authors reported those with high levels of arts engagement, of at least 100 hours per year, had significantly better mental wellbeing than those with zero hours per year. They concluded that a minimum annual threshold of 100 hours was necessary to trigger mental health benefits.

Although this last study adjusted for possible confounds, neither investigation directly compared arts engagement with other recreational activities, such as sports event attendance or visiting the zoo. Factors such as social engagement with others, or being away from the home environment and its more sedentary domestic activities such as watching television, may have contributed to the health benefits, rather than factors purely specific to the creative arts events that the participants attended.

Of all the arts, music in particular has been shown to influence the health and happiness of its listeners. A cross-cultural study of 895 British and Pakistani students demonstrated a significant positive relationship between their interests in music, the time they spent listening to music, and standardised measures of health and happiness (Rana, Akhtar, & North, 2011). Engagement with the arts is driven by a need for meaning and relevance in daily life (Stuckey & Nobel, 2010). Such existential issues are fundamental to our mental, social, and physical wellbeing.

Creative works may also serve as potent distractions and means of escape from the harsh realities of life, as was seen with the popularity of movie theatres during the Great Depression of the 1930s. In today's Western societies, music is applied widely as a self-help technology, both consciously and instinctively (Ruud, 2013). Music is also used therapeutically to help others achieve better health and wellness outcomes.

Music therapy and music in medicine

What an eager assembly! What an empire is this!
The weary have life, and the hungry have bliss;
The mourner is cheered, and the anxious have rest;
And the guilt-burthened soul is no longer opprest.

William Wordsworth, 1807 (Stillinger, 1965)

The capacity for music to influence both affective and physiological parameters is well documented in the research literature. Pioneering nurse Florence Nightingale used soothing live music in the pre-phonograph days of the mid 1800s to create a healing environment for her military patients (Nilsson, 2008). Today the nursing profession continues to contribute to a growing body of research in this area, indicating an ongoing desire to assist patients to achieve better outcomes through the addition of non-medical interventions. And those early seeds sown by Florence Nightingale have spawned the specialist profession of music therapy (MT).

Music therapy

Modern MT arose from post-war experiences of using music in the rehabilitation of traumatised soldiers (Olofsson & Fossum, 2009). Recognised for over 70 years (Mazer, 2010), MT has developed into a valued and respected empirically-based profession with highly educated practitioners (Daykin, Bunt, & McClean, 2006). Music therapists work in a wide variety of clinical settings, using live as well as recorded music listening, and active music making. As examples, specifically selected music interventions can allow expression of previously withheld feelings and thoughts in cancer patients, enhance immune response, facilitate speech and gait rehabilitation, and reduce anxiety in surgical patients (Petterson, 2001). The focus of MT is the therapeutic relationship built between therapist and client, with music being the means to facilitate this relationship.

There is a growing interest in MT programs from patients as well as health administrators, but access to such services is still very limited due to a shortage of practitioners (Curtis, 2011). Such interest in musical services highlights the perceived need to introduce more culture into medical environments (MacDonald et al., 2012). The vast majority of patients and families in a recent

survey believed strongly that music in the hospital enhanced their quality of life (QOL). Yet music is applied therapeutically in less than 10% of United States medical institutions (Chémali, 2010).

Music in medicine

Innovative programs do exist in some hospitals where visual arts, live musicians, and book and poetry readings are incorporated into patient care (Rockwood Lane, 2006). In such programs, arts media become the therapeutic foci, with artists and musicians being the conduits. In particular, bedside music programs are gaining increasing popularity and respect (Richards, Johnson, Sparks, & Emerson, 2007). These are generally termed music in medicine to differentiate them from MT. For example, the charity *Music in Hospitals* has been providing high quality live music in many clinical settings in the United Kingdom since 1948, with a holistic approach to illness helping to humanise these otherwise sterile environments (Trythall, 2006).

A review of hospital music programs highlighted positive outcomes, such as decreased drug consumption and length of hospital stay, positive physiological and psychological changes in clinical outcomes, and improved job satisfaction and doctor-patient relationships (Trythall, 2006). Music can bring positive benefits to patients directly, as well as indirectly through modifying the behaviour of staff caring for them (Kemper & Danhauer, 2005).

Music in clinical settings can be used, without predetermined therapeutic goals, for distraction, or for social benefits. Or its application may target specific needs of individual patients, carers and staff (Preti & Welch, 2004). Music can also contribute to healthcare by enhancing the clinical environment, thereby impacting positively on patient outcomes (Staricoff & Clift, 2011). However, there is still not enough quality systematic research to confirm the how and why of beneficial psychological and physiological effects of music (Koelsch & Stegemann, 2012). Before this issue can be addressed though, it is important to clarify what is meant by the word *music*.

What is music?

It is the most remarkable blend of art and science, logic and emotion, physics and psychology, known to us.

(Ball, 2010, p. 2)

Hundreds of journal articles and other empirical papers have been reviewed for this dissertation, with no complete definitions of music being offered. Susanne Metzner (2012, p. 163) describes music, rather than defines it, as "a sound object, which is created by humans". Lu (2003) is one of the few to make an attempt to operationalise the construct of music. She sees it as "an orderly arrangement of sound consisting of melody, harmony, rhythm, tone, and pitch [that] has a personal and intimate meaning for each individual" (p. 65). There is an assumption from most writers that their readers know what music is. But it can mean so many different things. For some researchers, music means song, for others it is instrumental music. Or it could be created digitally, or improvised live. Ethnomusicologists have taught us how culturally diverse musical expression can be (Cross, 2009), further confusing what the construct of music actually means.

Even most books on the subject fail to define music, or evade this challenging task. Defining music is difficult as it encompasses so many various expressions, both culturally and historically. Including all these facets into a meaningful and workable definition is not feasible, according to Philip Ball (2010). Bernie Krause started with the simple statement of music being "nonlinguistic and conscious *control of sound*" (Krause, 2012, p. 110). But he realised that this failed to encapsulate two important factors: structure and intent. Daniel Levitin (2006, p. 14) quotes the 20th century composer Edgard Varèse, who described music simply as "organised sound". This definition does allude to the factors that Krause felt were missing from his.

A Westernised perspective

In the introduction to his treatise on the philosophy of music, Lewis Rowell (1984, p. 1) deliberately avoids the "dangerous task of defining music", choosing to allow the topic to have as wide a domain as possible without the confines of a

Western-centric definition. He prefers to "for now let music signify anything that is normally called music." Ian Cross offers a specific contemporary Western definition of music: "a consumable commodity constituted of complexly patterned sound that is produced by a class of specialists and engaged with through listening for primarily hedonic reasons" (Cross, 2009, p. 6). Others describe music by its functions, as for example, "a universal, human, dynamic, multi-purpose sound signalling system" (Williamson, 2014, p. 4).

A more functional perspective

. . . what people mean by 'music' is always pluralistic, even fluid and contradictory, as dictated by the situated circumstances of its use.

(Elliot & Silverman, 2012, p. 26)

Philip Ball describes music by its qualities and origins: "complex mixtures of acoustic frequencies and amplitudes" and "an inevitable product of human intelligence" (Ball, 2010, pp. 2 & 5). This perception of "sonic order", as Blacking (1976, p. 11) points out, is a human construct. Sounds are processed in the mind, through innate and/or learned pathways, before they become music. Finding a rational, minimal definition is hampered by this human aspect to music, which compounds its complexity, making the construct neither clear nor invariable (Metzner, 2012).

Elliot and Silverman (2012) propose that it is these personal, social and cultural functions of sounds that make them music, rather than any of their sonic characteristics. As Murray and Lamont (2012, p. 76) claim, "music is an inherently social act". It is, ultimately, a "gift of civilized life" (Bernatzky, Presch, Anderson, & Panksepp, 2011, p. 1990).

Multimodal complexities

Many writers agree that music has a universal potential to influence our thoughts and emotions, behaviours and identities (e.g., MacDonald et al., 2012). Musical engagement is a multi-modal experience, drawing on emotional, cognitive, and sensorimotor modalities. Whether making music or enjoying the music making of others, any form of musical activity involves listening,

watching, feeling, moving, co-ordinating, remembering and anticipating (Altenmüller & Schlaug, 2012).

Listening to music is the most widespread of musical activities, being also inherent in active music making and dancing (Kreutz, Quiroga Murcia, & Bongard, 2012). When we hear music, it is not just with our ears. Music perception results from resonance of the entire body (Cousto, 2000). This is clearly demonstrated by Scottish percussionist Evelyn Glennie. Almost completely deaf since the age of twelve, she uses her whole body as a resonating chamber. She feels the music through her bare feet, as well as hands, arms, cheekbones, scalp, abdomen, chest, legs, and so on (Glennie, 2003). Considering the way the entire body can feel music, and the range of other modalities involved, music listening can be as engaging as music performance (Murray & Lamont, 2012). For the purpose of this thesis, the application of music refers to music listening, unless otherwise specified.

Meaningful, structured and patterned sound

Music is a rich and complex medium, made up of many characteristics. It cannot, and should not, be studied as a generic concept. Rather, all its components need to be examined and understood individually (Chémali, 2010) before music can be explored as a whole. It is then that we can examine how music, as meaningful, structured and patterned sound, affects us in specific as well as in holistic ways.

Characteristics of music

> *The tendencies and practices in music are only observed and catalogued upon analysis, after the fact. It is the hearts and minds of human beings that shape and weave melodies, harmonies, and rhythms together into meaningful tapestries, imbued with the interior landscapes of their immediate experiences.*
>
> (Martineau, 2008, p. 1)

Music has four main properties: pitch (vibration frequency), timing (rhythm and speed), amplitude (volume, or in musical terms, dynamics), and timbre (quality of sound, or tonal colour). Structure of music is evident when there is order, rather than randomness, in sequencing of one or more of these musical properties. To add to its complexity, music is ephemeral: it is in constant flux, creating fluid sound architecture in the dimension of time rather than space. Like colour, sounds are experienced due to our ability to differentiate between varying wavelengths and frequencies (Cousto, 2000). It is a function of our brain to shape meaning out of the chaos created by a stream of soundwaves hitting our auditory system when we listen to music (Levitin, 2009). This enables us to perceive the elements of music as melody, harmony and rhythm (Martineau, 2008).

Musical structure

> *She was standing in front of the piano. Without looking down she lowered her hands and started to play, just chording sounds, reducing melody to a skeleton. She paused after each set of notes as if bringing her hands out of water to see what she had caught, then continued, placing down the main bones of the tune.*
>
> (Ondaatje, 1992, p. 67)

As an architectural structure, music is made up of vertical features and horizontal features. Vertical structures, like columns in a cathedral, are defined mainly by temporal factors such as beat and rhythm. Harmony, which is the relationships between different pitches and combinations of these tones, also contributes to the sense of vertical structure. Horizontal structure, creating the arches and other horizontal features of our metaphorical cathedral, emanates from the melodic line as well as harmonic sequences. Rhythmic elements

further contribute to the sense of horizontal lines through their impact on the forward movement of the music. Each of these building blocks contributes in distinct ways to our perception of music. These features also play important roles in distinguishing between different genres of music.

Rhythm and tempo

And the rhythm of life is a powerful beat,
Puts a tingle in your fingers and a tingle in your feet,
Rhythm in your bedroom,
Rhythm in the street,
Yes, the rhythm of life is a powerful beat.

(Fields, 1966)

The main temporal elements of music are the beat, or pulse, overlayed by the rhythm. The beat tends to be embedded and stable, although the speed, or tempo, and even the groupings of this pulse may change. Rhythm creates forward movement in subdivisions or multiples of the beat.

Rhythm and relaxation

The anxiolytic or relaxing effect of music appears to be due mainly to its rhythmic aspects (Nilsson, 2008; Spintge, Short, Larkins, & Bebbington, 1999). Research has shown that a steady beat is analogous to the biological pulse, and may serve as a meditative focus point. The most relaxing tempo is that which mimics the resting heart rate of 60 to 80 beats per minute (bbm; Bringman, Giesecke, Thörne, & Bringman, 2009). Two minutes of a live subcontra C bass tone bar played steadily at 66 bpm was found to be more effective than silence in reducing self-reported anxiety levels following experimentally induced state anxiety (Gadberry, 2011). The experimenter was out of sight of the participants whilst playing the tone bar, removing visual cues as possible factors in the outcomes.

An investigation, into the cardiovascular (CV) and other physiological changes induced by music, found that a music-induced arousal effect mainly related to faster tempi, with slow or meditative music inducing a relaxation effect. The researchers noted that trained musicians were more sensitive to tempo than non-musicians as they were able to synchronise their breathing with musical phrasing. Interestingly, relaxation was particularly evident during

two-minute pauses that occurred between the four-minute music selections (Bernardi, Porta, & Sleight, 2006).

Dynamics and the sounds of silence

The notes I handle no better than many pianists.
But the pauses in between the notes –
ah, that is where the art resides!

Arthur Schnabel

Bernardi and her colleagues explain the consequence of gaps between musical pieces by suggesting that the arousal effect stimulated by music is turned off when the music stops, resulting in the observed relaxation effect during the hiatus between pieces (Bernardi et al., 2006). An alternate explanation has been offered on the basis of entrainment. As a principal of physics, entrainment refers to how two objects vibrating at similar frequencies develop mutually sympathetic resonances, eventually vibrating at the same frequency (Yehuda, 2011). Similarly, heart rate (HR) and breathing may synchronise with the beat of the music, resulting in a relaxation or an arousal effect, depending on the speed of the beat. Larsen and Galletly (2006) suggest that the biological oscillators of respiration and HR are driven at an increased frequency by the music, but are not driven by anything external during the pauses, hence resulting in a decrease to their intrinsic frequency. During the period of silence, this decrease in intrinsic frequency is observed as a relaxation effect.

Dynamics and arousal

Level of arousal can also be influenced by other factors, such as dynamics. Dynamics refers to the level of volume in music, and how this is controlled by the musician to emphasise melodic lines, rhythmic patterns, harmonic changes, and so forth. Dynamics can range from silence through to deafening levels of volume, as in a large symphony orchestra playing at full *fortissimo*, or a heavily amplified rock band. Some listeners are attracted to this very loud and arousing music. It has been associated with sensation seeking, high levels of resting arousal, extroversion, and impulsiveness (Lamont & Greasley, 2009). Others prefer softer acoustic music. Dynamics are linked with specific emotional expression. Loud music tends to be associated with high activation, power,

excitement, tension, anger, and also joy. In contrast, soft music is linked more with low activation, submissiveness, softness, peace, tenderness, sadness, and fear (Gabrielssohn, 2009).

It is not hard to understand that loud sounds such as thunder, shouting, or alarms may alert us to danger, and therefore arouse the autonomic nervous system (ANS). In contrast, soft sounds are associated with soothing whispers, lullabies, and gentle breezes, and so pose no immediate threat. Relaxation is thereby facilitated through these non-threatening sounds. Soft music of 60–70 decibels (dB) was recommended as most effective in a study looking specifically at musical amplitude and relaxation (Staum & Brotons, 2000). Closely linked to the loudness of a musical sound is its quality: whether it is pleasant or harsh, dissonant or harmonic.

Timbre, pitch and harmony

Now I've heard there was a secret chord
That David played, and it pleased the Lord
But you don't really care for music, do you?
It goes like this
The fourth, the fifth
The minor fall, the major lift
The baffled king composing Hallelujah

(Cohen, 1984)

Consonance and dissonance

Melody and harmony are constructed from horizontal and vertical combinations of tones of discrete pitches. A series of tones sounded over time creates a melody, which has a distinct contour. A narrow pitch range results in a topography that is flatter than when there is more distance between the high and low pitches. When two or more tones are sounded simultaneously, they create chords. Neighbouring notes, known as seconds, clash as their sound waves hit each other, creating dissonant harmonies. Other intervals, such as thirds, fourths, fifths and octaves, create pleasant harmonies when sounded together. The harmonic structure of a piece depends on the swing between dissonant and consonant sounds, creating a sense of tension and release. As Leibniz explained in 1712, there are pleasures to be derived from consonance

and displeasure from dissonance; but dissonances can be pleasing, coming between the episodes of consonance, creating light and shade (Heller-Roazen, 2011).

Timbre

Tonal colour, or timbre, is what distinguishes one instrument from another (Samson, 2003), and even one voice from another. Overtones, or harmonics, of instruments are partly responsible for their distinct timbres, which vary according to their size and the materials of which they are constructed (Levitin, 2006). The pitch range in which an instrument sits also plays a part. So, a violin will sound distinctly different from its larger cousin, the cello. The violin, with its higher range in the treble clef, produces less audible overtones than the lower range of the cello. These overtones, or partials, contribute to the richness of the cello sound compared to the thinner sound of notes on a violin. Some instruments, such as untuned percussion (e.g., cymbals or bass drum), lack a clear sense of pitch due to the large number of overtones produced when struck (Levitin, 2006).

Overtones

Overtones resonate with the fundamental tone as whole-number multiples of its basic frequency (Cousto, 2000), creating, in effect, a one-note chord (Ball, 2010). Clarity of a tonal centre reduces when intervals such as minor thirds and seconds in the higher overtones clash with the other partials. This creates a dissonant effect similar to gently pressing a fist or flat hand on the piano keys, striking neighbouring notes rather than just the selected notes of a chord. The soundwaves produced by these tones clash with each other, creating a beating effect. Consonance occurs between tones when the soundwaves they produce do not clash with each other, but instead blend as they lock in to each others' frequencies.

Aversive, unpleasant sounds are typically of high amplitude, and produce high frequency harmonics (Zald & Pardo, 2002). Overtones produced by lower tones tend not to be as unpleasant, and can even be used for their meditative effect. For example, some Buddhist monks use a technique of multiphonic throat singing, with an individual chanter producing multiple tones.

Modern digital recordings tend to eliminate some of the overtones through a process of noise reduction as a means of producing a purer hi-fidelity sound. Most recordings are not true replications of a single performance but are constructed and manipulated from multiple takes, much like editing of a film scene, to achieve the recording engineer's ideal of how the piece should sound (Wallach, 2003).

Timbre and emotions

Timbre has been shown to be a vital factor, independently affecting the perception of musical emotions even after controlling for other variables such as acoustic, cognitive and performance factors (Hailstone et al., 2009). However, the tonal quality, and its contribution to whether music is pleasant or not, is only one factor in determining musical preferences.

Musical genre and musical preferences

. . . virtually any act of musical composition, performance, listening, or understanding will engage some and ignore or repress others . . .

(Kramer, 2002, p. 2)

In our Western conception of music, participants are labelled as players, performers, listeners, teachers, creators, scholars, therapists, or academics. Although many who engage in and with music may fit more than one such category, these roles still tend to be discrete. Levitin (2006) tells us that Americans spend more money on music than on sex or prescription drugs. Such an investment highlights the important role music plays in Western society as entertainment, mood regulator, and social facilitator (Lonsdale & North, 2011). We can also surmise from this level of exposure that most listeners would develop a degree of expertise.

Listeners have expertise

Musically untrained listeners do indeed demonstrate sophisticated understanding of musical structure, performing similarly to their conservatorium student peers in a series of music perception experiments (Bigand, 2003). Music, like language, has a set of rules or grammar which allows

us to conceptualise and understand the form of a piece of music. This in turn facilitates musical expectations, as well as develops musical tastes and preferences (Levitin, 2006).

Musical taste

Despite musical expertise being widespread in listeners, preferential differences between musicians and non-musicians, as well as between genders, have been found in numerous studies. In one such study, tertiary music students and females were likely to prefer softer music for relaxation when compared to non-music students and males. Overall, participants overwhelmingly preferred soft music in comparison to medium or loud music for relaxation, as measured by self-report data collected using a continuous response digital interface (Staum & Brotons, 2000).

Personality contributes to musical taste, but other individual differences such as age, sex, and income are more salient factors in forming these tastes (North, 2010). In a study looking at music as a distraction from induced pain, older listeners aged over 35 years preferred classical music significantly more than did the younger participants (Raudenbush & Wright, 2010). More specifically, pleasant classical music, such as Bach's Brandenburg concertos, was found to increase tolerance to induced pain significantly more than unpleasant dissonant music, such as Ligetti's cello concerto, in non-musician participants (Silvestrini, Piguet, Cedraschi, & Zentner, 2011). The concept of pleasantness when applied to music is related to the affective dimensions of Russell's circumplex model (Ritossa & Rickard, 2004; Russell, 1980), and is a term widely used in music psychology research. There is also some general agreement that highly dissonant music is considered to be unpleasant (Zatorre, 2003).

Preference and familiarity

Musical preference can be viewed parsimoniously as a purely cognitive process, based on familiarity or exposure. Differences between young listeners based on sex may also be explained thus, as young females tend to listen to more music than their male peers (Schubert, Hargreaves, & North, 2014). Most people tend to be conservative, preferring what they already know, so familiar tunes may be comforting, as well as triggering familiar memories and enjoyment (Staricoff, 2004).

Genre and emotions

Musical genre, rather than personal preference, appears to be the prime factor affecting emotional response to music (Lu, 2003). Lu's review concluded there was no difference between participants' own choice and experimenter selected music in improving immune function, as measured by salivary immunoglobulin-A (sIgA). Similar conclusions were drawn in an earlier study which looked at both subjective ratings and objective physiological responses to excitatory and sedative symphonic movements (Iwanaga & Moroki, 1999). Continuous measurements of physiological responses of heart rate (HR), respiration rate (RR), and blood pressure (BP) were greater during excitatory music compared to sedative music. There was no effect of music preference on these objective parameters for the 47 undergraduate student participants, although their favourite music, regardless of type, did lower subjective tension.

Volume, preference and relaxation

The relaxation response is affected by the amplitude, or volume, of music. In a within-subject design, young adults listened to 27 minutes of music whilst relaxing (Staum & Brotons, 2000). Each participant heard a randomised order of loud (80-90 dB), medium (70-80 dB) or soft music (60-70 dB) in three-minute blocks. Continuous measurements of HR and preference resulted in an overwhelming preference for soft compared to medium or loud music. In addition, males preferred loud music more than females did, and music majors preferred softer music more than their peers.

Familiarity, preference and relaxation

In a more recent study, the perceived degree of relaxation of 80 healthy adult listeners was correlated with both music preference and familiarity (Tan, Yowler, Super, & Fratianne, 2012). The 30 selections used were deemed by 14 music therapists as having the necessary properties to promote relaxation. Post hoc analysis of the selections found that they tended to have a tempo of around 60 bpm, with pitches ranging around C5 (an octave above middle C), no large dynamic changes, and simple harmonic and rhythmic structure. Ninety percent of the pieces had major keys, and 83.3% were purely instrumental, of which 40% were played on string instruments. Such homogeneity suggests there was

not enough variety in the thirty pieces to truly test participants' personal preferences.

Music selection and pleasantness

Some investigators have concluded that preferred music is a more effective analgesic than researcher selected music (e.g., Mitchell & MacDonald, 2006), and that it is also more effective for lowering BP (Gangrade, 2011). But pleasantness was found to be a more useful predictor of emotions expressed in music than was liking of the piece (Ritossa & Rickard, 2004).

Despite mixed findings of studies regarding preferred versus selected genres and their respective effects on listeners, the evidence points to the use of pleasant, non-dissonant classical music of a moderate tempo as being most effective in relieving anxiety and pain.

Song, lyrics, and the meaning of music

> *[Music] bypasses both language and the systems of rational thought that depend on language. If words are involved, the music takes precedence; it expresses . . . more than words can say.*
>
> (Kramer, 2002, p. 12)

Whilst the jury is still out on the role of music preference in psychological and physiological change, more consistent observations have been made regarding the confounding effects of lyrics in musical interventions. Music itself conveys universal emotional meanings, grounded in its form and structure, which listeners tend to agree upon (Kramer, 2002; Krumhansl, 2002). However, care must be taken not to oversimplify the semantics of music as it relies on specific interplays between musical experience and the context in which it occurs (Kramer, 2002).

Also, meaning focuses on logic, where emotional responses to music may have little in common with such rational analysis. Words of songs convey meaning and emotions more explicitly than the notes. The poetic contribution of lyrics may confound the emotional content of the music. Likewise, lyrics may distract from the musical content of the piece (Bringman et al., 2009).

Similarities between music and language

Words are tricky things, a friend of his had told him,
they're much more tricky than violins.

(Ondaatje, 1992, p. 39)

Both music and language are "sounds organized in time" (Lerdahl, 2001, p. 337). Musical structures have parallels in the phonological and prosodic structures of language. Lerdahl suggests that there are neurological commonalities between some aspects of music and language. He specifies that groupings, meter, duration, contour, and timbral similarity are neurologically shared by both domains, whilst linguistic syntax and semantics, and musical pitch relations, have discrete neurological maps (Lerdahl, 2001). This view does indicate that some elements of language, such as prosody, may be perceived as having musical attributes. Therefore, adding lyrics to a music intervention may result in measuring the effects of the language component of the songs in addition to their melodies and rhythms.

Lyrics versus melody

Prima la musica et poi la parola
(First the music and then the word)

Opera by Antonio Salieri, 1786

When we listen to songs, are the lyrics or the melody more salient? That apparently depends on the nature of the emotions being expressed by the melody and lyrics. Ali and Peynircioğlu (2006) came to this conclusion after asking participants to rate musical excerpts where lyrics and melodies with low familiarity were deliberately mismatched on the basis of their affect. The four categories of emotion were adapted from the four quadrants of Russell's circumplex model (Russell, 1980). The interaction between arousal and likeability generated angry, sad, happy, and calm labels. Emotions of the melodies were found to dominate over the emotions conveyed by the lyrics. Both congruent and mismatched lyrics detracted from emotional responses to music with positive valence (happy or calm), but enhanced the responses to negatively valenced music (sad or angry).

Whilst these findings may be relevant for unfamiliar music, memories elicited by familiar songs could result in different outcomes. The salience of

melody versus lyrics can perhaps also be affected by the listener's level of musical training. Whatever the specific processes may be, it is clear that the addition of lyrics to music interventions is a potential confound.

Studies using song

Many MT studies use live voice and guitar as their interventions, often featuring participants' preferred songs (e.g., Ferrer, 2007; Magill Bailey, 1983; Segall, 2007). Live music, consisting of 20 minutes of preferred songs accompanied by guitar, was found to significantly improve measures of anxiety, fear, fatigue, relaxation, and diastolic BP for patients undergoing chemotherapy treatment (Ferrer, 2007). The control group received standard chemotherapy treatment without any other intervention, so it is not clear if it was the music, lyrics, or presence of and attention from the music therapist that contributed to these positive outcomes. Participants were also encouraged to sing along, so their active participation further confounded the study.

Recorded music interventions have similarly been clouded by the inclusion of lyrics with the music. Selections have been made based on personal preference, or genre, or timbre, or tempo, but the issue of instrumental music versus song with lyrics has not received the consideration that it should (Gangrade, 2011). Many studies have used music selected by the participants, which may or may not contain lyrics, and could be from any genre and degree of stimulation. It is difficult to glean from such studies the specific elements of music that have an effect on participants. All that can be assumed is that they liked the music that they chose, but not on what basis.

Aesthetics, music and noise

The cognition of music through thought and ideas is an appreciation of organization, whereas the perception or sensation of music is an appreciation of the beauty and pleasure of music.

(Rosenfeld & Dun, 1999, p. 37)

Aesthetics

The term aesthetics has evolved to mean the perception of beauty and the sublime. Inherent in the term is a sense of rational order (Heller-Roazen, 2011). The concept of music as a fine art arose during the move towards rational thinking in the Age of Enlightenment of the 18th century. Music was valued for

its intrinsic beauty or meaning, and for its ability to humanise and stimulate the intellect through the aesthetic experiences it provided. This art for art's sake attitude still persists today, with music conceptualised as existing apart from any possible extra-musical benefits it may have (Elliot & Silverman, 2012).

Noise

Long before our current period in history, music was recognised as producing both beneficial and potentially deleterious effects (Mazer, 2010). Both Confucius and Plato wrote that music could influence the individual and society at large, for better or worse. For some listeners music can become noise, described by Krause (2012, p. 65) as "unwanted and unrelated sound fragments". Krause goes on to categorise noise as "an acoustic event that clashes with expectation" (p. 158), and so, it becomes unwanted, interfering, distracting, or irritating (Hendy, 2013). Perhaps the sounds are out of context with the environment of the listener; or too loud; or even too soft, so that they become an irritation in the background of auditory perception.

Noise is inherent in music (Rothenberg, 2013). Tension is created through clashing harmonies, unexpected changes in dynamics, bending intonation of notes to make them slightly out of tune, harsh unpleasant timbres, excessive volume, persistent driving rhythms, and so forth. Some of these attributes have attracted the attention of individuals and institutions that have exerted their power by controlling the listening options of the populace.

Music for good or evil

Throughout history there are incidences of the banning of particular music. Plato proposed that the Lydian and some other modes should be avoided as they precipitated drunk and idle behaviours, whilst certain rhythms made people mean, promiscuous or deranged (Elliot & Silverman, 2012). In the eleventh century, the tri-tone, or diminished 5th, was avoided as it was regarded as the *diabolus in musica* (devil in music) for its dissonant qualities (Grout & Palisca, 2001). Music was not lawful in Afghanistan for two decades up to 2003 during the reign of the Taliban (Mazer, 2010). The political power of music was further highlighted by the banning of Western music in Iran earlier this century (Mazer, 2010).

Whilst such edicts have been imposed from above, music can also be disturbing to the individual if it is inappropriate to the person or to their experience, or musical tastes, or the setting in which music is being heard. In these situations, music becomes noise (Mazer, 2010).

Music is everywhere

So the issue is not whether we are engaging with music; in fact, we are gorging on it.

(Williamson, 2014, p. 4)

The ubiquitous nature of music is a double-edged sword. Music is pervasive, being constantly present in our environment. If we are focusing on other activities, we try and block out unwanted intrusive auditory stimuli. Unlike visual stimuli, which can be avoided by averting or closing the eyes, the ears cannot be shut off (Macken, Phelps, & Jones, 2009). Auditory screening requires cognitive effort and may contribute to stress levels, especially if the unwanted sounds are present for a protracted period (Kirschbaum & Hellhammer, 1999).

Chronic exposure to workplace environmental noise, which may include music, has been shown to affect the hypothalamic-pituitary-adrenal (HPA) axis, as indicated through increased salivary cortisol (sC) levels, or moderation of the normal circadian decline of sC levels in the afternoon (Kirschbaum & Hellhammer, 1999).

Noise and stress

Without doubt, there is emotional information in almost any kind of sound received by humans every day . . .

(Weninger, Eyben, Schuller, Mortillaro, & Scherer, 2013, p. 1)

Noise, as an environmental stressor, is a known health risk for workers as well as the general population (Zheng & Ariizumi, 2007). Chronic noise exposure may damage hearing, and cause sleep disturbances and stress-related CV symptoms. A neuroimaging investigation of eight healthy participants uncovered some of the reasons for these negative outcomes (Zald & Pardo, 2002). Compared to white noise, aversive sounds precipitated significant activations of the amygdala, which also plays a role in fear responses (Koelsch & Stegemann, 2012). Noise can also suppress immune function, resulting in less resistance to infections (Zheng & Ariizumi, 2007).

Noise pollution is a common problem in hospital environments (Cabrera & Lee, 2000). Medical and office equipment, staff and visitors' movements and conversations, patients' televisions, alarms and beepers, telephones, and even lifts opening and closing, can all contribute to a cacophony of sounds that patients need to deal with when they are supposed to be resting and recuperating. These sounds are mostly foreign to the patients and cannot be controlled by them (Mazer, 2010). Although music itself can become another layer of this tapestry of noise, purposeful live music has been used in hospitals to mask and distract from such auditory intrusions.

Live music as an antidote for hospital noise

A pilot study introduced live music, played solo or as a duet on violin, keyboard and/or guitar, into waiting rooms and treatment areas of a hospital cancer centre and outpatient infusion facility (Canga, Hahm, Lucido, & Loewy, 2012). A range of genres, including familiar tunes, as well as improvised music, was played during the 30-minute sessions. Surveys of patients, staff and carers found that the most popular genre was classical, followed by easy listening. Positive effects on stress levels were reported, as well as reduced perception of noise. The study demonstrated an appropriate and beneficial application of live music in a clinical environment. Few studies, though, have looked at the specific effects of live presentation of music — where both listener and musician are present — compared to recorded music.

Modes of presentation: live versus recorded music

. . . it can be concluded that it is relatively simple to delude the ear by manipulating what is perceived by the eye, even for a relatively complex musical judgement task.

(Behne & Wöllner, 2011, p. 334)

Engaging with live music is more than just a listening process: it involves visual cues as well as social, emotional, and other effects of the physical presence of the musician (Magill Bailey, 1983). In a variety of clinical contexts, visual and audiovisual interventions have demonstrated the ability to distract the individual from pain and anxiety. A simple visual distraction, using a kaleidoscope, was effective in lowering pain perception in adults during

phlebotomy (Cason & Grissom, 1997). Audiovisual distraction using a television was found to be more effective than audio distraction through headphones in managing anxiety in paediatric dental patients (Marwah, Prabhakar, & Raju, 2007). The multisensory nature of live music provides both audio and visual aspects to draw attention into the experience and away from somatic and psychological symptoms.

Music, movement and expression

That tall Man, a giant in bulk and in height,
Not an inch of his body is free from delight;
Can he keep himself still, if he would? oh, not he!
The music stirs in him like wind through a tree.

William Wordsworth, 1807 (Stillinger, 1965)

Music cannot exist without movement (Levitin, 2009). Creating music requires the musician to interact physically with an instrument. Even the use of the human voice requires a singer to move. Listening to music in a purely auditory form, in isolation from the gestures inherent in its creation, is a relatively recent product of recording technology (Chapados & Levitin, 2008). Music stimulates movement in response to its temporal structures. And these temporal structures are also perceived visually when watching a musician play or sing. So, visual input provides important cues about auditory temporal structures (Levitin, 2009). Musicians also convey emotional content to the listener through body movements and facial expressions (Krahé, Hahn, & Whitney, 2015).

An experiment, comparing three modes of presentation, investigated the objective physiological expression of emotional response to musical performance by measuring electrodermal activity (Chapados & Levitin, 2008). Twelve musically trained females aged 20 to 25 years of age were randomly allocated to one of three short (75 to 80 sec) audiovisual (AV), audio only (AO) or visual only (VO) excerpts of a solo clarinet piece by Stravinsky. These excerpts were repeated ten times for each participant, with 30 sec intervals between each repetition. Electrodermal amplitude for the AV presentations was significantly higher than the sum of electrodermal responses to the AO and VO presentations. So AV response is more than the sum of its parts, indicating the role of a potent property created by this bimodal interaction, and highlighting the implications of seeing as well as hearing the musician.

In an original study from 1990 and its subsequent replication (Behne & Wöllner, 2011), videos of pianist actors were combined with the same soundtrack as that of the original performer. These were all presented to unsuspecting participants who were asked to rate them for performance dimensions such as confidence, precision, and expression. Even musically trained participants did not realise they were listening to the same performer and reported perceived differences between the AV performances. Gender differences between performers were also suggested, with male musical interpretations being perceived as more precise, whilst females were perceived as more dramatic. Physical attractiveness and appropriateness of dress could also affect listeners' evaluations (Behne & Wöllner, 2011).

In a recent similar study, the melody of two contrasting movements from a Beethoven Bagatelle titled "Lustig" (happy) and "Traurig" (sad), played on a B-flat clarinet, was videoed and edited to manipulate either a match or mismatch of the sound and vision of the differently valenced movements (Krahé et al., 2015). Student participants (N = 72) were randomly allocated to one of the four conditions: happy music with happy body movements, happy music with sad body movements, sad music with sad body movements, or sad music with happy body movements. They were asked to rate both perceived and felt emotions for the clip they were shown. Results demonstrated a significant interaction between the music and emotional content — body movements and facial expressions — of the performer. Incongruent visual information moderated the emotion ratings of participants. These findings confirm that both the auditory information conveyed by the music and the visual aspects of the performer's body movements culminate in the perceived and felt emotions of those watching AV, and by inference also live performances.

Salience of visual cues

The preceding studies illustrate how both auditory and visual outputs from the musician determine the emotional content for those listening, and watching. It also appears that visual stimuli are more salient than the audio stimuli and exert a moderating effect on what the listener is hearing. In their meta-analysis of 15 aggregated studies (N = 1298), Platz and Kopiez (2012) calculated the average effect size of the visual component in music performance, which included

evaluations such as liking, expressiveness or overall quality of the performances. They revealed a medium effect size of d = 0.51 *SD*, 95% *CI* (0.42, 0.59), again confirming how central visual cues are to the listeners' perception of music. However, visual factors alone are not enough to explain how live music may differ in its effects from recorded music.

Non-visual cues in live music

Live music therapy was shown to be more beneficial than recorded music in an Israeli study with preterm neonates (Arnon et al., 2006). These tiny infants were unlikely to be using visual cues when processing music. Yet the live music significantly reduced heart rate and improved behavioural parameters at the 30 minute interval after the therapy had ended, although it had no significant effect on these measures during the intervention. This delayed effect could be explained by the activating and arousing effects whilst the infants were exposed to the musical stimuli. Their intrinsic physiological levels were lowered, resulting in the relaxation response observed (see Larsen & Galletly, 2006). The recorded music group and no music control group showed no significant differences on any of the measures either during or after the 30 minute intervention (Arnon et al., 2006).

A seminal study, comparing live music and tape-recorded music with 50 hospitalised oncology patients, used live singing with guitar and recorded music of the same material (Magill Bailey, 1983). These were pre-recordings of the same songs and performer, not recordings of the actual live performances. The live music group reported significantly less tension-anxiety, more vigour and greater improvement in mood compared to the recorded music group after 25 minutes of music. The researcher concluded that human elements in live music were the key factors in the differing outcomes. Factors included body language, the human voice, and other subtle communications between the musician and patient. It could also be that the quality of the sound from the tape recordings was inferior to the live acoustic sound (Finnäs, 2001).

Multisensory interventions, such as live music, are more engaging than those drawing on single senses (Cason & Grissom, 1997). They tend to also be a more immediate, vivid and direct experience for the listener, with a heightened feeling of contact with the musician (Finnäs, 2001). In her review, Staricoff

(2004) concluded that live music has more significant benefits than recorded music in the clinical setting. It also tends to cast a wider net, including people other than the target patient.

Social and environmental benefits of live music

Bedside therapeutic music is being more widely implemented due to greater understanding of its benefits, and respect for its practitioners (Richards et al., 2007). Live music and its positive effects cannot be contained and limited to the individual person who is the focus of the musician. Other patients, as well as staff and visitors, also benefit from the presence of live music. Studies have indicated the positive benefits that staff members derive from music programs, helping to create less stressful work environments (Staricoff, 2004). In the neonate study cited earlier, it was noted that both staff and parents preferred the live over the recorded music (Arnon et al., 2006).

Live music certainly addresses the lack of aesthetic stimulation found in most hospital environments (O'Brien, 1999). Unfortunately, there has been little systematic research comparing live music with audiovisual and audio presentations, even in non-clinical settings (Finnäs, 2001). Similarly, little is known about the comparative effects of music interventions and non-music interventions which share many of the same aesthetic and performance attributes, such as readings of poetry or stories.

Clinical applications of music

. . . there is a clear need to bring more culture and humanity into medical systems . . .

(MacDonald, Kreutz, & Mitchell, 2012, p. 10)

Before exploring more specifics of therapeutic music interventions, there are some general issues to consider regarding the possible benefits music can bring to patients suffering pain and anxiety. In the following discussion, two areas of medical care are examined where these symptoms are common, namely palliative care and surgical settings. Not all music listening yields health benefits (Pothoulaki, MacDonald, & Flowers, 2012). However, there is a growing appreciation of the potential that music has, both as an adjuvant, or complementary therapy, and as a stand-alone intervention.

In her systematic review of 42 randomized controlled trials of music in surgical settings, Nilsson (2008) found music interventions helped reduce patients' pain and anxiety in approximately half of the studies. This does raise the question of why the remaining studies did not demonstrate such beneficial results. Nilsson did suggest various methodological issues that compromised some studies. These are discussed in a later chapter.

A non-systematic review of the literature from 2004 to 2011 identified 103 studies that showed strong evidence of psychological and physiological benefits for patients from music interventions (Staricoff & Clift, 2011). Positive outcomes included reduction in stress, anxiety, and depression, as well as reduced drug consumption and shorter hospital stays. Furthermore, measurable financial benefits can flow from these outcomes (Romo & Gifford, 2007).

Music as a low-risk intervention

Music is a safe kind of high.

(Jimi Hendrix)

Use of music in clinical settings is generally regarded as a low-risk treatment option when compared with pharmacological interventions (Gangrade, 2011). This is not to say that music is risk free. Possible harmful effects of music are its potential perception as noise, through excessive volume, disturbing others who

do not want to listen to it, or as unwanted background sounds. Although it usually encourages connection with others, music can be isolating, may reinforce negative thoughts, and even be a catalyst for antisocial behaviour (Ruud, 2013). It may also offend or alienate if culturally inappropriate (Clarke, 2005), or annoy or irritate if it does not match the musical taste of the listener. However, whilst the excess of some behaviours — such as eating, gambling and drug use — may lead to addiction in the user, excessive music listening is not generally associated with such detrimental outcomes (Rickard, 2014).

Contraindications for music

Few contraindications have been noted for the use of music, though it is best avoided where a person has active psychiatric symptoms or epilepsy (Spintge et al., 1999), or is receiving aggressive clinical treatments that result in high fevers or toxicity (O'Brien, 1999). Generally though, music is accepted as being a non-invasive, culturally diverse, easily accessed and safe intervention (Mitchell & MacDonald, 2006).

Music is ideally applied as part of a supportive multidisciplinary approach to improving patient outcomes (MacDonald et al., 1999). In this context, it is regarded as a low cost and safe non-invasive intervention which is readily available — especially in the recorded form — and easy to provide in the clinical context (Cepeda, Carr, Lau, & Alvarez, 2006; Finlay, 2013).

Music for the control of pain

Music, like pain, is a powerful multidimensional experience
with sensory, cognitive, behavioural and social elements.

(Gold & Clare, 2012, p. 546)

Pain is, like music, a difficult construct to define. The International Association for the Study of Pain defines it as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (Merskey & Bogduk, 1994). This dualistic medical-model definition arises from the clinician’s perspective. But pain cannot be seen or objectively observed by others (O'Brien & Kane, 2014). It is very personal and idiosyncratic, and should be defined more in terms of the individual’s experience. Quintner and his colleagues describe the lived experience of pain as

an *aporia*: a secret, private space which excludes the observer (Quintner, Cohen, Buchanan, Katz, & Williamson, 2008). Margo McCaffery's widely quoted 1968 definition, that "pain is whatever the experiencing person says it is, existing whenever he says it does" (Pasero & McCaffery, 2001, p. 73), acknowledges this personal subjective nature of pain.

Chronic pain

Chronic pain can be defined as pain experienced every day for three months of the past six months. It impacts on a large portion of the Australian population, being reported by 17.1% and 20.0% of males and females respectively in a telephone survey of 17,543 adult Australians (Blyth et al., 2001). As well as the obvious personal and wider social costs, the survey highlights the resulting financial costs to both the individual and community. Those reporting chronic pain were more likely to be on disability or unemployment benefits. They also reported high levels of psychological distress, poor self-rated health, and some degree of interference with daily activities caused by their pain (Blyth et al., 2001).

Chronic pain is persistent, not responding to standard treatments and routine methods of pain control such as non-narcotic analgesics (Merskey & Bogduk, 1994). This poses a big challenge to sufferers' health and wellbeing (Mitchell & MacDonald, 2012). Music may act on reducing chronic pain through diverting attention to aesthetic stimuli, thereby distracting from pain sensations and increasing pain tolerance. It may also reduce the stress response, so lessening the muscle tension which can exacerbate pain (Spintge et al., 1999).

Acute pain

Similar processes are at play when using music to deal with acute pain. From the dentist's chair, to the emergency department, to the operating theatre, to the delivery room, many patients experience pain or the fear of pain in clinical settings. Acute, or short-term, pain also contributes to negative clinical, psychosocial and economic outcomes. For example, post-operative pain impedes ambulation and recovery, as well as sometimes requiring opiates which can have detrimental side effects such as nausea, constipation, confusion and drowsiness (Richards et al., 2007).

Music can be a powerful analgesic for managing temporary pain. One article reported the case of a highly apprehensive 28 year old female facing dental treatment (Bhagania & Agnithotry, 2011). She chose Indian devotional music played through ear phones as an alternative to local nerve block anaesthesia for extraction of a badly decayed tooth. The patient reported no pain during the extraction, nor did she exhibit any overt signs of being in pain. However, music is not usually recommended as a first line treatment for pain as it cannot be relied upon to be as effective as in the case just described (Cepeda et al., 2006).

Pain models

Recent years have seen an increase in the search for a better understanding of pain and its processes (Mitchell & MacDonald, 2012). Biomedical models, which explain pain symptoms dualistically, as expressions of structural pathology, fail to explain the individual experience of pain, which may be at odds with a patient's clinical presentation (Quintner et al., 2008).

Developers of the gate control theory, Ronald Melzack and Patrick Wall, were pioneers in pain research in the 1960s. Their conceptual model includes brain processes that can select, filter, and modulate pain signals (Melzack, 1999). The theory's focus on central nervous system (CNS) mechanisms was a huge move away from the existing concepts of pain being explained by peripheral nervous system activities, opening up ideas about interactions between pain and other modalities (Devine, 2002; Melzack, 1999). The key premise is that simultaneously firing large diameter sensory nerve fibres can block impulses from smaller diameter pain fibres (Devine, 2002). The model therefore acknowledges the capacity for auditory stimuli to influence pain perception (Magill, 2001).

Melzack further developed his ideas into the neuromatrix theory, which explains the brain's role as well as other complex determinants of pain. Past pain experiences, current stress levels and emotional states, as well as cognitive and genetic factors, can all play roles in the person's current pain experience (Sand-Jecklin & Emerson, 2010). The neuromatrix theory helps understanding of phantom limb pain, as well as the role of stress and cortisol in chronic pain (Devine, 2002; Melzack, 1999).

Treatment of pain

Pain response results from both a sensory component, of how the pain feels, and an affective component, that is, how distressing the sensations are (Cason & Grissom, 1997). Severe pain can consume the sufferer's entire attention (Devine, 2002). Rather than focusing only on treating the underlying disease or injury, it has been proposed that pain should be tackled as a disease in its own right (Siddall & Cousins, 2004). But only the person experiencing pain can be treated, not the abstraction of the pain itself (O'Brien & Kane, 2014).

So an approach increasingly applied for treating persistent pain is to engage the whole person, harnessing the ability of the mind and body to adapt and change (Davies et al., 2011). A multi-faceted regime to manage pain and its symptoms is recommended. This combines pharmacological and non-pharmacological strategies with psychosocial approaches (O'Brien & Kane, 2014).

Despite more awareness of non-pharmacological pain relief options, their use is still rare, or at best sporadic, in contemporary medical practice (Bernatzky et al., 2011; Zaza, Sellick, Willan, Reyno, & Browman, 1999). This is in part due to the medicalised healthcare environment in which pain is treated, compounded by a shortage of specialist practitioners and a lack of quality research (Hogan, 1999).

Distraction to target pain

A comparative study demonstrated that an auditory attention task was as effective as pleasant music in reducing induced pain in a laboratory experiment (Silvestrini et al., 2011). The attention task required verbal responses from the participants, so was not a true comparison to the passive music listening intervention. However, it does illustrate one of the ways music provides analgesic effects, namely through distraction from the pain sensation (Krout, 2007).

Electronic gaming was found to be another effective distraction for experimentally-induced pain (Jameson, Trevena, & Swain, 2011). However, being an active rather than passive intervention, gaming is unlikely to reduce muscle tension in the way music listening does. Distraction is one key to music's ability to reduce stress and anxiety and increase the relaxation response. A

positive relaxed state of mind results in fewer pain impulses reaching conscious awareness (Krout, 2007). Whilst the threshold for pain may be similar between individuals, their tolerance can vary widely (Devine, 2002). It is this tolerance for pain, or the conscious perception of the pain impulses, that is often measured in research evaluating the benefits of music for mitigating pain.

Experimental studies of music and pain

Many studies examining the effects of music on pain use experimentally induced pain, such as the cold-pressor technique, which involves measuring how long a participant can tolerate having their hand immersed in icy water (e.g., Silvestrini et al., 2011). One such study, using a within-subject design (N = 54), compared pain tolerance and pain intensity ratings between listening to white noise, relaxation music, and participants' own choice of music (Mitchell & MacDonald, 2006). Preferred music resulted in significantly longer pain tolerance than the relaxation music and the white noise control, as well as significantly lower perceived pain intensity for the female participants.

Clinical studies of music and pain

Experimental studies provide vital knowledge about pain processes, in particular acute pain, and how music may moderate pain. However, experimentally-induced pain cannot fully incorporate the emotional and social complexities of pain experienced in the clinical setting (Knox, Beveridge, Mitchell, & MacDonald, 2011). It is therefore important to explore the possibilities that music offers as an analgesic with real patients (Mitchell & MacDonald, 2012).

Music's potential in the clinical setting has already been acknowledged in systematic reviews, such as the Cochrane review of 51 studies (Cepeda et al., 2006). It found that music listening does reduce pain intensity levels and opioid requirements, but the clinical significance of these benefits is unclear as their magnitude is small.

With very ill patients, such as those receiving palliative care (PC), passive music listening, rather than active music making, is especially appropriate (Murray & Lamont, 2012). The specific analgesic needs of PC patients are now discussed in light of the limited research available with this population.

Pain in the palliative care setting

Pain associated with advanced cancer is multifaceted and complex, and is influenced by physiological, psychological, social, and spiritual phenomena.

(Magill, 2001, p. 167)

Pain is the most common, and most feared, experience of those with terminal illnesses (Dimaio, 2010). Pain is a particularly prominent issue for patients with advanced cancer, with 70% suffering some level of pain (Barnard & Gwyther, 2006). It may present as acute pain, associated with the many medical procedures cancer patients typically undergo (Kwekkeboom, 2003). Unfortunately, it can also present as constant, pervasive chronic pain, usually from the disease process itself (Spintge et al., 1999). All types of pain create major challenges for cancer sufferers, their families and health teams through their impact on QOL (Mills Groen, 2007).

Neuropathic pain

Neuropathic pain — an alteration in normal pain transmission — occurs where there is damage or pathological change in the peripheral or central nervous systems (Bennett, 2010). This distressing symptom is all too common in terminally ill patients, occurring in up to 40% of those with painful cancers. Unfortunately, conventional analgesic drugs are often not effective, so additional or alternative pharmacological strategies are used to tackle this altered pain state (Bennett, 2010).

Drugs, such as opioids, antidepressants, and anti-epileptics, are required to manage neuropathic pain. Unfortunately they may have adverse side effects, such as constipation, nausea and drowsiness (Barnard & Gwyther, 2006; Bennett, 2010). Even whilst taking strong analgesics, patients may still require what are called breakthrough doses when pain is not controlled with their regular schedule of drugs (Barnard & Gwyther, 2006).

Psychosocial pain

Another less tangible aspect of pain is psychosocial or spiritual pain. The term *total pain* was coined in the 1960s by the late Dame Cicely Saunders, founder of the hospice movement (Barnard & Gwyther, 2006). Total pain encompasses the suffering component of pain and suffering. It includes the physical hurting as

well as the emotional, social, bureaucratic, financial and existential, or spiritual, hurt experienced by terminally ill patients and their loved ones (Barnard & Gwyther, 2006).

The role of palliative care

> *Who the hell were we to be given this responsibility, expected to be wise as old priests, know how to lead people towards something no one wanted and somehow make them feel comfortable.*
>
> (Ondaatje, 1992, p. 89)

For patients faced with terminal illness, and their families, PC aims to improve QOL through providing early assessment of pain and other symptoms, and so prevent and relieve suffering (O'Callaghan, 2009). It incorporates, but is not limited to, end-of-life care (O'Brien & Kane, 2014). Its focus is on care but not cure (Mills Groen, 2007), with the aim of maximizing QOL for the individual and his or her carers (O'Brien & Kane, 2014). PC is a philosophy rather than a model of care (Lloyd-Green, 1999), and may be provided in a hospital, hospice, or the patient’s own home.

Music is an intervention well-suited to terminally ill patients as it targets the four domains of PC — physiological, emotional, social, and spiritual care (Romo & Gifford, 2007) — all of which impact on pain.

Music therapy in palliative care

Music therapists have greatly contributed to the appreciation of the role that music can play in PC. However, research carried out by this profession is often confounded by the therapist also being the data collector, as well as the wide range of interventions encompassed in these studies.

A quantitative study of 200 patients with chronic and/or advanced illnesses found statistically significant improvements in objective measures of anxiety, body movements, facial expression, mood, pain, shortness of breath, and verbalisations (Gallagher, Lagman, Walsh, Davis, & LeGrand, 2006). MT interventions included passive listening and active participatory music activities as well as psychosocial interventions such as life review, relaxation, and planning funeral music. The authors listed 17 different genres of music used. They concluded that MT is an asset to PC programs. However, it is not possible to extract the musical component from all the other variables that contributed

to these positive outcomes. The authors also acknowledged the potential for bias in their study, with the music therapists collecting their own data.

Methodological limitations of studies

Confounds, such as those identified in the above study, are common in many of the papers reviewed. The issue of bias was confirmed in comments made in a Cochrane review of MT for end-of-life care. Bradt and Dileo (2011) noted that, whilst a limited number of studies suggested MT contributed to improved QOL outcomes, these results were from studies that had high risks of bias. Despite these methodological compromises, there is, with the limited range of studies available to date, some empirical support for the important role that music can play for patients with terminal illness.

The role of music in reclaiming sense of control

The upheaval that confronts a person faced with dying highlights some of the ways that music may help pain management. An individual's sense of control is greatly challenged by the realisation that death is imminent. It is also challenged by being in a hospital environment. If the person is at the same time dealing with refractory (intractable) pain, the sense of loss of control is further exacerbated.

Music may help in regaining some semblance of control over these difficult circumstances by offering choices, the ability to alter some aspects of the environment, and to offer a means of "self-medicating" for pain and other symptoms such as anxiety (Gold & Clare, 2012; Stuckey & Nobel, 2010). Reclaiming a sense of control may also help address the feeling of loss of identity that results from the illness, a bleak prognosis, and in the immediate moment, the pain (Morley, 2010).

Music as an adjunct to existing treatments

Effective pain management is pivotal to ensuring that palliative aims are met. Whilst consistent applications of analgesic guidelines will yield satisfactory outcomes in most cases, there are those for whom these protocols do not produce the desired outcomes. Persistent pain or dose-limiting side effects require different tactics and adjuvant approaches (O'Brien & Kane, 2014). In

such circumstances, music offers an alternative or additional tool for tackling pain (Bernatzky et al., 2011).

However, the paucity of research in the area of music and the terminally ill (Hogan, 1999) leaves many unanswered questions regarding the best approaches and protocols to use with this vulnerable population. Similarly, more research is needed in the area of music for surgical patients (Richards et al., 2007).

Pain and surgery

Cure sometimes, treat often, comfort always.

Hippocrates

The surgical ward is typically a highly medicalised environment. The prime focus is on treating patients through invasive medical interventions, supported by pharmacological therapies to deal with pain. Acute pain from the surgical procedures is a common post-operative condition. Also, patients presenting to surgery may already experience chronic pain from the underlying issues precipitating surgery.

Implications of the trend towards shorter hospital stays

Advances in surgical techniques are facilitating shorter hospitalisations, even same-day admission and discharge. With a high turnover of patients, there is limited opportunity for staff to explore alternative avenues of pain interventions.

Concerns over infection control may also contribute to resistance to the use of music-creating and listening equipment (Lee, Chao, Yiin, Chiang, & Chao, 2011). Running trials in such a setting requires an open and cooperative team of nurses and other staff willing to facilitate the research.

Measuring music's impact on pain

A review of 42 randomised controlled trials of perioperative music interventions for anxiety and pain found there were mixed results in studies where vital ANS signs had been used as outcome measures (Nilsson, 2008). This may in part be due to the physical arousal stimulated by music (Ferrer, 2007).

Analgesia consumption yielded more consistent results as a measure of pain. In her review, Nilsson (2008) found there was a significant reduction in analgesic use in seven of the 15 studies (47%) using this outcome measure.

Similar trends emerged in a review looking at the therapeutic effects of the arts, especially music, in healthcare. Music was found to result in a significant reduction in perioperative anaesthesia and postoperative analgesia (Ferrer, 2007). It may even supplant drugs in some cases (Bernatzky et al., 2011), as was demonstrated in the tooth extraction case cited earlier (Bhagania & Agnithotry, 2011).

Patients in a study who listened to their choice of music via headphones during urological or renal procedures required significantly less self-controlled propofol (sedative) or alfentanil (opioid analgesic) than those who did not receive the music intervention. It is important to note, though, that the no-music group in this study had no headphones to mask the sounds of the operating theatre, a factor which could have contributed to the observed group differences (Koch, Kain, Ayoub, & Rosenbaum, 1998).

There are limited numbers of music studies that specifically measure the outcome of pain in surgical patients. These outcomes are assessed using both subjective self-report measures, as well as objective measures such as analgesia consumption and length of hospitalisation. Challenges in, and options for, pain assessment are discussed next.

Assessment of pain

. . . the pain was my world,
an aura that haloed me for three feet around.

(Angelou, 1969, p. 184)

The idiosyncratic nature of pain is at odds with options for objective measurement (Breivik et al., 2008). In both health care and research settings, self-report — using reliable and valid tools such as pain rating scales — is the standard for assessing pain (Pasero & McCaffery, 2001). Where individuals are unable to indicate their pain levels on such an instrument, observations of pain behaviours are used. These might include verbalisations, or non-verbal sounds or gestures of pain and suffering, facial expressions, body postures, and

limitations to movement and activities (Bhagania & Agnithotry, 2011). However, these behaviours, and opinions of nurses, physicians and families, are not as reliable as the person's self-report of pain (Pasero & McCaffery, 2001).

Self-rating pain scales

Pain scales are widely used in clinical settings and research. They include the faces rating scale (FRS), the 0 - 10 numeric rating scale (NRS), and the 0 - 100 mm visual analogue scale (VAS). The NRS and the VAS are equally sensitive in assessing acute post-operative pain, and are both more powerful than a verbal categorical rating scale for detecting changes in pain intensity (Breivik et al., 2008). However, meaningful treatment effects can only be detected where sufficient baseline pain intensity levels are reported (Breivik et al., 2008).

Benefits of alternative objective measures

Some patients may under report pain, due to culturally inherent stoicism (Breivik et al., 2008), not wanting to complain, mistakenly accepting pain as inevitable, or fear of being prescribed strong medications (Curtiss, 2010). In such situations, standard self-report measures are not accurate reflections of the patient's pain experience (Shirasaki et al., 2007).

With this in mind, a Japanese research group explored the possibility that physiological measures might be used to assess pain. They measured salivary α-amylase (sAA), using a hand-held analyser, comparing 30 patients with chronic pain to 20 pain-free patients all undergoing elective surgery using epidural analgesia. For the pain group, both the VAS and sAA decreased markedly after the block, with a significant correlation (r = 0.561, p < .01) found between the two measures. The no-pain control group had no significant change in sAA levels (Shirasaki et al., 2007). These results indicate a shared role played by the sympathetic adrenomedullary (SAM) system in pain, together with its already-established role in acute stress.

Anxiolytic effects of music

The potential of music to reduce anxiety is probably one of its most relevant and ubiquitous features in human evolution.

(Koelsch & Stegemann, 2012, p. 447)

Stress is a physiological response to intense systemic demand on the individual (Kunert, 2002). Whilst highly adaptive in the short term, allowing humans to respond to perceived danger, long term stress is damaging (Kirschbaum & Hellhammer, 1999). Stress is typically experienced as emotional discomfort and apprehension, generally called *anxiety* (Kennedy Sheldon, Swanson, Dolce, Marsh, & Summers, 2008). Anxiety is described as a feeling of concern or worry (Marrs, 2006), accompanied by a sense of heightened arousal (Bottomley, 1998).

Music stimulates and inhibits chemical messenger pathways in the body which elicit biological responses to stress (Gangrade, 2011). These can be measured through ANS responses such as BP.

Musical genre and blood pressure

Participants who listened to classical music whilst recovering from a stressful task had significantly lower systolic BP than those who heard no music, or those who listened to jazz or popular music (Chafin, Roy, Gerin, & Christenfeld, 2004). An acute stress scenario was created in another study by having 86 participants prepare a speech at short notice (Sandstrom & Russo, 2010). Participants first were falsely told they may be randomly selected to deliver their speech. They then listened to two-minute clips of happy, peaceful, sad, or agitated music. Both subjective and physiological recovery was better facilitated by music with a positive valence, and low-arousal music was more effective than high-arousal music. Peaceful music, which has a combination of positive valence and low-arousal, was found in follow-up measures to be more effective than emotionally neutral white noise.

Limitations of measuring stress in a laboratory

As is the case with pain studies, stress studies carried out in laboratory situations do not fully encapsulate all the factors at play for a patient experiencing genuine anxiety in a clinical environment. One severely limiting

factor is that the laboratory experiments can only stimulate acute stress. Chronic stress conditions must be measured *in vivo*. Even for acute stress, it is important to observe and measure the effects music may have in real settings with real patients.

Music can target anxiety in hospital patients

A study investigating the effects of familiar live voice and guitar music on the anxiety levels of 50 patients undergoing chemotherapy found no significant differences between the music group and the non-music controls in systolic BP or HR, but significant improvements for the music group in diastolic BP and measures of anxiety, fear, fatigue and relaxation. Subjective measures included a VAS and questionnaire (Ferrer, 2007).

Hospitals can be stressful and depersonalised environments. Noise from equipment and human activity is a potential source of stress (Kirschbaum & Hellhammer, 1999) for which music can provide a distraction or mask (Krout, 2007; Standley, 1999). Engagement with music can also remove patients from their illness identity, providing pleasurable experiences and enjoyable social interludes (Preti & Welch, 2004; Rosenfeld & Dun, 1999; Stuckey & Nobel, 2010).

Nilsson (2008) found that, in 12 of the 24 studies in her review measuring anxiety, music significantly reduced anxiety scores in surgical patients. Most of the studies used the State-Trait Anxiety Inventory (STAI; Spielberger, 1983) as the outcome measure. Numeric scales, VAS, and sedative consumption were also used as outcomes by some of the researchers. All three studies in the review that measured sedative use reported significant reductions associated with music interventions (Nilsson, 2008). As well as the demonstrated use with surgical patients, music has also been shown to be effective in moderating anxiety in PC patients.

Anxiety and palliative care

Even though many sources of distress may not be readily visible or easily articulated by patients, the degree to which these shape end-of- life experience is profound.

(Chochinov et al., 2009, p. 646)

Dealing with a terminal illness raises deep, often unresolved, existential issues for the individual (Bolmsjö, 2000). Whilst pain may be controlled for most patients, few will die without experiencing some degree of emotional distress (Bolmsjö, 2000). From the time of diagnosis, a person with a terminal illness must negotiate its physical, financial and social ramifications and, above all else, the emotional upheaval it precipitates.

Whilst the focus of most interventions is typically aimed at physical wellbeing, emotional issues such as anxiety may not receive the attention they require for the holistic wellbeing of the individual (Pasacreta & Pickett, 1998). Most patients are not being diagnosed or treated for symptoms of anxiety (Bottomley, 1998). Fear and confusion, loss of identity and privacy, feeling unwell, being in pain, an uncertain future, and dealing with the medical system and environments, all contribute to stress and anxiety.

The prevalence of anxiety symptoms in the PC population has been variously quoted as 19-48% (Archie, Bruera, & Cohen, 2013). For recently diagnosed cancer patients, anxiety incidences may be as high as 50% (Marrs, 2006). All these figures present anxiety as a significant issue which needs to be addressed by those working in oncology and PC, more so as living with a terminal illness is often a lengthy process of constant readjustment (Andersen, Kiecolt-Glaser, & Glaser, 1994).

How music may help

The need for beauty (and for some, spiritual solace) may be particularly great towards the end of life for many patients. In this respect, music may exceed where standard pharmacological means fall short.

(Archie, Bruera, & Cohen, 2013, p. 12)

Numerous qualitative studies have provided insight into the processes and individual benefits derived from music interventions. However, available empirical data on the applications of music in PC is limited (Hilliard, 2005). A

narrative review looking at quantitative studies published between 1970 and 2012 concluded that music-based interventions may improve outcomes for cancer patients, in particular through their positive impact on pain, anxiety, mood disturbance, and QOL (Archie et al., 2013). The authors recommended that there was more still to be understood about which subpopulations of cancer patients are most likely to respond to music interventions, which of these are most effective, and what instruments can best measure the effectiveness of such interventions.

Whilst music can be applied as an anxiolytic, it may also be inspiring and uplifting. Musical aesthetics can allow some listeners to transcend their immediate environments and reach more spiritual levels of awareness (Aldridge, 1995). For terminally ill patients, the conduit that music may provide to spiritual and existential matters is important in offering opportunities for catharsis and closure (Norton, 2011).

Anxiety in surgical patients

When I have fears that I may cease to be
Before my pen has glean'd my teeming brain

John Keats (Fox, 2012, p. 62)

Many surgical patients experience fear and anxiety before being taken to the operating theatre. Waiting time before surgery, or even before short investigative procedures, is a well-known source of anxiety (Cooke, Chaboyer, Schluter, & Hiratos, 2005; Mathern Ghetti, 2011). There can be many hours of waiting, in a strange unfamiliar environment, allowing time to brood, cogitate, worry, and fear what is to come (Cooke et al., 2005). Fears surrounding unfamiliar environments, loss of control, disfigurement, and even death (Wang, Kulkarni, Dolev, & Kain, 2002), are understandable but potentially harmful.

Temporary periods of stress can have immediate impacts on the immune system, which may impair a patient's capacity to cope with surgery and recovery (Knight & Rickard, 2001). Typically such anxiety is dealt with by administering drugs that encourage patients to relax before undergoing their treatments. However, premeds may not be effective in lowering perceived

anxiety (Mathern Ghetti, 2011), and may interfere with the actual procedures themselves (Spintge et al., 1999).

Also, with the trend towards shorter pre-operative admission times (Mitchell, 2003) it can be impractical to administer premedication effectively. Likewise, sedatives may be withheld during surgery to facilitate early discharge (Lepage, Drolet, Girard, Grenier, & DeGagné, 2001). With such time pressures, the immediate physical needs of patients take priority over their emotional, psychological and spiritual needs (Nilsson, 2008).

Anxiety may prolong post-operative recovery both directly or indirectly, through increased analgesic and sedative requirements (Lee et al., 2012). Time constraints in surgery units limit non-pharmacological psycho-educational interventions (Mitchell, 2003); but recorded music can be self-administered, with the added benefit of promoting a sense of self control (Cooke et al., 2005).

Evidence of music's benefits in surgical wards

Empirical investigations into the possible benefits of music for surgical patients go back as far as 1914 (Cervellin & Lippi, 2011). Music has been found in some studies to be as effective as, or even more effective than, pharmacological methods for reducing anxiety in patients before surgery. In a randomised clinical trial of 372 patients scheduled for elective surgery (Bringman et al., 2009), preoperative midazolam (n = 150) was compared to relaxing music played through earphones (n = 177). The music group showed a significantly greater decline in the STAI-State anxiety score compared to the midazolam group. However, as there was no control for the noise-masking effect of headphones, it is unwise to attribute the entire anxiolytic effect to the music alone.

Another study did control for headphones by having the non-music group also wear them. It reported that listening to slow movements of Mozart piano sonatas significantly reduced the amount of sedative drugs required to achieve comparable levels of sedation in critically ill patients. Those receiving the music intervention also had reduced levels of systemic stress hormones, as well as significantly lower BP and HR, compared to the controls (Conrad et al., 2007). Patient-controlled midazolam use was similarly reduced in 25 patients listening to their choice of music via headphones — compared to the 25 non-music and

non-headphone wearing controls — whilst undergoing surgery using spinal anaesthesia (Lepage et al., 2001). Both groups achieved similar degrees of relaxation as measured by the STAI and VAS, which were found to have a moderately positive correlation.

Measuring anxiety

Mental stressors are not so open to objective measurement. They have no clear-cut physical qualities, since they are dependent on the perceptions of the person involved.

(Singer, 1995, p. 235)

Subjective measures

Anxiety can be assessed subjectively, through instruments such as the STAI or VAS. The STAI (Spielberger, 1983) is a 20 item questionnaire in two parts. The first ten questions measure the person's anxiety trait (STAI-T) whilst the second set of ten items measures his or her current state of anxiety (STAI-S). In repeat measure studies only this latter part is required for scoring after the initial baseline measures. Even so, when dealing with very ill patients, or when there are time constraints, there can be obstacles to completing the STAI.

On the other hand, the VAS takes only seconds to administer (Lee et al., 2012), providing a quick and easy snapshot of the current anxiety state. The person is asked to mark on a horizontal 10 cm line, set between a happy and a sad face, how they are currently feeling with regards to their anxiety level: from no anxiety through to the worst anxiety imaginable.

The VAS has proven reliability and sensitivity for measuring anxiety, as well as pain (Vaughn et al., 2007). A moderate positive correlation with the STAI has also been demonstrated (Lepage et al., 2001). The VAS was employed in a study of 17 surgical patients listening to live harp music (Aragon & Farris, 2002). The intervention was shown to have statistically significant positive effects on subjective pain and anxiety. Statistically significant positive trends in systolic BP and oxygen saturation were also observed. However, with no control group, definitive interpretation as to whether the music itself or other factors contributed to these outcomes is not possible.

Objective measures

When assessing anxiety, it is recommended that both subjective and objective measures are used (Pearson, Maddern, & Fitridge, 2005). Previous research using self-reported stress and anxiety shows consistent reduction in their levels associated with music interventions (De Marco, Alexander, Nehrenz, & Gallagher, 2012). One explanation for this is the impact of demand characteristics, as well as possible reporting bias in anxious individuals (Pearson et al., 2005). The very nature of the instruments used to assess anxiety and pain actually alert the user to their specific purpose.

Vital signs

Physiological signs, such as BP and HR, may provide objective measures of stress levels. However, these show inconsistent results when applied to music studies (De Marco et al., 2012). In her systematic review of 42 randomised controlled trials of perioperative music interventions, Nilsson (2008) reported that most (19 of 24) used the STAI, with the NRS and VAS also being used in some (3 and 4 respectively of 24) studies. Of the 24 using these subjective measures, 12 (50%) showed significantly reduced anxiety scores. For the 24 studies using vital signs, 6 out of 22 (27%) had significantly reduced HR and BP, 3 out of 8 (38%) demonstrated a significant drop in respiration rate (RR), and for 2 out of 3 (67%) studies there was a significant improvement in oxygen saturation.

As suggested earlier, the stimulating and activating nature of music may contribute to the difficulties in using vital signs as outcome measures. Whilst a person may report feeling less anxious after listening to music, this is not necessarily reflected in their BP, HR or RR readings.

Sedative consumption

Sedative use was more consistent as an outcome measure, with all three studies in the review using this objective measure reporting significantly less sedation for the music intervention groups (Nilsson, 2008). Other reviews have reported similar effects. For example, in her arts in health review, Staricoff (2004) noted the effectiveness of music in postoperative recovery as demonstrated by the reduction in sedative use.

Length of hospital stay

Another objective outcome measure used — but only rarely — for surgical patients is length of hospital stay. Although this does not specifically measure anxiety, it may be a reflection of the overall recovery and wellbeing of the patient. Factors such as support at home, availability of transportation home, hospital policies, already short admission times, and time of day that surgery is performed, can all influence discharge time.

Length of hospital stay is generally used in conjunction with other outcome measures. In one such study (Walworth, Rumana, Nguyen, & Jarred, 2008), patients undergoing brain surgery were randomly assigned to either the live pre- and post-operative MT group (n = 14) or the no-music control group (n = 13). No significant difference in length of hospital stay was found between the two groups. Statistically significant differences were found in four other QOL measures: anxiety, perception of hospitalisation, pain, and stress. In contrast, a MT program in an American neonate ward was found to be very cost effective (Schwartz, Ritchie, Sacks, & Phillips, 1999). The 21 infants in the music group were discharged 3.1 days earlier than the control group (n = 46). This benefit was further reflected in $6,891 savings in hospital charges and $1,706 lower respiratory charges for the music group.

Biomarkers

Stress hormones such as cortisol have successfully been used to measure music's effect on anxiety. For example, in a randomised German study using recorded music for patients undergoing cerebral angiograms (N = 30), plasma cortisol levels stabilised in the music group whilst they rose in the control group (Schneider, Schedlowski, Schürmeyer, & Becker, 2001). Systolic BP was also significantly lower in the music group, but there was no significant difference in HR between the two groups. The researchers observed that those who exhibited most stress before their procedures were the patients who benefited most from the music intervention.

A growing body of music psychology research applies biomarkers as outcome measures, in particular salivary biomarkers such as cortisol, α-amylase (AA), immunoglobulin-A (IgA), and to a lesser degree cytokines, for example interleukin-1β (IL-1β). These provide a snapshot of some of the physiological

functioning of the individual, reflecting stress and immune function in particular. The use of such biomarkers is discussed in detail in the conceptual framework and methodology chapters.

Are pain and anxiety really measurable as separate constructs?

Pray that you will never have to suffer
all that you are able to endure.

Folk saying

Music listening is an effective analgesic and anxiolytic, in part due to its ability to mask disturbing environmental sounds and distract the listener from existing stress or pain. Pain, or the anticipation of pain, tends to make a person anxious. Fear of pain is common in both surgical and cancer treatment settings (Bernatzky et al., 2011; Dimaio, 2010). Anxiety may contribute to muscle tension, which can increase the perception of pain (Bernatzky et al., 2011), so it would be expected that both pain and anxiety will decrease simultaneously with an effective intervention. This outcome was demonstrated by intra-operative music decreasing self-controlled sedative as well as analgesic requirements of conscious patients (Koch et al., 1998).

If these two constructs are intimately linked in the actual experience of pain, as suggested in the preceding discussion, there is a question as to whether they can be measured separately, or how discrete the terms actually are. Indeed, when asked about pain levels, the respondent may be referring not only to physical pain, but also psychological pain, which includes anxiety.

Dissociation between acute pain and anxiety

Several studies indicated dissociation between the two constructs. A live MT intervention with 27 brain tumour surgery patients found significant differences between the music group and the non-music group for self-reported anxiety, perception of hospitalization, relaxation and stress, but not for mood and pain (Walworth et al., 2008). On the other hand, a study which used nature sounds and scenes as distractions to reduce self-reported pain and anxiety during bronchoscopy (N = 80) found pain, but not anxiety, was reduced in the group which received the intervention (Diette, Lechtzin, Haponik, Devrotes, & Rubin, 2003).

A study using recorded music for minor surgical patients (*N* = 40) resulted in significantly lower anxiety in the postoperative music group compared to the control group, as measured with the STAI. However, there was no difference between the groups for pain, and no changes in pain perception in the music group over the assessment period, as measured using the McGill Pain Questionnaire (MPQ) and VAS (MacDonald et al., 1999).

Outcome measures used in the above studies were mostly self-report scales or questionnaires, which may account for some of the variability in results. The very process of reporting pain and anxiety may increase these symptoms as attention is drawn back to them, countering the distractive effects of the interventions (Christenfeld, 1997; Jameson et al., 2011). As all three of these studies involved surgical patients, the effects of both analgesic and sedative medications may have confounded the outcomes. Unfortunately, medication is an ever-present confounding factor when dealing with clinical populations. Also, these studies were addressing mainly the acute pain associated with surgery. Fear about experiencing pain after surgery can be self-fulfilling. Evidence points to a positive correlation between preoperative anxiety and subsequent postoperative pain (Vaughn et al., 2007).

Chronic pain and anxiety

When considering chronic pain, it is now well established that it frequently presents together with anxiety disorders (Asmundson, McMillan, & Carleton, 2011). The nature of the relationship between pain and anxiety is still poorly understood (Hartford et al., 2008). However, it is apparent that the two stressors of pain and anxiety interact (Bernatzky, Strickner, Presch, Wendtner, & Kullich, 2012). Early research into discovering any causal link between these conditions is still equivocal. In some instances, anxiety disorders predate the onset of pain, whereas in other cases chronic pain is present before the onset of anxiety. A single traumatic event may precipitate the development of both disorders, and each condition may contribute to the maintenance or exacerbation of the other (Asmundson et al., 2011).

Lack of control over pain is a potential source of anxiety, especially if it is associated with a life-threatening illness (Vaughn et al., 2007). Pain increases

both emotional and affective agitation, heightened by diminished locus of control and self-efficacy (Bernatzky et al., 2012).

The Japanese study discussed in the earlier section on pain assessment, introduced the idea that pain and stress may share the same physiological mechanisms (Shirasaki et al., 2007). A correlation was found between salivary α-amylase (sAA) levels and self-reported reduction of chronic pain through epidural block. This was indicative of both pain and stress sharing SAM pathways. Measurements of cortisol also confirm the link between pain and anxiety via the HPA axis, with acute pain increasing levels of this stress marker, and chronic pain resulting in the same cortisol suppression seen with chronic stress (King & Hegadoren, 2002).

For the purposes of both research and clinical outcomes, the most important information required is whether the intervention is effective: in other words, whether the person feels better or shows signs of improved functioning. Trying to build parameters around each specific outcome may not be necessary if an outcome measure is used that subsumes the specific constructs being assessed. Psychological and physiological processes underpinning pain and anxiety are complex (Magill, 2001). Furthermore, these mechanisms also share immune system pathways.

Music and the immune system

[Biomarkers are] measurable and quantifiable biologic parameters that can serve as indicators for health and physiology-related assessments.

(Spielmann & Wong, 2011, p. 346)

There is a growing awareness of the range of physical and mental problems that are associated with pain, stress and immunity, and the wide-ranging health effects of their complex interactions (North & Hargreaves, 2009). An objective method increasingly used to assess stress is measuring biomarkers such as cortisol and α-amylase (AA), as well as immunoglobulin-A (IgA), which is an indicator of immune response.

When looking at an intervention such as music which affects the whole person — cognitively, emotionally, spiritually and physically — it is difficult to

separate the symptoms such as pain, anxiety, and mood from one another as they are so interdependent. What can be measured objectively is the person's immune response, which is a barometer of more general psychological and physiological functioning (Hucklebridge et al., 2000; McCraty, Atkinson, Rein, & Watkins, 1996).

Immune system and the ANS

It is well established that immune function is affected by the ANS (Kreutz et al., 2004). ANS responses can be triggered by emotions via the limbic system, a group of neural structures in the cerebral hemispheres (Krout, 2007). Stress stimulates a chain of chemical messages via the HPA axis, culminating in the release of cortisol, a corticosteroid hormone necessary for glucose metabolism. Transient increases in markers of the immune response, such as IgA, occur with increased HPA axis activity (Koelsch et al., 2011). IgA increases during acute stress, but lower levels seen in chronic stress indicate a suppressed immune function.

A review of the literature on the relationship between music and neurotransmitters found that music proved effective in its ability to promote positive immune function (Gangrade, 2011). An earlier review focusing on music and salivary IgA (sIgA) concluded that the positive effects of music were apparent through increased sIgA, positive mood change, relaxation response, and reduction of cortisol (Lu, 2003).

Music, stress and immunity

Several studies have claimed that music may be equal to some pharmacological treatments in countering harmful effects of stress on immunity (Gangrade, 2011). Music has even been shown to stimulate T-cell proliferation and anti-tumour signalling in rodents (Núñez et al., 2002). Various other animal studies support the physiological effect of music through, for example, more settled behaviour, better healing, and increased milk yields in cows exposed to calming classical music, whilst heavy rock music increased barking and aggression in dogs (North & Hargreaves, 2009).

IgA as immune marker

An English research group used mood states induced by either mental recall or music to compare sIgA levels in response to positive versus negative moods. Significant elevation of sIgA occurred in both positive and negative mood states induced by music or mental recall, with some evidence of a more pronounced response for positive mood in the mental recall condition. Elevated sIgA levels held for at least 30 minutes after the end of the interventions. No changes in free cortisol levels were found in any of the mood states (Hucklebridge et al., 2000).

These results indicate that negative moods such as sadness associated with listening to music are not necessarily stressful, and may indeed mobilise the immune system as effectively as happy music.

Cytokines as immune markers

Cytokines such as interleukin-1β (IL-1β) are crucial to the maintenance of healthy immune function (Gangrade, 2011). These are measured only rarely in music psychology research, but are useful outcome variables as they provide feedback on the inflammation processes of the music listener. In a recent systematic review of the PNE effects of music, only 8 of the 63 studies examined cytokine responses (Fancourt et al., 2014). Pro-inflammatory IL-6 decreased significantly in 4 of the 5 studies in which it was tested, whilst IL-1, a mediator of inflammation, increased in response to music in another study in the review (Bartlett, Kaufman, & Smeltekop, 1993; Fancourt et al., 2014).

Music, relaxation and immune response

Based on the accumulated literature to date, music listening appears to facilitate a relaxation response, and thereby an increased immune response, partly through the integrated paths of processing music through the brain and body. These include the release of endogenous opioids and morphines, as well as the involvement of the thalamus, which helps the body to naturally synchronise with rhythmic components of music (Krout, 2007).

Music, via endocrine and immune pathways triggered by factors such as emotions and rhythmic entrainment, has the potential to affect every organ of the body in both unwell and healthy people (Koelsch & Stegemann, 2012).

Music in non-clinical settings

. . . the act of making or even simply listening to music . . . appears to have specific disease-preventative or health-promoting qualities.

(Ruud, 2012, p. 87)

Much of our current understanding of the positive values of music in the clinical environment has arisen from research undertaken with non-clinical populations. As with other areas of psychology, it is likely that many researchers recruited tertiary students as participants (Wintre, North, & Sugar, 2001). In addition, a growing body of enquiry is focusing on the benefits of music for the general population in terms of health and wellbeing.

Music and wellbeing

She used another metaphor – her 'musical home pharmacy' – for her music collection, to which she turned every night after work for several years.

(Ruud, 2013, p. 4)

Promoting wellness involves a global approach to health, including healthy lifestyles, stress management, and emotional self-regulation (Harrington, 2013). The pursuit of wellness applies to those with and also without medical ailments (Krout, 2007). Music listeners understand that music can alter their emotional state and contribute to relaxation (Sloboda, 2005). This is illustrated by the fact that music is a multibillion dollar industry, buoyed by a population that is hungry for the vast array of biopsychosocial effects that can be self-managed through its interactions with music (Lonsdale & North, 2011).

Music, wellness and the immune system

Two recent narrative reviews have indicated evidence for music's ability to boost the immune system, and thus contribute to wellness (Chanda & Levitin, 2013; Kreutz et al., 2012). This PNE approach to understanding music's effects is an exciting emerging field which has yet to yield the full picture on interwoven relationships between systems, such as the CNS — previously thought to be discrete — and the immune system.

It is particularly appropriate to be enquiring into the PNE processes at play as there is a need to substantiate the already widely-held belief that music has

many benefits for psychological and physical health and wellbeing, and to better understand how and why music has the ability to affect health and wellness outcomes. The PNE model is discussed in more detail in the next chapter.

Students and stress

Stress is a major issue for college students as they cope with a variety of academic, social, and personal challenges.

(Oman, Shapiro, Thoresen, Plante, & Flinders, 2008, p. 569)

Tertiary students are a common source of participants for behavioural science research. With its increasing diversification this cohort is an ideal population to test, with new methodologies, novel interventions aimed at reducing stress.

Student participants and external validity

Historically, students have been a readily available convenience sample for researchers to access as participants in their projects. A review of 1,719 articles published in six prestigious psychology journals found that 68.31% used undergraduate students exclusively as participants (Wintre et al., 2001).

Concerns have been raised as to the external validity of such research, which relies on this discrete population of students, but such concerns were not reflected in any decrease in the practice of recruiting students as participants in the last quarter of the 20th century (Wintre et al., 2001). However, there are counterarguments which claim that external validity is not intrinsically threatened by the use of student participants (Druckman & Cam, 2009).

Diversity in student populations

Australian universities are seeing a diversification of their student demographics, with increasing numbers of international and mature-aged students enrolling (Ramsay, Jones, & Barker, 2007). According to the official website of Edith Cowan University in Western Australia, there were 3,300 international students, drawn from 104 countries, in the total student body of over 22,000 (ECU, 2015). With respect to age, in the past 20 years the numbers of mature-aged (over 21 years of age) students at Australian universities have doubled (Ramsay et al., 2007).

Student life and stress

Entering university life precipitates an important phase of personal, environmental, cultural, social, and academic adjustment (Ramsay et al., 2007). Whether the student is a young school leaver, a mature adult, or a student from a different cultural background, there are hurdles he or she must face when undertaking tertiary education. Such challenges all have the potential to be stressful (Oman et al., 2008). In addition, a student may be experiencing stresses from home life, financial pressures, relationship issues, health problems, and so forth. Stress resulting from both academic and extracurricular circumstances can adversely affect students' performance as well as their health and wellbeing (Hyun, Quinn, Madon, & Lustig, 2007).

Students from overseas are particularly vulnerable. A survey of 551 international graduate students at a USA college found that around 44% reported emotional or stress-related problems in the past year that impacted significantly on their wellbeing or academic performance (Hyun et al., 2007).

Stress can diminish immune response, increasing vulnerability to infections or reactivating latent herpes viruses (Glaser & Kiecolt-Glaser, 2005). Student stress and anxiety were found to have significant correlations with physical illness as well as depression (Rawson, Bloomer, & Kendall, 1994). Exam stress is a particularly salient construct, verified using salivary pH (spH) of nursing students (N = 83) to compare exam-day levels with those three months later (Cohen & Khalaila, 2014). Salivary pH was higher (less acidic) post-exam compared to the exam period, indicating less anxiety after the exams were over.

This discussion highlights the burden that stress and anxiety impose on the student body, as well as the wider population, in terms of health implications and impacts on wellbeing and productivity. A better understanding of the benefits of music in non-clinical settings, and the underlying processes that facilitate these benefits, may lead to more empirically-based interventions in such populations, as well as enhancing the knowledge base for clinical applications of music.

In order to carry out the much-needed music psychology research in this discrete area, a clear conceptual framework is required in which to place the specific aims and methodologies of the study. This is discussed in the next chapter.

Chapter 2: BRIDGE - Purpose and Conceptual Framework

It is wise to see models, theories, constructs, hypotheses and even ideas as heuristic devices, not as holy truths.

(Antonovsky, 1996, p. 11)

A model or framework for understanding how music moderates experiences of pain, stress, and the immune system, needs to be flexible enough to allow continuous integration of new findings from all areas of scientific investigation (Metzner, 2012). Historically, research in music psychology emanates from a biomedical model (Daykin, 2012). It also integrates aspects of cognitive psychology and social psychology, as well as anthropology, philosophy, musicology, physiology and acoustics (Lehmann, 2006).

More recently, many papers utilise neurology and neurochemistry methodologies (e.g., Chanda & Levitin, 2013). Closely related to these disciplines are contributions added by psychoneuroendocrine (PNE) researchers (e.g., Kreutz et al., 2012) who place the latest pieces in the incomplete jigsaw of complex processes associated with music and health.

Music psychology has arisen from diverse disciplines, with no single, clear-cut epistemological framework (Ockelford, 2009). The field has therefore been allowed to evolve, without pre-conceived constraints, into an intrinsically interdisciplinary area of empirical research (Thaut, 2009). Its strengths lie in its flexibility to pursue interdisciplinary collaborative explorations unfettered by tightly defined academic boundaries (Hallam, Cross, & Thaut, 2009).

A discussion follows of the various frameworks through which music psychology research is understood, culminating in an explanation of the PNE model, which promises to paint a broader, more holistic picture by drawing on and extending the earlier models.

Biomedical model

. . . the medical model has continued to shape research,
including research on music and arts.

(Daykin, 2012, p. 66)

The dualist biomedical model views health and illness as dichotomous states, with its focus being mainly on biological factors associated with health status (Harrington, 2013). This rationalist approach is still firmly based on Descartes' 17th century neoclassical concept of discrete and separate entities of body and soul (Sacks, 1984).

The role of the HPA axis is central to the biomedical model's concept of stress. Stress sets off a chain reaction of hormones released in the hypothalamus and anterior pituitary, culminating in the release of cortisol by the adrenal cortex (Kalman & Grahn, 2004). Music is able to moderate this response through stimulation of endorphins (Salimpoor, Benovoy, Larcher, Dagher, & Zatorre, 2011), rhythmic effects on the ANS via the thalamus (Krout, 2007), and possibly through other pathways still to be understood.

The biomedical model explains all symptoms as being part of the disease process. In essence, the model views any deviations from normal health as resulting from observable, tangible, and hopefully diagnosable, pathology. This positivist model does not allow for the psychosocial factors that are now understood to play a vital part in the manifestation of symptoms such as anxiety and pain.

Pain is viewed as a direct result of pathological changes: a reductionist view implying that any pain in the absence of observable tissue damage is psychosomatic, or imagined (Quintner et al., 2008). Chronic pain is still often seen through biomedical lenses, resulting in stigmatisation and inadequate treatment of sufferers (Cohen, Quintner, Buchanan, Nielsen, & Guy, 2011). But firstly the following discussion is concerned with the biomedical view of stress.

Music and the physiology of stress

[Stress is a] constellation of cognitive, emotional, physiological, and behavioural reactions the organism experiences as it transacts with perceived threats and challenges.

(Harrington, 2013, p. 8)

Stress is a normal part of life. The word *stress* is freely used in everyday communications as well as in the scientific literature. However, it is often unclear what the term is referring to. Is it the emotional response to a taxing event? Or is it the physical manifestation of being overwhelmed by ongoing or past events, actual or perceived (Fancourt et al., 2014)?

Stress can be conceptualised as a non-specific response to demands, which may be negative, causing distress. But it can also be motivating, enjoyable, positive eustress (Harrington, 2013). Generally though, the word refers to the former, that is, a negative response.

Distress is not a necessary outcome of negative major or minor life events, but is likely to occur when the demands of the stressor are perceived by an individual as exceeding his or her own coping resources (Bennett Herbert & Cohen, 1993). The resultant response may be short-lived acute stress, or it may develop into longer lasting, or chronic, stress. These two manifestations of stress are the body's adaptation to potentially challenging or dangerous stimuli, which initially set in motion the 'fight-or-flight' mechanism via the SAM system (Knight & Rickard, 2001). Where a stressor is perceived as being beyond an individual's control, the HPA axis is more likely to be activated (Knight & Rickard, 2001). This system is also implicated in cumulative chronic stress, such as that experienced with chronically ill patients (Bennett Herbert & Cohen, 1993).

Stress and the relaxation response

Stress may be expressed physically through body tension, physiological changes to HR, BP and RR; physical ailments and illnesses; or as anxiety, depression, anger, sleep disturbances, and so on (Bennett Herbert & Cohen, 1993; Harrington, 2013; Miller, Chen, & Zhou, 2007; Segerstrom & Miller, 2004). Chronic stress in particular can lead to adverse health outcomes such as clinical

depression, upper respiratory infection, relapse of autoimmune conditions, and so forth (Miller et al., 2007).

The body has a natural need and tendency to return to a balanced state, or homeostasis. It often requires repeated and conscious practice to develop the ability to trigger a relaxation response (Tan et al., 2012). The individual's capacity to de-stress, to return physiologically to baseline levels relatively quickly, impacts on the burden resulting from stressors (Glaser & Kiecolt-Glaser, 2005). This is where music may play a positive role.

Music, entrainment and relaxation

The underlying tempo is important in the physiological response generated from a piece of music (Bernardi et al., 2006). Entrainment of the body's rhythms to the music can result in an increase or decrease in HR and RR, depending on whether the music is upbeat or has a slower, more soothing repetitive rhythm (Yehuda, 2011). Numerous studies have looked at the effects of music on vital signs such as HR, RR and BP as reflections of changes in stress levels or anxiety, but with variable and inconsistent results (Knight & Rickard, 2001).

Limitations of the biomedical model

Knight and Rickard (2001) aimed to address methodological factors and confounding variables of past studies in their examination of the moderating effects of music on stress-induced vital signs. A cognitive stressor task of preparing an oral presentation was given to 87 undergraduate students, assigned to small groups of 6 to 12 participants. Some participants listened to Canon in D by Pachelbel (1653-1706) whilst preparing their presentations, whilst others prepared in silence. Comparison of pre-intervention and post-stressor subjective and physiological measures of anxiety found significant increases in subjective anxiety, HR and BP in the non-music group, but not in the music-listening group. Whilst no significant effects were found for salivary cortisol (sC) levels, music did increase salivary immunoglobulin-A (sIgA) levels, indicating moderation of the stress response. Those who reported the task as stressful benefited more from the music, as reflected in a larger effect of music on stress reactivity (measured by subjective stress and systolic BP), than those that did not report the task as stressful. This cannot be explained by the

biomedical model alone: there are other factors contributing to this difference, such as personality, plus emotional and cognitive factors.

In another study, a three-minute mental arithmetic task was used to induce stress in individual participants (N = 75), who were then randomly assigned to listen to their choice of music genre (classical, jazz or pop), or researcher-selected music, or to sit in silence (Chafin et al., 2004). Cardiovascular recovery was assessed with measures of systolic and diastolic BP and HR. Subjective measures of anxiety were taken using 7-point Likert-type scales as well as the STAI. The post-hoc application of music — but not all genres of music — was found to be beneficial in reducing stress arousal. Only classical music was shown to be more effective than sitting in silence. The biomedical model cannot fully account for this differential effect of musical genres, other than by the rhythmic elements inherent in the musical styles.

Physiological constructs: part of the story

Studies using cortisol as a measure of stress have also shown inconsistent results, with some studies reporting increased activation of cortisol, whilst others demonstrated a decrease in cortisol, after the application of a stressor (Miller et al., 2007). This is due in part to the circumstances under which cortisol, a glucocorticoid, is released, and the changes in cortisol levels that occur with chronic stress. With an acute stressor, cortisol levels increase in the blood about 30 minutes after exposure (Bennett Herbert & Cohen, 1993). However, repeated and prolonged exposure to stressors may lead to habituation, changing the pattern of cortisol release. Cortisol both mediates and inhibits the stress response so that over-activation is avoided (Kunert, 2002), thereby aiming to restore homeostasis.

The stressful experience of undergoing a cerebral angiogram was the setting for a study using plasma cortisol levels to measure the anxiolytic effects of music (Schneider et al., 2001). Those who listened to music avoided the rising levels of cortisol seen in the patients that were not exposed to music. Systolic BP was also significantly lower in the music-listening group. As with the earlier study discussed, which used Pachelbel's Canon to counter the effects of preparing an oral presentation (Knight & Rickard, 2001), in this study the more

anxious participants were also found to benefit most from the music (Schneider et al., 2001).

A randomised controlled study of preoperative adult patients (N = 93) compared those listening to 30 minutes of patient-selected music with a control group receiving no intervention (Wang et al., 2002). The music-listening group reported significantly lower anxiety levels compared to the control group. However, physiological measures, such as HR, BP, electrodermal activity, as well as serum cortisol, epinephrine (adrenaline) and norepinephrine (noradrenaline), were not found to significantly differ between the two groups. The researchers explained this dichotomy between the psychological and physiological parameters as possibly being due to trait-related differences in SNS responsiveness. This again highlights the necessity to consider factors other than purely biomedical constructs in understanding how music influences anxiety levels.

Music can also be arousing

Music, especially if it is stimulating, may increase physiological markers such as HR and BP rather than reduce them. When using patient-selected music, researchers have no control over tempo and other factors inherent in music selected by individual participants. The thalamus plays a role in determining which sensory information to attend to and be processed in higher cortical brain centres. Involvement of the hypothalamus and reticular formation result in increased arousal (Harrington, 2013). This could also account for anomalies in vital signs associated with music listening, as the music becomes arousing rather than sedative.

Even what is regarded as sedative music can be arousing. A study comparing self-selected stimulative and sedative music supported evidence of the arousing effects of both (Lingham & Theorell, 2009). It used a combination of vital signs (HR, RR and expired carbon dioxide) and a questionnaire with VASs to report emotional responses. Results showed that stimulative music precipitated both aroused physiological responses and aroused feelings (joyous, elated and energetic), with no significant effect on sedative emotions (calm and relaxed). Sedative music, however, induced both aroused and sedative emotions as well as a slight, but significant, increase in HR, a sign of arousal. It is clear

from these outcomes that it is not a simple matter of applying sedative music to achieve relaxation as even such music may arouse the listener.

Cortisol and α-amylase as physiological markers

Another consideration in using cortisol is that this biomarker is not sufficiently sensitive to assess the immediate physiological changes triggered by the music. To assess short term changes in the stress response it may be better to target a specific SNS marker such as salivary α-amylase (sAA), an enzyme produced in the oral mucosa (Gordis, Granger, Susman, & Trickett, 2006) which is associated with the pre-digestion of carbohydrates in the saliva (Granger, Kivlighan, El-Sheikh, Gordis, & Stroud, 2007).

Levels of sAA increase in response to physical and emotional stress (Granger et al., 2007), with the salivary glands responsible for its production being innervated by both sympathetic and parasympathetic nerves (Nater et al., 2005). Therefore sAA can also indicate a relaxation response, as was seen in a study of 75 Japanese breast cancer surgical patients (Minowa & Koitabashi, 2012). Measurements were taken before and after 10 to 20 minutes of relaxation, which consisted of relaxing with eyes closed or listening to a music CD, the nature of which was unspecified. These measurements were repeated similarly on postoperative days 1, 2, 3 and 7, together with the state anxiety component of the STAI, VAS for pain, and HR variability (HRV). Findings were that the sAA levels decreased significantly with relaxation in perioperative patients, and these changes were weakly correlated with the STAI and VAS measures for anxiety and pain respectively.

In their study comparing the effects of relaxing music — Allegri's *Miserere* (1630s) — on multiple physiological and psychological outcomes, Thoma and her colleagues (2013) confirmed the useful role of sAA in detecting recovery from induced stress. The group listening to music before exposure to a stressor reached baseline levels of sAA considerably faster than the no-music control group. HR and psychological measures did not significantly differ between the two groups. The authors concluded that the music impacted predominantly on the ANS, and to a lesser degree on the endocrine and psychological stress response.

Measuring stress and relaxation responses

These brief examples from the literature highlight the point that two different responses can be measured when assessing the effects of musical interventions. Stress is the initial response triggered by a stressor, where the relaxation response is the body's way of returning to homeostasis, or balance. Both these responses can be explained through the activities of the HPA axis and SAM systems, as well as the role of the parasympathetic nervous system (PNS) in restoring homeostasis (Harrington, 2013).

It is apparent from findings of the studies discussed here that there are factors at play beyond the purely physiological in understanding how music affects the response to stress. Emotions and thoughts, as well as personality traits, coping styles and social factors, all mediate the individual's response to stress (Knight & Rickard, 2001). Similarly, a purely biomedical model will have shortcomings in explaining how music can impact on both acute and chronic pain.

The biomedical model of pain

We assume that pain files an accurate damage report.

(Doidge, 2007, p. 190)

The biomedical model explains pain as a symptom of disease or injury, assuming a direct neurological connection between the site of physical damage and the brain (Quintner et al., 2008). Pain is often seen as a symptom of an underlying disease process (Siddall & Cousins, 2004). This fails to explain how the sensation of pain is so individual, with debilitating pain experienced by some without any clinical symptoms, whilst others report low levels of pain when there are obvious signs of pathology.

Music can assist pain relief through stress reduction and reduced muscle tension (Spintge et al., 1999). Also, pain inhibiting structures of the CNS may be activated, as explained in the gate-control theory of pain (Spintge et al., 1999). Stimuli such as music provide efferent peripheral nerve impulses which compete with afferent pain signals, resulting in fewer pain impulses being consciously perceived (Krout, 2007). This seminal theory was further developed into the neuromatrix theory, acknowledging that a mainly biomedical model

cannot account for all that encompasses pain. The neuromatrix theory describes a neural network in the brain — a body-self neuromatrix — that integrates multiple sensory, cognitive, emotional, and neural inputs, culminating in the experience of pain (Melzack, 1999).

Studies using induced pain

Experimentally-induced pain studies with healthy subjects have made a substantial contribution to the body of knowledge about how music may mitigate pain (Mitchell & MacDonald, 2012). Few of these have explained the effects of music solely through a biomedical framework.

A study by Mitchell and MacDonald (2006) used the gate-control theory as its theoretical framework. Pain was induced in the participants (N = 54) using the cold-pressor method. Preferred music was found to increase pain tolerance significantly more than the prescribed relaxation music or no music. The authors attributed the differential effects as due to distraction as well as perceived control. However, these factors are not purely biomedical but draw also on cognitive and emotional domains.

In vivo studies

Other studies have used real scenarios, with patients experiencing pain being assessed for their responses to music interventions. Music listening was found in some studies to reduce requirements for surgical analgesia (e.g., Koch et al., 1998) and levels of pain intensity (e.g., Cepeda et al., 2006), including that experienced in chronic pain (e.g., Finlay, 2013).

Chronic pain can be viewed purely physically as an increase in sensitisations in the nervous system (Gold & Clare, 2012). However, the processes by which music demonstrates the above benefits are mostly explained by mechanisms beyond the simply biomedical, such as diverting attention away from the somatic experience, as well as memories and emotions triggered by the music.

Music and neurology

> *. . . neurology is largely a veterinary business – it deals almost exclusively with what can be measured and tested; hardly at all with the inner experience, the inner structure, the subjectivity of the subject. It prides itself on managing to exclude these, on being a wholly "objective" science, on being wholly concerned (like physics) with the public, the visible, the demonstrable.*
>
> (Sacks, 1984, p. 202)

Understanding music's effects from a neurological perspective requires firstly the examination of structures of the nervous system implicated in music processing. Rather than clear discrete structures being solely responsible, there is a growing appreciation that a complex web exists of neurological interactions for the perception and processing of music.

Indeed, the processing of music is not hemisphere-specific: nearly every neural sub-system throughout the brain has a part to play (Levitin, 2006). The very nature of music, which unfolds over time, requires immediate responses to sound stimuli as well as processing of the structure of music's accumulating temporal, melodic, harmonic and other stimuli (Popescu, Otsuka, & Ioannides, 2004). Music listening requires interactions between neural systems that process patterns to form representations of the world, and more primal systems that assess what these representations mean for survival and what action is required as a result of the interpretations (Milner, 2009).

Neurological structures and music

> *. . . gives enough goosebumps to fill a pillowcase!*
>
> Palliative care patient, aged 80 years

In their magnetoencephalographic (MEG) study, Popescu and his colleagues (2004) found that the frontal areas of the brain were implicated in the integrative role of responding to constants in the music, where the motor-related structures specifically correlated with the levels of rhythmicity. Other neuroimaging studies have looked at the processing of timbre, which appears to predominantly involve the right temporal lobe areas, as well as possibly the frontal regions of the brain (Samson, 2003).

Electroencephalogram (EEG) studies related to the consonance-dissonance dichotomy (consonant versus dissonant intervals) have confirmed the importance of mesolimbic temporal lobe structures in explaining the pleasure associated with music listening (Wieser, 2003). Variations in dissonance are

associated with activations of the parahippocampal and orbitofrontal regions. These paralimbic areas mediate between perceptual-cognitive representations and emotions by evoking particular reactions whilst also inhibiting incompatible ones (Zatorre, 2003).

So the neurostructural evidence points to the importance of the limbic system's emotional processing in music perception. This is further highlighted by the effect known as musical chills, where the listener experiences an intense physiological and emotional reaction to a piece or passage of music. Again, involved here are two opposing systems: an activating system in the dorsal midbrain, orbitofrontal cortex, and other areas associated with reward and motivation, together with the inhibiting effects of decreased activity in the amygdala. This structure, rich in cortisol receptors (Chanda & Levitin, 2013), is associated with fear and negative emotion (Zatorre, 2003).

Neurology, music, pain and anxiety

Mental states cause brain states, which cause body states; body states are then mapped in the brain and incorporated into the ongoing mental states.

(Damasio & Damasio, 2006, p. 17)

How does the above brief neurological outline help us understand the way music moderates pain and anxiety? The structuralist concept of pain describes its perception as occurring primarily in the thalamus (Devine, 2002). The thalamus and the cerebellum are two of the many brain structures involved in synchronisation to rhythm (Thaut, 2003). They also are part of pleasure and reward processes in the limbic system (Chanda & Levitin, 2013). The ancient Greeks recognised this important link between music and a sense of pleasure created through movement (Yehuda, 2011).

Processing of pain involves the somatosensory cortex, where the input is perceived and interpreted, the limbic system which processes the emotional experiences, and the brainstem's autonomic responses. Modulation of the pain experience occurs in the midbrain and medulla, in part through endogenous analgesic release (Devine, 2002).

Hormones and brain waves

Anxiety reduction through music listening may also be partly explained by the release of endogenous hormones in various structures of the nervous system. Music triggers the release of the reward hormone dopamine in the nucleus accumbens as well as increasing serotonin, a mood booster, and endorphins for wellbeing and relaxation; whilst slow music reduces the levels of the arousal regulator noradrenaline (Yehuda, 2011). In addition to chemical changes, music can elicit changes in brain waves. The frequency of their oscillations has been observed to synchronise, or entrain, with the rhythm of music, resulting in relaxation effects in the listener (Yehuda, 2011).

Neuroplasticity

As well as hormonal and electrical changes triggered in the nervous system by music, actual structural changes may also take place. Neuroplasticity is understood as perceptual and functional change brought about by new connections between neurones, pruning of existing neural connections, changes in neural networks, or remapping or reorganisation of an entire region of the brain (Stegemöller, 2014).

Music is a powerful stimulus of the nervous system, engaging the brain and even retraining neural and behavioural functions (Yehuda, 2011). Dopamine, associated with reward and motivation, appears to play an important role in the process of neuroplasticity (Stegemöller, 2014). It is one of the ways that music can contribute to the altering of negative experiences such as pain and anxiety. The stressful impact of noise is thought to suppress neuroplasticity, whereas music helps to promote it, thus providing an antidote for noise (Stegemöller, 2014).

Neuroplasticity may help in regaining skills and functions lost through injury or illness. Music can change activity in abnormally functioning brain structures in depressed individuals, thus possibly moderating symptoms (Altenmüller & Schlaug, 2012).

On the flipside, neuroplasticity can also contribute to chronic pain through the genetic reprogramming of dorsal root nerve cells which previously were sensitised against pain input (Spintge et al., 1999). Importantly, the mind-body connection involves both top-down and bottom-up processes, with the ability

for both the mind to change functions and behaviours in the body and the body to change perceptions and thoughts in the brain (Damasio & Damasio, 2006).

As has been described, some neurological processing of music stimulates emotions via the limbic system and the release of neurochemicals. However, more complex interactions, involving cognitive processes and emotions, seem to account for the wide range of pain experiences as well as the therapeutic effects of music in moderating pain and anxiety.

Cognitive – emotional model

The emotional reactions which music may arouse are as numerous as the individuals reacting, and the subjectivity of emotional experiences which is reflected in all this variability is the core of our problem. . . . Science is usually befuddled by subjectivity. Its object is communality, not individuality.

(Fisichelli & Paperte, 1952, p.15)

Music's capacity to induce emotions in listeners is a recurring theme when explaining its positive effects on health and wellness (e.g., Juslin & Västfjäll, 2008; Wheeler, Sokhadze, Baruth, Behrens, & Quinn, 2011). Music's ability to evoke strong emotions is evident in its use in film and other multimedia. In everyday life, music is used to self-regulate emotions through catharsis, or to change moods, or to comfort and soothe, or to facilitate relaxation (Juslin & Västfjäll, 2008).

In addition, some of music's facility to moderate negative physical and mental states has been attributed to cognitive factors such as distraction, expectation, musical tastes and training, memories, aesthetic appraisal, and so forth (Grewe, Nagel, Kopiez, & Altenmüller, 2007; Krumhansl, 1997 & 2002; Spintge et al., 1999). The boundary between cognition and emotion in relation to music perception is at times blurred, a concept elaborated on in the following discussion.

Emotions and cognition: an intermeshed relationship

The thrills, chills, and tears we experience from music are the result of having our expectations artfully manipulated by a skilled composer and the musicians who interpret that music.

(Levitin, 2006, p. 111)

What are emotions? Once again, the literature lacks consensus regarding a clear definition (Elliot & Silverman, 2012). However, Juslin (2009, p. 131) sums up the characteristics of emotions that researchers agree on, as "brief (lasting minutes to a few hours) but intense responses to potentially important events or changes in the external or internal environment".

The cyclic process of emotions requires cognitive appraisal, subjective feelings, physiological responses, verbal expressions, physical actions, and self-regulation. These profound psychophysiological changes can occur within milliseconds of a stimulus event (Elliot & Silverman, 2012). So emotions experienced by an individual are primarily created through interplays between physiological arousal and cognition (Wheeler et al., 2011).

Emotions versus moods

Briefly, emotions are short-lived responses to a trigger, such as an event or thought, whereas moods are usually longer lasting, more global, and do not require a specific trigger (Williamson, 2014). Emotions elicited by Western music can be reduced down to three — happy, sad, and scared/fearful — which are recognised by both Western as well as a native African population naive to Western music (Fritz et al., 2009).

Perceived versus felt emotions

There is a difference in music between perceived emotions and felt emotions. The former refers to the cognitive appraisal of structural elements of the music, such as a minor key being commonly associated with a sad affect (Levitin, 2006). Music inherently conveys emotional meaning through auditory characteristics such as timbre, as well as through global aspects of musical structure (Krumhansl, 2002).

Performance aspects may influence this appraisal: the emotions and skill of musicians can moderate emotions felt by listeners (Konečni, 2010). Felt emotions may differ from their perception of affect, and are influenced by the above factors as well as physiological and psychosocial factors (Gabrielssohn, 2009; Juslin, 2009). Also, perception of the affect in music may occur with only brief exposure to the sound stimulus, whilst emotional change needs a longer period of time before the listener feels it (Ilie & Thompson, 2011).

Cognitive factors, such as contemplation and analysis of the music, can also mediate emotional responses to music (Konečni, 2010). Trained musicians are particularly prone to the intrusive cognitive activity of analysing music and performance (Graham, 2010). This is illustrated by a study of music induced emotions by Kreutz and his colleagues where, contrary to their hypothesis,

participants with lower musical expertise reported stronger emotions in general than their more highly trained peers (Kreutz et al., 2008).

Musical structure and emotions

Various researchers have demonstrated a reliable consensus amongst listeners between structural factors in a piece of music and the emotional valence elicited (Hailstone et al., 2009). These structural elements include melody, mode, harmony, volume, tempo, rhythm, and instrumentation which is reflected in timbral differences (Hailstone et al., 2009). Tonal and timbral aspects of music have been found to significantly correlate with pain tolerance and perceived intensity (Knox et al., 2011). They contribute to the emotions expressed in the music, thereby enhancing listeners' emotional engagement (Knox et al., 2011).

Music and the neuromatrix theory

The combined roles of both cognition and emotion are seen in music's effects on pain as explained using the neuromatrix theory (Melzack, 1999). Pain is processed through a series of parallel and cyclical processing loops in the CNS, including sensory-discriminative, affective-motivational and cognitive-evaluative pathways. A personalised nerve-impulse pattern, or neurosignature, results in a uniquely individual experience of pain (Finlay, 2013). The pathways that form the neuromatrix are the same as described earlier in the processing of music, thus highlighting the role of both cognitive and emotional processes in the experiences of pain as well as music, and the manner in which they may intersect and interrelate with one another in the nervous system.

Emotions and the anxiolytic effects of music

Evidence of music's ability to reduce anxiety has already been demonstrated. What is still not fully understood is how emotions play a role in these anxiolytic outcomes. Part of the explanation is the direct effects of music on the ANS, influencing vital signs such as HR, BP and RR. These somatic internal experiences can directly trigger emotions through the bottom-up processes discussed earlier. So, dissonant or loud music may result in fear as the SAM and HPA pathways are activated. Soothing, peaceful, pleasant music can have the opposite effect of calming the ANS through parasympathetic pathways, thus

slowing down vital signs and restoring homeostasis. As a result, emotions such as peace and happiness may be felt.

The idea that aspects of musical sounds are reflected in the human sounds made in various emotional states also helps understand the connection between music and emotions. In particular, this is illustrated by increased volume and range of pitches in speech when agitated, compared to slower, lower and less pitch range in the voice of a calmer person (Williamson, 2014).

A between-subjects study compared the differential effects of the valence and arousal dimensions of music on recovery, as measured by skin conductance level and HR, after an acute psychological stressor (Sandstrom & Russo, 2010). After completing their task of preparing speeches, participants listened to two minutes of happy, peaceful, sad or agitated music. Both subjective and physiological recovery was promoted more with positively valenced music rather than music with a negative valence, and likewise with low-arousal music rather than high-arousal music. Overall, peaceful music was found to be the most effective in promoting recovery from acute stress, indicating a strong emotional component in music's anxiolytic effect. The peaceful music was also low-arousing, and so helped promote the PNS in restoring homeostasis.

How does music evoke emotions?

. . . there is no doubt that moods can be regulated, managed, adjusted, and optimized by music exposure and choice.

(Konečni, 2010, p. 716)

Music evokes emotions through both top-down and bottom-up mechanisms. Individuals are generally aware of how they can implement music themselves for mood management (Sloboda, Lamont, & Greasley, 2009). This top-down cognitive appraisal of music's capacity to affect our emotions does raise the possibility that such an expectation may result in a self-fulfilling or placebo effect. Bottom-up triggers include the physiological responses to elements in the music, such as timbre, rhythm and volume, which elicit autonomic responses that then translate into emotions (Gilman & Paperte, 1949).

Mechanisms of emotions elicited by music

> *Snatches of melodies of old songs drifted through her mind, and for an instant she saw her mother's work-worn hands arranging her First Communion dress. Recollections came to her of old friends, a grey rabbit she had once owned and a tortoise, a yellow cat, and a duck that had only one leg.*
>
> (Gallico, 1954, p. 11)

In addition to the important role of cognitive appraisal, Juslin and Västfjäll (2008) propose six other mechanisms that may explain how listening to music gives rise to emotions. Firstly, primitive brain stem reflexes, such as the startle reflex, are activated in response to arousing sounds that are sudden, dissonant, loud, or fast. The second mechanism they suggest is evaluative conditioning, from the repeated pairing of a piece of music with other positive or negative stimuli. Thirdly, emotional contagion internalises the perceived emotions expressed in music. Visual imagery arising in response to music is their fourth suggested mechanism for evoking emotions. A piece of music can also trigger memories of a particular event. This is known as episodic memory, their fifth emotion-evoking mechanism. Musical expectancy is the final mechanism. It describes where the musical expectation of the listener is violated, delayed or confirmed by specific structural features in the music. Music oscillates this way between tension and release, through harmonic shifts, dynamics, rhythm, and so forth. Emotional states can therefore fluctuate over the duration of one piece of (Wheeler et al., 2011).

Music can also trigger immediate physiological changes through evoking emotional memories, of which the listener may not even be consciously aware (Elliot & Silverman, 2012). All of these mechanisms contribute to emotional engagement with music (Knox et al., 2011), thus allowing the beneficial effects of the stimuli to play out in the listener's psychophysiological responses.

Musical pleasure

In ancient times, the Greeks recognised music as having three therapeutic functions: restoring equilibrium to body and soul, creating a sense of pleasure through movement, and emotional catharsis (Rowell, 1984). Equilibrium, or homeostasis, can be achieved through the neurophysiological pathways described in earlier sections of this thesis, as well as through psychological —

cognitive and emotional — processes. In part, these involve an element of the second therapeutic function, that is, the function of pleasure.

Studies using positron emission tomography (PET) to examine intense pleasant emotional responses to music have detected increased blood flow in brain regions associated with reward/motivation, emotion, and arousal — the same cerebral structures known to respond to food, sex, and drugs — all of which can induce euphoria (Blood & Zatorre, 2001). A more recent review of the neuroanatomical basis for music's effect on emotions confirms the modulation of structures such as the amygdala, nucleus accumbens, hypothalamus, hippocampus, insula, cingulated cortex and orbitofrontal cortex in response to music, as seen in functional neuroimaging studies (Koelsch, 2014).

Pleasure is induced through acoustic aspects of music, and also through music's innate tendency to stimulate movement. And, as the early Greeks clearly observed, music cannot exist without movement: that of the musician as well as the listener (Levitin, 2009). Auditory-motor pathways ensure that auditory rhythms result in rapid entrainment of motor responses (Thaut, 2003).

Mirror neurons: a mind-body connection

It is useful at this point to mention the role of mirror neurons in the perception and processing of emotions related to music. The brain's body maps and emotional structures can simulate body states and emotions in anticipation of their occurrence, or even states not actually taking place in the individual but occurring in another individual or object (Damasio & Damasio, 2006). Mirror neurons are activated in the brain structures related to particular external movements or emotions as if they were actually happening in the individual.

On hearing music — and even more so when seeing the musicians create it — emotions are generated in response to the acoustic and visual stimuli, as well as through the internal constructions the brain makes of them. This is further compounded by the perceptions the brain creates of the body itself as it responds to the music. So, there are dynamic mutual influences between the mind and body, in part driven by the need to create homeostasis after the motor upheaval triggered by the whole emotive process (Damasio & Damasio, 2006).

Emotional catharsis

Homeostasis may also be promoted through emotional catharsis, where emotions such as anger or sadness are purged through musical engagement (Ruud, 2013). An interesting phenomenon pursued by a number of researchers is that of listening to sad music when depressed (e.g.,Thahlier, Miron, & Rauscher, 2012; Van den Tol & Edwards, 2011; Wilhelm, Gillis, Schubert, & Whittle, 2013). Listeners can be drawn to sad music, effectively entraining their music choices to their moods. The negative affect of the music focuses listeners' attention on their sadness, thus allowing negative moods to dissipate (Wilhelm et al., 2013).

Such mood enhancement is one of many functions of sad music identified by Van den Tol and Edwards (2011). Others include (re-)experiencing affect, retrieving memories, distraction, mood enhancement, as well as cognitive and social functions. Music was perceived as a comforting friend by some listeners in their study. Also, sad music can trigger weeping, which is a particularly important and helpful emotional release for terminally ill patients (Norton, 2011).

Musical chills

Some intense responses to music can be measured physiologically. A recent study, using both positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), found endogenous dopamine was released in the ventral striatum, part of the mesolimbic system of the brain, at peak emotional arousal during music listening (Salimpoor et al., 2011). Such musical chills, which may be experienced as shivers down the spine or a general spreading tingling feeling, with or without goosebumps (piloerection), are recognised by their clear and discrete pattern of ANS arousal, providing an objective indicator of pleasure (Archie et al., 2013; Harrison & Loui, 2014; Salimpoor et al., 2011).

Music as a distraction

Emotions are processed by the limbic system, which includes the thalamus, amygdala, hypothalamus, and the hippocampus which is associated with memory processing (Krout, 2007). Musical sounds appear to inherently have emotional meaning, and global aspects of musical structures are associated with

the overall mood of a piece, as well as being a link between cognition and emotion (Krumhansl, 2002).

Emotions are evoked through temporal and harmonic phenomena, creating expectation and delay, prediction, anticipation and surprise, through tension and resolution (Salimpoor et al., 2011). Attention is rapidly focused on music's pleasurable aesthetic stimulus as well as cognitive processing of musical structure and organisation (Rosenfeld & Dun, 1999; Scheirer, 2000). As a consequence, attention is drawn away from distressing somatic symptoms and thoughts.

Engagement with music

> *Music is part of being human, and there is no human culture in which it is not highly developed and esteemed. Its very ubiquity may cause it to be trivialized in daily life: we switch on a radio, switch it off, hum a tune, tap our feet, find the words of an old song going through our minds, and think nothing of it.*
>
> (Sacks, 2007, p. 347)

Awareness of the value of it in terms of psychological benefits is a powerful motivator for engagement with music, leading people to deliberately use music for specific intended outcomes (Sloboda, 2005). Music is an ever present accompaniment to daily life, with functions including regulation of arousal and mood, developing self-awareness, and expressing social relatedness (Schäfer, Sedlmeier, Städtler, & Huron, 2013).

However, much of this soundtrack is peripheral: it occurs whilst we are busy doing other things, such as exercise or housework (Sloboda, 2005), or unintentionally whilst in public areas such as shops or workplaces (Furnham & Strbac, 2002). Depending on our level of choice in the presence of music, it may facilitate or hamper our performance in cognitive tasks. Music may be viewed as background noise, which becomes stressful, or as a useful aid to arousal, especially for extraverts who require a higher optimum level of cortical arousal for better performance outcomes (Furnham & Strbac, 2002).

Music and attention

Cognitive performance can be stimulated by music via core executive functions, including attention, working memory, planning, and motor control (Altenmüller & Schlaug, 2012). Attention in particular is an important function in

explanations of music's therapeutic role. It is widely stated that music's distractive power facilitates its ability to moderate pain and anxiety (e.g., Kristjánsdóttir & Kristjánsdóttir, 2010; Spintge et al., 1999). The distractive function of music may be explained simply by the concept that our attentional resources are limited: music competes with pain and anxiety for attention, thus reducing the conscious experience of these negative symptoms (Kwekkeboom, 2003).

Environmental sounds cannot be shut off from our sound receptors, so resulting in the obligatory processing of all auditory stimuli, whether consciously or not (Macken et al., 2009). However, the processes involved in musical engagement appear to be more multifaceted and complex, involving both cognitive as well as emotional pathways.

Immersion and absorption in music

The Porter sits down on the weight which he bore;
The lass with her barrow wheels hither her store; –
If a thief could be here he might pilfer at ease;
She sees the Musician, 'tis all that she sees!

William Wordsworth (Stillinger, 1965)

The father of flow psychology, Mihalyi Cziksentmihalyi, regards music, in particular music making, as a universal flow-inducing stimulus (Diaz, 2010). Flow is an intrinsically rewarding consciousness state experienced through immersion in everyday activities (Privette, 1983). Cognitively, perceptions of time and space alter, contracting and expanding in a flow state (Diaz, 2010; Sherry, 2004). Listeners' outer space can cease to exist under the influence of music, especially when they are highly absorbed (Schäfer, Fachner, & Smukalla, 2013). And from an emotional perspective, peak or flow experiences are described as intense joy (Diaz, 2011; Maslow, 1968; Privette, 1983).

Factors that may affect immersion in an experience are the elements of difficulty, with a task that is too easy or familiar leading to boredom. If it is too complex the person is also less likely to engage. Novelty or freshness in the experience encourages engagement (Sherry, 2004), which can be described as being connected emotionally and intellectually to an activity of interest (Chin & Rickard, 2012).

Recorded music is ever present in the environment, so it is likely that attention is neither automatically drawn to it, nor is retained, as other more salient stimuli compete for attention. In his article about the values of recorded music, Jeremy Wallach (2003) comments that the popularity and attraction of recorded music is in part due to the absence of visual stimuli, providing sounds that do not require the listeners' full attention. Furthermore, recordings are often heard multiple times by a listener over periods of months and years, so the value of each opportunity to listen is diminished. However, live music is more likely to draw one's attention as it is less frequently experienced in our society, and each performance is unique (Browne & Krause, 2016). Live music is more novel and engages more sensory domains than recorded music does.

Related to the concept of flow is the construct of absorption, described as being effortless engagement which is not goal directed (Herbert, 2011b). Absorption has elements of mindfulness, or being in the moment, as well as changes in sensory awareness (Herbert, 2011b). Indeed, fundamental aspects of flow states are heightened attention, similar to meditative states, and feelings of seamless absorption (Diaz, 2010). Music, as a multi-sensory stimulus, is particularly suited to facilitate absorption as it provides a range of attentional loci (Herbert, 2011b). Again, this is even more so where the music is live, supplying visual as well as auditory and somatic input.

Live music is more engaging than recorded music

The superiority of live music over recorded music in engaging listeners has been demonstrated in several studies with dementia patients. Live interactive music was shown to have immediate significant and positive engagement effects in 69% of participants in a randomized within-subjects study of 32 adults with moderate to severe dementia. The pre-recorded music resulted in 25% of participants showing positive engagement, which was not statistically significant when compared with the baseline silent condition of 12.5% level of positive engagement (Holmes, Knights, Dean, Hodkinson, & Hopkins, 2006). Sessional (hired) musicians were used for this study, but the precise nature of their interaction with participants was not specified.

Another within-subject repeated measures study of 24 participants with moderate to severe dementia used continuous time sampling to compare effects

of live music with recorded or no music conditions (Sherratt, Thornton, & Hatton, 2004). Participants were observed for engagement, wellbeing and problem behaviours. Findings supported the superior effectiveness of live music for increasing levels of engagement and wellbeing, but no significant differences were found between conditions for moderating challenging behaviour. These studies highlight the capacity of music — and in particular live music — to engage and absorb listeners, irrespective of their level of cognitive functioning.

A third study with dementia patients supported the above findings and also demonstrated the importance of providing cognitive challenges in the music to maximise engagement (Groene, 2001). By comparing complex guitar accompaniments with harmonically and rhythmically simple guitar accompaniments in both live and pre-recorded sing-along sessions, the researcher found that the participants were more engaged with the complex accompaniments. This was measured by how long they remained in the singing area of the aged care facility. The live music conditions generated more participation from the listeners, as seen in the levels of applause during, and compliments after, the sessions. So even in cognitively impaired listeners, it is important to remember the role of maximising cognitive stimulation in order to engage them and keep them engaged. This may also extrapolate to those with varying levels of consciousness, such as patients in palliative care or surgery wards.

In her essay on live music in hospitals, Susan Trythall (2006) describes several observations of skilled live musicians using physical entrainment of listeners through their embodied playing. The patients were mirroring the musicians' natural swaying movements as they played their instruments, which the musicians then exaggerated to enhance the listeners' responses. It is these types of two-way interactions that are not possible with recordings, but only with live music. Synchronised movements between musician and listener are an indication of the listener being engaged and absorbed in the experience.

Absorption and dissociation

Where absorption becomes heightened, it could lead to dissociative experiences: an individual may feel detached from themselves, their surroundings, or activities they are engaged in (Herbert, 2011a). Indeed,

listeners may specifically choose music to separate themselves from the environment or activities they are participating in, such as travel on public transport, or carrying out a boring task such as housework (Sloboda, 2005).

Dissociative episodes led to lower arousal levels and increased emotional detachment in participants (N = 20) of an *in vivo* study of musical and non-musical experiences (Herbert, 2011a). The study concluded that both passive and active musical activities are, for many, efficient ways to achieve dissociation from self or environment.

Surrender to the musical experience

The music completed the spell under which Mouche found herself and carried her away into this strangest of all strange lands of make-believe into which she had wandered out of the unhappy night.

(Gallico, 1954, p. 19)

Engagement with music fully and mindfully requires an element of trust and surrender to the experience, to allow the listener to embrace the emotional and aesthetic space created by the music (Levitin, 2006). Many factors, such as whether they like the music, whether it resonates with their current mood or circumstance, the sound quality and salience, the ability of the performers, other distractions, the environment and context in which listening takes place, whether others are present, and so forth, will all influence listeners in how much they relinquish their sense of control over their environment and their responses to the music.

Summary of cognitive-emotional framework of music

Music has the ability to engage the listener, drawing attention into the listening experience and away from the somatic experience. It can evoke emotions such as pleasure and fear through its aesthetic as well as structural qualities. In particular, temporal and harmonic factors such as tension and resolution induce musical expectations, anticipation, and surprise in the listener (Salimpoor et al., 2011). This interplay between cognition and emotion when processing music results in physiological responses (Krumhansl, 2002).

The interaction of cognitive and emotional processes contributes to the ability of music to engage the listener and thereby provide therapeutic outcomes such as decreased anxiety and pain. The degree of challenge and

novelty in the music is important. This may also partly explain the heightened effects of live music compared to recorded music. However, there appear to be other factors contributing to the differential effects of live and recorded music.

The Intention of Muſick is not only to pleaſe the Ear, but to expreſſ Sentiments, ſtrike the Imagination, affect the Mind, and command the Paſſions.

(Geminiani, 1751, p. 1)

Biopsychosocial model

. . . music contributes to health and wellbeing in numerous ways because it interconnects with the self as a unity – as a fluid and integrated matrix of body-mind-conscious-and-unconscious systems that are continuously sculpted by cultural, social, and environmental processes.

(Elliot & Silverman, 2012, p. 33)

Many layers of variables play their part in idiosyncratic and heterogeneous emotional responses to music, including social, cultural, contextual, historical, and educational factors (Zatorre, 2003). It is therefore limiting to frame our understanding of emotional responses to music, and any flow-on health benefits, purely through an emotional - cognitive perspective.

There is a growing understanding and evidence to support the concept of psychosocial factors influencing health outcomes. Certain diseases are associated with chronic stress, depression, hostility, social isolation, low socioeconomic status, and possibly other psychosocial influences (Miller, Chen, & Cole, 2009). Conversely, health and wellbeing is associated with positive existential experiences such as the level of meaningfulness in one's life, as well as practical issues such as better socioeconomic circumstances and levels of social support and interaction (Antonovsky, 1996; Cohen, 2004; Miller, Chen, et al., 2009; Ruud, 2013).

Music, pain and the biopsychosocial model

As an example, consider the experience of pain. Chronic pain is best understood through the biopsychosocial model framework, which encompasses interactions between neurology, psychology (including beliefs, coping mechanisms, emotions and behaviours), physiology, and social factors (Gold & Clare, 2012). Acute pain associated with hospitalisation is moderated by a person's experience, learning and culture, including expectations of pain and whether pain is regarded as a normal part of life. Responses to pain, such as stoicism, are also embedded in the enculturation of both pain sufferers and their carers (Peacock & Patel, 2008).

Psychosocial implications of cancer

We run our battles and trials until we can run them no more.

Female palliative care patient, aged 36 years

Cancer diagnosis and any ensuing medical interventions, whether curative or palliative or both, trigger a host of psychosocial challenges (Chochinov et al., 2009; Pasacreta & Pickett, 1998). Cancer patients are two to three times more likely to experience mood disturbances than their healthy peers, are at high risk of anxiety, and are also likely to have a diminished QOL as a result of their illness (Archie et al., 2013). These same psychosocial issues, as well as physical symptoms such as pain, have been shown in numerous studies to respond to music-based interventions (Archie et al., 2013).

Music as a social facilitator

Once more he stept into the street;
And to his lips again
Laid his long pipe of smooth straight cane;
And ere he blew three notes (such sweet
Soft notes as yet musician's cunning
Never gave the enraptured air)
There was a rustling, that seemed like a bustling
Of merry crowds justling at pitching and hustling,
Small feet were pattering, wooden shoes clattering,
Little hands clapping, and little tongues chattering,
And, like fowls in a farm-yard when barley is scattering,
Out came the children running.

(Browning, 1888, pp. 25 - 34)

Both passive and active music activities can affect the body and brain aurally, physically (through movement and sensations of vibrations), socially, and personally (Fancourt et al., 2014). Music is a potent social facilitator via socio-emotional processes such as increasing positive affect, decreasing stress levels, and by lessening focus on somatic symptoms such as pain (Bernatzky et al., 2011). These changes act indirectly by reducing barriers to social interaction. More direct psychosocial outcomes of music listening are social relatedness and self-awareness (Schäfer, Sedlmeier, et al., 2013).

When shared, music can lead to the loss or sublimation of the ego and an increased sense of connectedness with others (Clayton, 2009; Krause & Brown,

2017). Music channels our innate tendency to entrain both actions and emotions with its aural stimuli as well as with music makers and fellow listeners (Clayton, 2009). The presence of fellow listeners is particularly salient. Listening to music in the presence of others led to decreased self-reported stress levels, as did solitary music listening when deliberately engaged in for relaxation (Linnemann, Strahler, & Nater 2016). The social context of music listening, as well as the intention of the listener are both important factors in how the experience is perceived.

Live music as a social facilitator

A live music experience is more likely to draw the listener in because, in addition to being a multisensory experience, it relies on the physical presence of a musician. Where recorded music may encourage introspection, live music is a more connecting, social experience, leading to reduced feelings of isolation (Magill Bailey, 1983). When presented in a group situation, it can encourage communication and cohesion as the listeners, and musicians, are connected in a shared pleasurable experience.

Communication between the performer and listener, whether alone or in a group, is a two way dynamic, with the musician responding instinctively to the listener's responses to the music, creating a sense of intimacy. The listener becomes the focus of the musician's efforts. There is an immediacy and freshness to a live performance which is not available in a recording. Where a recording may draw more on the cognition of music and appreciation of its structure and organisation, live music is a more perceptual or sensory experience, focusing on aesthetics and pleasure (Rosenfeld & Dun, 1999).

The nature and quality of a performance is better in front of an audience, compared to without an audience, according to the authors of a recent study (Shoda & Adachi 2015). Listeners, presented with recordings of Schumann's *Träumerei* performed by different pianists either in front of an audience or without an audience, evaluated those recorded with an audience as sounding better. Somehow the presence of the audience enhanced or facilitated the pianists' performances.

For the listener, music can come to be associated with low threat, low stress and low pain situations (Spintge et al., 1999) and, in the case of live music,

pleasurable social interactions. Live music also tends to draw in others within a clinical setting, enhancing connectedness with fellow patients, staff and visitors (O'Callaghan, 2001). It is generally understood that social support and positive interactions can moderate the effects of stress (Bennett Herbert & Cohen, 1993). Music interventions target the person as a whole being, addressing the individual's physical, emotional, cognitive, social, spiritual, and aesthetic needs. The biopsychosocial model recognises that all these factors are interrelated and interdependent in achieving favourable outcomes with any therapeutic music intervention.

Illness identity

The sick me is over there, and the listening me is here.

Female palliative care patient, aged 36

Loss of control of self and the environment is a common experience for people who are faced with health issues. Perception of a stressful or distressing situation being beyond one's control is likely to trigger an HPA axis response, which can be measured with biomarkers such as cortisol or IgA. Where a situation is understood as being within one's control, but challenging, the SNS is activated, as seen in changes to HR and BP as well as the enzyme α-amylase (Knight & Rickard, 2001).

Hospitalised patients in particular find themselves in a very controlled institutional environment where they have little sense of self-determination. Their individual identity, tied up with family, friends, work, home, leisure activities, health status, physical appearance and even clothing, is suddenly stripped away as they become patients. Music can restore a sense of familiarity and individuality to a person's environment. At the same time it enhances the internal locus of control if the person has a sense of choice and decision making in the listening experience (Finlay, 2013). One important benefit of engaging with creative and artistic activities is that it transports patients away from their identity as someone who is unwell, helping to reconcile moods and self-concepts (Stuckey & Nobel, 2010). It allows them to focus on their whole selves in a holistic intervention targeting every aspect of their psychosocial and physical wellbeing.

Unfortunately, there has been relatively little research addressing the social contexts of arts participation in clinical settings (Daykin, 2012). In part this may be due to the general lack of appreciation of the values that the arts, and in particular music, have in society.

Music versus noise

. . . our own society has systematically downgraded the musical experience to a point at which we regard it as something that happens while we're busy getting on with our lives.

(Ford, 2002, p. 25)

Silence is something rarely experienced by most people living in urbanised societies. We are surrounded by sounds: nature sounds of wind, rain, frogs and birds; environmental sounds of traffic, conversations, children playing, dogs barking, clocks ticking, alarms, machinery and appliances, and so on. And overlaying these sounds are those emitted from radios, televisions, mobile electronic devices, and broadcasts in public spaces such as shopping areas. Often they include music.

As a society, we have learned to block out much of this accidental and involuntary background noise in order to focus on the sounds that we choose, or need, to attend to (Ford, 2002). Dealing with a constant barrage of auditory stimulation can be an intrusive and insidious source of environmental stress, which compounds and escalates as the noise feeds on itself (Mazer, 2010). If a persistent noise is deemed non-threatening by the listener, a process of habituation allows it to recede into the background of consciousness (Levitin, 2006). The more acoustically and emotionally salient sounds can then be attended to.

Ecological approach

How any given music affects us will depend not only upon the music but also upon our own listening histories, our musical identities, associations and memories, and the social context within which our listening takes place.

(Ruud, 2013, p. 7)

Contextual aspects of music listening

The context in which we listen to music has a huge influence on the way it is perceived, the value placed on it, and the benefits that may or may not result from it. Ruud (2012) claims that it is the social engagement arising from musical participation, over and above the inherent qualities of the music, that brings health-related benefits. He describes the dynamic triad of person, situation and music as being central to these benefits.

Clarke views music listening through an ecological perspective, as a dialectic relationship between organism and environment (Clarke, 2005; Ruud, 2013). He describes the role of auditory perception as identifying the origin of sounds and then finding their affordance, or meaning and utility. Musical sounds, like all sounds, are actively perceived in the wider context of other sounds. Perceptual learning, says Clarke, occurs through exposure to the environment, shaping and refining perceptual capacities through perceptual differentiation.

Environment includes physical objects as well as more abstract or nonmaterial constructs such as cultural and social practices, emotional states and ideologies (Clarke, 2005). Variables indicating cultural learning significantly influence emotional responses to music (Kreutz et al., 2008). These can affect personal musical preferences as well as music expertise, both factors in perception, emotional response, and therefore therapeutic outcomes.

Music's impact on the environment

Patrick used to say he wanted a duet by two
women on musical instruments when he died.
Squeezebox and violin. That's all.
He was so damn sentimental.

(Ondaatje, 1992, p. 88)

As well as the environment's influence on music perception, music in turn can change the environment. As described earlier, music is used for auditory masking, as for example to regain control over auditory space by listening through earphones in public spaces like a bus or train (Krause & Brown, 2017;

Yehuda, 2011). It may also be a means for creating emotional space, such as a peaceful room for a massage, a romantic setting for an intimate dinner, or an uplifting or reflective space for celebrating. These pragmatic uses of music are applied widely in everyday situations as well as therapeutic settings.

Music's capacity to keep the community healthy

Therapeutic uses of music are not necessarily separated from the everyday uses just discussed. Antonovsky's salutogenic model views health on a continuum, from entropic to salutary, rather than the dichotomous concept of health versus illness (Antonovsky, 1996; Harrington, 2013). Whilst the biomedical model focuses attention on specific diseases, with their related risk factors, Antonovsky's holistic approach emphasises health promotion through his concept of salutary factors that actively contribute to health (Antonovsky, 1996).

As has already been shown, engagement with music can contribute positively to community health outcomes (Bygren et al., 2009; Johansson et al., 2001; Stuckey & Nobel, 2010). Ruud (2013) coined the term *cultural immunogen* to describe engagement with artistic pursuits in the context of health-related behaviour, in a similar way that dental hygiene and car safety belts are regarded as behavioural immunogens. Health promoting behaviours such as these are the antithesis of behavioural pathogens, such as smoking and drink-driving. According to Ruud (2013), there is a lack of interest in the interactions between cultural consumption and health-related topics such as stress, pain, and anxiety. This is despite the growing evidence of the positive health benefits of music listening.

Music therapy, together with the related research field of music psychology, has historically been framed in a psychosocial methodology. This framework encompasses many possible approaches and specialities. As with other areas of psychology, there has been a trend in the past few decades towards neuroscience, and in particular immunological aspects of this growing field, in both clinical practice and research into the therapeutic possibilities of music (de l'Etoile, 2009). The following section discusses the benefits of undertaking research within such a framework.

Psychoneuroendocrine approach

Then he killed the lights in a lonely lane
and, an ape with angel glands,
erased the final wisps of pain
with the music of rubber bands.

(Leonard Cohen, 1967)

Over the past three decades the emerging field of psychoneuroimmunology has been making an impact in many areas of research including neurology, medicine, psychology, and in particular, music psychology. Psychoneuro-immunology (PNI) and psychoneuroendocrinology (PNE) explore the relationships between the body's immune systems, the CNS, and psychological processes (Bartlett et al., 1993; Harrington, 2013). Strictly speaking, PNI focuses more on markers of the immune system, such as cytokines and immunoglobulins, whereas PNE examines hormonal changes, measuring cortisol, and other markers such as oxytocins and adrenaline (see Fancourt et al., 2014). In practice, these terms are interchangeable as most researchers tend now to look at the immune and endocrine functions as integrated systems. For the purpose of this thesis, the term PNE is used.

The overarching concept of PNI and PNE is that psychological challenges, expressed in hormonal changes, can impact on the immune system by modifying the actual immune response, compromising its ability to function effectively (Segerstrom & Miller, 2004). The body's immune system protects it from exogenous threats to wellbeing such as bacteria, viruses, fungi and toxins, as well as endogenous threats from its own cells which may be infected or mutated (Harrington, 2013).

Natural and acquired immune responses

There are two types of immune response, providing natural versus specific immunity (Segerstrom & Miller, 2004). Natural, or innate, immunity is activated within minutes or hours of the immune system being challenged, stimulating the release of cytokines, such as interleukin-1 (IL-1) and interleukin-6 (IL-6) that promote fever and inflammation. Specific immunity is also known as adaptive or acquired immunity (Harrington, 2013). Whilst being more

specifically targeted, it is slower to react to a challenge. It is responsible for the release of antibodies, such as immunoglobulin-A (IgA) that neutralises bacterial toxins.

Usually an increase in the level of immune markers in the blood or saliva is indicative of an increase in the robustness of the immune response. However, a generalised systematic inflammation, as seen in autoimmune illnesses, will also be reflected in elevated levels of cytokines (Segerstrom & Miller, 2004).

The immune system, stress, and the brain-gut connection

. . . emotions always have a mirror image in our gut.

(Mayer et al., p. 50)

Both psychological and physiological mechanisms of stress can challenge the immune system. These include emotional factors including affect, emotional valence and arousal, as well as motivational states and cognitive appraisals of the stressor. Physiological mechanisms include the activation of the SNS, as well as release of a variety of hormones. All these culminate in behavioural changes, such as decreased physical activity and depression (known as illness behaviour), increase in body mass and smoking, and disturbed sleep (Segerstrom & Miller, 2004).

Cytokines can trigger these top-down and bottom-up processes by activating the vagus nerve which links the gastrointestinal system and brainstem (Patterson, 2011). This important neural connection is a conduit for the release of inflammation-promoting cytokines in the brain when a person is experiencing intestinal sickness, as well as the reverse reaction of gut problems stimulated by psychological stress.

It is also now understood that both acute and chronic stressors can precipitate lowered resistance to viral infections, slower wound healing, and a generally increased likelihood of illness or worsening of existing maladies (Harrington, 2013). Acute stressors, such as public speaking, trigger transient natural immune responses, with resultant increase in inflammation, exacerbating conditions such as asthma. Stressors of longer durations such as school exams challenge specific or acquired immune responses, expressed as

increased vulnerability to colds, flu, cold-sores, and so on (Miller, Chen, et al., 2009). Stress-induced up-regulation of inflammatory responses, as outlined above, points to the potential of music to down-regulate these same responses through its capacity to reduce stress and promote relaxation (Archie et al., 2013).

Music and the immune system

Music can target these same psychological and physiological mechanisms by interrupting the cascade of hormonal release from the HPA axis and SAM system. Music counters negative affective responses by evoking strong emotions such as joy, sadness and peace, as well as intense pleasure (Chanda & Levitin, 2013). The resultant release of opioids and other hormones helps modulate the stress response and pain perception (Chanda & Levitin, 2013). Just as nicotine from smoking cigarettes stimulates dopamine production, music has similar effects on the release of this neurotransmitter associated with feeling pleasure (Gangrade, 2011). In their exploratory review, Chanda and Levitin (2013) suggest that neurochemical changes precipitated by music may improve immune function and thus contribute to general health and wellbeing.

In their meta-analytic review of the effects of psychological interventions on the immune system, Miller and Cohen (2001) caution against the tendency to directly attribute immune changes to such interventions. In particular, they remind the reader to be mindful of the lack of empirical evidence showing any persistent or lasting effects from such interventions. However, they do point out the promising evidence arising from some animal studies, where behavioural interventions precipitate immune changes that could influence morbidity and even mortality. In addition, they cite human studies carried out in the 1980s and 1990s that indicate the potential of psychological interventions to elicit reliable immune changes. More recent work by those earlier researchers is consolidating the evidence for stress-induced immune dysfunction as well as the potential for psychological interventions to moderate such negative effects (e.g., Glaser & Kiecolt-Glaser, 2005)

Music and the neuroendocrine system

It is known that cortisol plays key roles in the CNS (memory, learning and emotion), the metabolic system (regulating glucose) and the immune system (regulating inflammatory responses), thus tying stress and these systems inextricably together (Miller et al., 2007). Music similarly can target all the systems simultaneously through its capacity to moderate affect, arousal, cognitive processes and physiological parameters. Numerous studies have demonstrated the ability of music to target the neuroendocrine system effectively before or during surgery, reducing the need for pre-meds (e.g., Bringman et al., 2009), or moderating the stress response as measured by decreased cortisol levels (e.g., Leardi et al., 2007).

There is growing evidence of circuits in the brain involved in emotional processing of music that are structurally as well as functionally linked to the HPA axis (Kreutz et al., 2012). These and other nervous system networks are further connected to endocrine pathways. Immune responses are modulated by the CNS via peripheral nervous system and endocrine systems (Glaser & Kiecolt-Glaser, 2005). Rather than being an autonomous and discrete unit shielded by the blood-brain and the blood-cerebrospinal barriers, the CNS is dependent on immune responses for its functionality whilst also being pivotal in these same responses (Glaser & Kiecolt-Glaser, 2005; Schwartz & Kipnis, 2011). Positive affect is associated with a decrease in cortisol levels, increases in salivary immunoglobulins, and the release of endogenous opioids which have analgesic effects. Negative affect, on the other hand, is widely associated in the literature with ill health and disease (Pressman & Cohen, 2005).

Sport as a non-musical comparison

Whilst non-musical social, emotive and immersive activities such as watching sport may have health benefits, they can also be stressful events for some. Indeed, watching a World Cup soccer match can double the risk of an acute cardiovascular (CV) event. In a study of 4279 acute CV events presenting at hospitals in the greater Munich area (Wilbert-Lampen et al., 2008), the incidence of CV emergencies was 2.66 times higher on days of World Cup matches involving the German team compared to non-soccer event control periods. Those with pre-existing CV disease were particularly at risk from

watching these soccer games, accounting for 47.0% of the CV events presenting on days the German team played, compared to 29.1% during the control periods.

So, whilst music listening can contribute to positive affect and reduced arousal, the opposite effects of watching some sport events, namely heightened arousal, together with negative affect such as anger and hostility, appear to have detrimental effects on health (Harrington, 2013). But one can only speculate as to the processes at play in this population study as psychosocial and PNE factors of individuals were not assessed. Behaviours associated with stress, such as reduced sleep and exercise, poorer diets and increased smoking and alcohol use, may also confound the direct interaction between the stress response and immune system (Bennett Herbert & Cohen, 1993). To better understand PNE processes influencing health outcomes, biomarkers of the neuroendocrine system can be measured to assess psychological and immunological responses to life events or targeted interventions (Glaser & Kiecolt-Glaser, 2005).

Saliva and biomarkers

Oral fluid, often called 'the mirror of the body', is a perfect medium to be explored for health and disease surveillance.

(Segal & Wong, 2008, p. 22)

The progress of PNE research in music psychology has in part been limited by the invasive and expensive methodologies associated with measuring biomarkers. Historically, markers of the endocrine and immune systems, such as cortisol, immunoglobulins, cytokines, and so on, have been measured in blood taken from participants (Gangrade, 2011). This requires trained personnel, as well as strict handling, transport and storage protocols. Also, the very act of having blood samples taken is for many people a stressful experience (Minowa & Koitabashi, 2012), thus confounding the constructs being measured, as well as raising ethical issues.

Emerging as a practical non-invasive alternative is the use of saliva to measure these same biomarkers. Almost any measurable marker in blood can also be detected in saliva (Segal & Wong, 2008). No special training is required to take the samples; and equipment, transport and storage are simpler than that

required for blood. Specifics of saliva collection and handling protocols are outlined in the methodology chapter.

About saliva

Saliva has a mixed reputation, being associated with negatively perceived behaviours such as spitting and drooling, whilst also being necessary for pleasurable activities such as eating and kissing (Segal & Wong, 2008). It plays a vital role in talking, chewing and swallowing, as well as oral health through its antimicrobial and antiviral properties (Morse, Furst, & Schacterle, 1986). Stress is usually, but not always, associated with decreased saliva secretion resulting in a dry mouth, or xerostomia (Cohen & Khalaila, 2014; Morse et al., 1986). For some individuals, stress results in the production of thick, "ropy" saliva (Morse et al., 1986). The relaxation response can likewise act differentially on saliva secretion, although it is generally associated with a more rapid flow of watery saliva (Cohen & Khalaila, 2014).

Saliva and music studies

Saliva sampling has been used to objectively assess the efficacy of music interventions in a variety of both laboratory and in vivo studies. Salivary IgA was measured before and after 66 students listened to 30 minutes of a tone/click, or Muzak tape, or radio broadcast, or silence (Charnetski, Brennan, & Harrison, 1998). Muzak was the only condition which resulted in an increase of sIgA, indicating improved immune competence. A review of studies using sIgA to measure the effects of music found that overall music increased sIgA, positive mood and relaxation (Lu, 2003).

Other salivary biomarkers have been used in similar laboratory studies over recent years. For example, relaxing music moderated the stress response, as indicated by no increase in salivary cortisol (sC) levels after induced social stress, whereas sC levels of participants recovering in silence continued to increase for 30 minutes (Khalfa, Dalla Bella, Roy, Peretz, & Lupien, 2003).

Use of salivary cortisol in music studies

Cortisol has also been a biomarker of choice in some clinical studies, such as a small (N = 10) hospice study that demonstrated a significant lowering of sC

levels after 40 minutes of music therapy (MT) in the form of live singing (Nakayama, Kikuta, & Takeda, 2009).

In a study of members of an amateur choir (*N* = 31), both sIgA and sC were used to detect physiological changes precipitated by listening to or participating in choral music (Kreutz et al., 2004). Singing and listening produced opposite emotional valences, namely increased positive and reduced negative affect for singing and increased negative affect for listening. Whilst singing influenced immune competence, as seen in increased sIgA, music listening decreased sC levels, indicating a relaxation response. These differential results indicate there are other processes involved in purely listening to music as compared to being actively involved in music making. Making music is a stimulating and arousing activity that requires active physical as well as cognitive and emotional engagement. Listening is a receptive and more passive activity, although, as explained earlier, it triggers physical as well as cognitive and emotional responses, thus also resulting in physiological and psychological arousal.

Salivary α-amylase and music studies

Salivary α-amylase (sAA), an enzyme produced in the salivary glands, has been demonstrated as a useful marker of the psychobiology of stress as expressed through the activities of the SNS (Granger, Johnson, Szanton, Out, & Schumann, 2012). However, few studies have used sAA to measure the effects of music interventions.

A study noted earlier assessed sAA as an indicator of the relaxation response in surgical patients, using 10 to 20 minutes of listening to a CD or simply closing the eyes to induce relaxation (Minowa & Koitabashi, 2012). The focus of that study was testing the sAA methodology rather than the music or relaxation interventions. It found significant decreases in sAA, correlating with subjective measures of pain and anxiety, after relaxation.

Thoma and her colleagues (2013) did specifically investigate the effects of music on the stress response, using sAA, sC, HR and respiratory sinus arrhythmia, as well as subjective measures of stress and anxiety. Those listening to relaxing music prior to a psychological stress test reached their baseline levels considerably faster after the test, as indicated by sAA levels, than those without pre-stress music.

Immunoglobulin-A in music research

Immunoglobulin-A (IgA) has been used in numerous studies exploring the effects of music on the immune, stress and relaxation responses of participants. IgA levels drop as stress increases, indicating the immune system being compromised by stress (Koh & Koh, 2007; Lu, 2003).

Likewise, the acquired immune system is activated as a person becomes more relaxed. Enhanced immunity, as seen in rising levels of IgA, has been associated with music in the majority of studies using this marker (Fancourt et al., 2014; Krout, 2007).

IgA is often used in association with other biomarkers, such as cortisol, in music studies. Other immune markers, such as cytokines, are also usually paired or grouped with additional markers of stress or immunity in music studies.

Cytokines in music research

Elevated levels of cytokines such as IL-1β and IL-6 have been linked to depression (e.g., Janssen, Caniato, Verster, & Baune, 2010; Miller, Maletic, & Raison, 2009), neurodegenerative diseases (e.g., Griffin, 2006), cardiovascular disease (Harrington, 2013), gum disease (Miller et al., 2010), and autoimmune illnesses such as arthritis and lupus (Harrington, 2013). Acute, or brief, stressors are also associated with increased levels of IL-6, indicating an up-regulation of natural immunity (Segerstrom & Miller, 2004).

Cytokines, along with other physiological markers, have been used to assess music's efficacy in a variety of studies. Listening to a preferred genre of music for 15 minutes was found to precipitate statistically significant changes, indicating reduced stress, in blood IL-1 and cortisol levels (Bartlett et al., 1993). The significant increases in IL-1 and decreases in cortisol in the immediate post-test were echoed in a significant lower level of cortisol and a meaningful but not significant higher level of IL-1 at 24 hours after the music listening intervention. Although there is still little known about how sustainable musically induced PNE effects are (Kreutz et al., 2012), these results show the capacity for even a short session of music to bring about measurable persistent physiological changes.

However, few studies have used cytokines to examine music's effects (Fancourt et al., 2014). And even fewer have measured these cytokines in saliva.

In a summary table of empirical music studies using neuroendocrine outcome measures (Kreutz et al., 2012), saliva samples were favoured for measuring cortisol and IgA, but the only study measuring IL-1 was that described above using blood samples (Bartlett et al., 1993). This is despite the fact that IL-1β appears to be available in measurable concentrations in saliva. Salivary IL-1β was readily detected in both pathological and healthy samples in a study of cytokines and oral cancer, whilst IL-1β concentration was below detectable levels in most of the same participants' blood samples (Brailo et al., 2012). In a study examining opiates and cytokines in response to music there was no IL-1β detected in any of the plasma samples (Stefano, Zhu, Cadet, Salamon, & Mantione, 2004).

The potential of pH as a marker for music research

Another potentially useful but neglected application of saliva as a physiological marker is its pH. A pH reading represents the relative concentration of hydrogen ions, reflecting the balance between acid and base, or alkalinity (Sandin & Chorot, 1985). Whilst the normal or optimum pH of saliva is around neutral — ranging between 6.5 and 7.5 — it tends to be more acidic with stress, whilst relaxation sees it rise towards the alkaline range (Khalaila et al., 2014).

Measuring pH requires only a simple commercially available meter and just minutes for each measurement, which compares favourably with the expensive and time consuming laboratory assaying required for the biomarkers usually measured in saliva. Past studies have used salivary pH (spH) to assess the effects of meditation (Morse et al., 1986), induced anxiety (Naumova et al., 2014; Sandin & Chorot, 1985), both induced anxiety and relaxation (Borgeat, Chagon, & Legault, 1984) and, recently, psychological distress in carers (Khalaila et al., 2014) and students' exam stress (Cohen & Khalaila, 2014).

However, at this point in time only one study was found measuring spH to detect physiological changes attributable to music interventions. Pre- and post-intervention levels of sAA were measured together with spH to assess the efficacy of a one-hour long receptive and active MT program for 20 patients with Parkinson's disease (Hanaoka, Kashihara, Moriwake, & Kasuya, 2010). Whilst no significant changes were detected in saliva flow and sAA, the spH

levels increased significantly after the intervention, indicating reduced stress or a relaxation response.

PNE: a multidisciplinary approach

The effects of music listening are due to complex mechanisms that defy simplistic biomedical, structuralist or purely psychological explanations. Music helps facilitate its benefits in part through its integration of a web of body and mind processes (Krout, 2007). The PNE model underpinning this thesis is represented in Figure 1. It highlights the complex web of interrelationships between structures in the brain, represented in the upper of the two circles. The interplay between stress, pain and anxiety are also highlighted. Some of the ways music moderates the activities of the nervous system, as well as how the presence of the live musician impacts on additional structures and functions, are also illustrated. Purple arrows indicate the interconnections between these components of the PNE responses. The resulting anticipated outcomes of lower vital signs (BP, HR and RR), as well as differential impacts on stress and immune markers, are shown in the lower circle of the diagram, with the small arrows clarifying the direction of such expected change in levels.

The complexity of responses to music listening indicates a need for a multidisciplinary approach to music research (Chémali, 2010). PNE research, which draws on biomedical disciplines as well as psychology, has been developing for only a few decades. Very little PNE data is available to date in the discipline of music psychology so its full impact is yet to be seen in this area of research (Kreutz et al., 2012). Such investigations, by enhancing understanding of the underlying biological and chemical processes (Harmon-Jones & Beer, 2009), are pivotal in helping form a more complete picture of what is occurring in the individual engaged with music, and to be able to compare different forms of musical activities, such as listening to live versus recorded music.

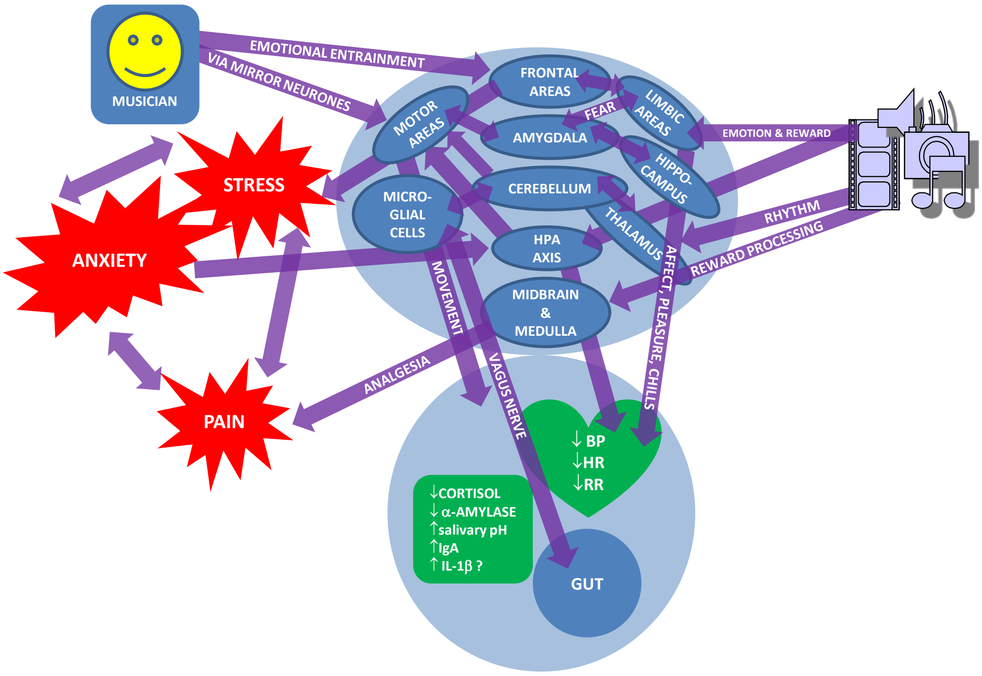

Figure 1. Conceptual model of PNE processes triggered by music listening

Summary

What is known so far

The literature provides evidence of positive impacts on health and wellness from music interventions, in particular when targeting pain and anxiety. Music has been used in a variety of settings, including with palliative care and surgical patients, as an adjunct to existing therapies for pain and anxiety, as well as a stand-alone analgesic or anxiolytic treatment.

This literature review has discussed the frameworks within which the therapeutic effects of music may be understood. Starting with the biomedical and the cognitive-emotional models, which each explain parts of the processes, followed by the more encompassing biopsychosocial model, the discussion culminated in an explanation of the psychoneuroendocrine approach adopted for this study.

What are the gaps

Operational definitions

Many shortcomings and gaps in the literature have been identified and noted in this review. These include the lack of a clear definition of music, with a wide range of interventions being generically labelled as music. Music may be anything from individuals listening to a purely instrumental piece of recorded music, to listening to and perhaps participating in a sing-along with voice and guitar, or even participants improvising on percussion instruments.

Apart from lack of a clear operational definition of what constitutes music in many of these studies, there are confounding variables such as the lyrics in the songs, the variability of musical genres, whether interventions occurred in groups or for individuals, if the music used was chosen by the participant or researcher, was it live or recorded, and so on. Some interventions have involved extra-musical activities — such as relaxation, meditation, visualisation and guided imagery — together with the music, so further confounding these studies.

Study designs and methodological issues

In addition to the potential problems generated from study designs, specific methodological issues were also uncovered in the literature review. These are discussed in more detail in the methodology chapter which follows. Briefly, they include lack of suitable control groups; using the therapist as data collector; non-standardised interventions; and reliance on subjective outcome measures, or on vital signs that give inconsistent results, or only a single biomarker.

Why do this study? How will it contribute?

Music research in palliative care

Both the quantity and quality of the body of research in music and PC needs augmenting. In their recent review of music-based interventions in PC, Archie and his colleagues concluded that the existing evidence did point to music's positive impact on pain, anxiety and mood in cancer patients, but that more research was needed to clarify what types of interventions are most effective, and which particular patients would most benefit from such interventions. They also recommended more research, particularly in collaboration with the neurosciences, to ascertain what outcome measures are best employed to evaluate the effectiveness of such interventions (Archie et al., 2013).

The authors of a Cochrane review of MT for end-of-life care pointed out methodological issues that compromised many studies, in particular the high risk of bias (Bradt & Dileo, 2011). They likewise recommended more research with this cohort.

Music research in surgical settings

Other types of clinical care, such as in surgical wards, have provided settings for research into the effects of music. Both for pre- and post-surgery, as well as in the operating theatre, promising results have emerged from a variety of music interventions. Nilsson (2008) found positive effects of reduced anxiety and pain in approximately half of 42 randomised controlled trials of perioperative music covered in her review. She concluded that further research with surgical patients was warranted, given the potential of this low cost intervention to improve their outcomes.

Live versus recorded music

Very little is known about the differential effects of listening to live versus recorded music. In simple terms, it appears that live music uses more of the listener's senses than recorded music does, thereby heightening engagement, with the flow-on effects of reducing pain and anxiety. Most previous studies using live music have either not compared it to recorded music (e.g., Camara, Ruszkowski, & Worak, 2008), or confounded the music with song lyrics (e.g., Magill Bailey, 1983), sometimes even more so by patient participation in a sing-along (e.g., Ferrer, 2007).

Live music studies tend to be small scale, non-blind studies with high risk of bias (Sand-Jecklin & Emerson, 2010). However a few, such as the neonate study comparing live to recorded or no music (Arnon et al., 2006), indicate a differential effect does exist between live and recorded music presentations, with only the live music intervention significantly reducing HR and inducing a deeper sleep in the preterm infants.

One of the aims of this study was to cast more light on the significance of how music is presented, and to enhance understanding of any difference in therapeutic benefits between live and recorded music listening.

Music versus stories

A repeatedly recurring issue in the literature review is the lack of suitable control groups used in studies. Many have chosen a no-music condition, which is inadequate in controlling for environmental noises as well as psychosocial factors. These factors are discussed in more detail in the methodology chapter.

This study aimed to address the need for a condition that controls for as many confounding variables as possible, particularly the psychosocial variables inherent in any intervention. By comparing stories being read to music being played — with all the other conditions being equal — the differences should be attributable to the music.

Music for non-clinical populations

Many music psychology studies are carried out in non-clinical controlled laboratory situations to facilitate recruitment of participants and standardisation of the conditions. Such studies have made a huge contribution to this area of research. However, external validity is an issue that can arise

from using discrete healthy populations to test therapies that are intended to be applied to clinical populations. This study addressed such concerns by testing the interventions in both controlled laboratory as well as *in vivo* settings.

Multidisciplinary approach

As well as multiple settings, the study was based on a mixed methods and multidisciplinary approach. It drew upon traditional psychological methods and instruments as well as utilising those of the biomedical disciplines. It explored the practicalities of using PNE methodologies (i.e., the objective and non-invasive collection of saliva in both laboratory and clinical settings) to measure biomarker indicators of physiological changes precipitated by the interventions.

In addition to biomarkers frequently used in PNE research, namely cortisol, α-amylase, IgA, and to a lesser degree IL-1β, the long-neglected pH of saliva was also explored as a possible simple and low-cost alternative or adjunct biomarker of stress. Only one music psychology study has been found to date using pH as a biomarker (Hanaoka et al., 2010), making this study a novel contribution to PNE music research.

Aims of this study

To sum up: this exploratory study aimed to test, through a variety of subjective and objective outcome measures, whether live music is more effective than video or audio recorded music in ameliorating symptoms of pain and anxiety and boosting immune responses of patients in a palliative care or surgical ward. The methodology was firstly applied to a non-clinical adult population in a controlled laboratory setting. In order to control for psychosocial confounds, some of the participants were read stories live or listened to an audio recording of the stories being read instead of listening to music.

It was also the aim of this study to assess the practicality and feasibility of using a range of salivary biomarkers to create a more complete picture of the physiological processes involved in the moderation of pain and anxiety, as well as possible immune system benefits, through the use of music interventions. Comparisons within this kaleidoscope of outcome measures promised to yield more insight into which measures are most practical and reliable in various research and evaluative settings.

Chapter 3: DEVELOPMENT - Methodology

Initially, the idea evolved to conduct an experiment to investigate whether music can alleviate pain and anxiety, and furthermore, whether it has differential effects over some other auditory materials. The next step was to consider methodological options for the study's design, interventions, data collection, and data analysis. This chapter provides the rationale for the decisions made regarding these aspects of the research design.

Some limitations of previous research methodologies

The preceding literature review has highlighted shortcomings in the designs of many previous studies. Firstly, rigour may be compromised due to demand characteristics and bias when a researcher is also the practitioner (e.g., Forsblom, Särkämö, Laitinen, & Tervaniemi, 2010; Magill Bailey, 1983). Music therapists typically use guitar and voice as live music interventions, with song lyrics confounding the musical effects (e.g., Ferrer, 2007). Some studies only compare musical interventions with silence, so do not allow inferences regarding music-specific effects (Silvestrini et al., 2011). Other studies combine music with relaxation or guided imagery, so again the music effect is clouded by other likely contributions to the outcomes (McCraty et al., 1996).

Inherent design weaknesses identified in some of the reviewed studies are discussed in this chapter, including sample sizes, outcome measures chosen, choice of — or even lack of — control groups, and so on. Also discussed is the reasoning behind this study's design and methodologies, based on an evaluation of the literature to date.

Confounds and bias

In an innovative three-year collaborative study, professional symphony orchestra musicians were paired with advanced MT students for 15 to 60 minute bedside live MT sessions for 371 adult PC patients (Curtis, 2011). The musicians were all string players: violinists, violists and cellists. Patients

received a variety of personalised interventions, including music listening, active music making and improvisation, music-centred relaxation and imagery, and music incorporated into multi-media life reviews. Results indicated significant differences in pre- and post-test measures for pain relief, relaxation, positive mood, and QOL. However, specific musical effects cannot be extracted from other aspects of the interventions, such as the relaxation and imagery, as well as psychosocial factors. Also, as the MT students were actively involved in the interventions, there was a risk of bias in their capacity as data collectors.

Harp music was trialled as a therapy for 17 surgical patients, with significant positive effects on pain and anxiety perception as well as physiological measures of systolic BP and oxygen saturation. The researcher herself noted that, with no control group, the positive results could have been due to the presence of the harpist and/or the data collector rather than the harp music (Aragon & Farris, 2002). In this case, the author was transparent about possible psychosocial confounds and compromised impartiality.

Also expressing concerns about bias were the authors of a review of methodological issues in oncology music interventions. They noted ambiguity in most of the studies with regards to possible dual roles of therapist and researcher (Pothoulaki, MacDonald, & Flowers, 2006). Such lack of disclosure keeps the readers of these articles ignorant of possible compromised objectivity, both on the part of the therapist/researcher and from the respondents who may be influenced by their expectations, either actual or perceived.

In addition to experimenter bias, Pothoulaki and her colleagues (2006) raised concerns about confounding variables such as demographics and diagnostic factors. Lack of control groups, as well as problems with responder bias, convenience sampling and small groups, were limitations of many studies in another review (Stuckey & Nobel, 2010). Avoiding confounding issues comes back to the initial design of any proposed study.

Study designs

A rigorous research project requires thoughtful planning and management of any potential biases that could compromise clear interpretation of the data. Realistically, no study is ever completely free of confounds, but these should be

controlled for as best as possible whilst also considering the need for external validity, or the likelihood of the results being reproduced outside the strict standardised limitations of the study.

At the same time, it should be deemed likely that the reported effects are indeed due to the intervention. Ensuring internal validity requires a degree of standardisation of interventions and, where possible, randomisation and blinding of participants, as well as those collecting and analysing the data. Balancing the need for both generalisability and rigor is an ever present challenge for researchers.

Control groups

Pothoulaki and colleagues (2006) found that randomised control trials of music interventions in oncology settings generally had poor external validity. They recommended between-subjects quasi-experimental designs as being most appropriate for such research. The authors also emphasised the importance of control groups, which are often neglected or are of insufficient relevance in research papers reviewed to date.

A content analysis of MT articles found that, of 692 articles published in the *Journal of Music Therapy* between 1964 and 2004, only 94 (13.5%) had at least one control group that did not receive music treatment. The author of this study (Jones, 2006) stipulated control groups included those receiving alternative treatments, placebo, no contact, or treatment as usual.

The nature of control groups, when they are used, should also be considered. For example, if participants listen to music via headphones, whilst the non-music group do not wear any, positive effects observed in the experimental group may in part be due to the masking effect of the headphones rather than the music alone (e.g., Koch et al., 1998; Lee et al., 2011). A more recent study addressed this issue by providing earphones to the no-music control group of critically ill patients, to match the experimental group listening to Mozart piano sonatas through headphones (To, Bertolo, Dinh, Jichici, & Hamielec, 2013).

Where the control condition is silence or no contact, the control participants are not exposed to the same psychosocial effects of interactions with the researcher or musician, or any other variables associated with implementing

the intervention. Again, it cannot be assumed that any positive outcomes are due to the music alone. Additionally, denying patients an intervention that is likely to benefit them could raise ethical issues (Pothoulaki et al., 2006). To address these concerns, a condition can be selected that matches the psychosocial factors as closely as possible but without a musical component, such as listening to stories.

A paediatric study asked the question: is it the calming music or the adult attention that helps hospitalised children relax and reduce their pain and anxiety? By having some of the children listen to stories rather than nursery rhymes and lullabies, the authors were able to conclude that music per se, rather than the social component of the interactions, helped improve the wellbeing of children in hospital (Longhi, Pickett, & Hargreaves, 2013).

Comparing mode of music presentation: apples and pears?

Similar confounding issues are apparent in studies comparing more than one intervention. In her study contrasting live to recorded music for patients undergoing magnetic resonance imaging (MRI) scans, the music therapist used different musical material for each condition (Walworth, 2010): the recorded music consisted of patient preferred genres of commercial recordings, whilst the live presentation was the researcher singing patient preferred genres, accompanied by her guitar. Walworth was assessing whether her live MT intervention was more effective than the existing recorded music used during the MRI scans, so her design seemed appropriate for establishing the greater efficacy of the live intervention.

However, when comparing live to recorded music interventions per se, all music presented to participants should be as standardised as possible to avoid potential confounds. Ideally, participants across all groups should be listening to the same performances.

Participants and settings

Much of our understanding of how music may moderate both pain and anxiety has been gleaned from research carried out in controlled laboratory environments using induced pain or stress scenarios to simulate real life experiences. However, there are limitations to such studies as they do not

account for all the biopsychosocial factors inherent in these complex experiences.

It is therefore useful to also look at real-life cases to gain a fuller understanding of how and why music can bring benefits to people impacted by pain and anxiety. This is particularly pertinent to those with chronic symptoms (e.g., Finlay, 2013), the nature of which cannot be duplicated in a laboratory. However, recruitment of sufficient patients for a rigorous clinical assessment of a methodology and/or an intervention within a defined time frame may prove challenging.

Sample size

> *Comparative studies are challenging because differences between effective therapies are likely to be small and can be detected reliably only in randomized trials, often large ones.*
>
> (Temple, 2012)

Many of the articles reviewed had issues with testing fewer than ideal numbers of participants. When only small differences are expected to be observed in the parameters being measured, very large numbers of participants are required in each group to obtain an adequate degree of statistical power (Haun, Mainous, & Looney, 2001). Requirements for participant numbers are magnified when there are multiple treatment groups in a study.

Whilst ideally a research project should tick all the boxes to ensure maximum power, internal and external validity, and statistical as well as clinical significance, the contributions of smaller exploratory projects provide valuable foundations for larger more rigorous studies to build upon.

Students as participants

In the area of psychology research, the most studied population is that of undergraduate tertiary students (Wintre et al., 2001). Although dependence on this discrete population raises issues of generalisability of results to the wider community, the convenience of using the available student population has allowed the collection of much useful data to inform further research.

The demographics of university students is diversifying, with a widening range of socioeconomic and ethnic backgrounds and more mature aged students compared to previous generations. Consequently, the external validity of research with student participants is improving. In a working paper from an

American university, the authors argue that student participants do not threaten external validity, unless the outcome measure effect size depends on a factor that has no variance in the convenience sample (Druckman & Cam, 2009).

Where a new methodology is being tested, and especially if it is to be applied to a vulnerable population such as PC patients, a preliminary study with students can help fine tune protocols and maximise the subsequent contribution that the clinical participants provide. For instance, a small pilot study measured CV and respiratory changes in 24 healthy adults — mostly students — to assess the potential clinical use of music for modulating stress (Bernardi et al., 2006). The pilot informed any future investigations, with the authors concluding that appropriate selections of music, in particular those with alternating fast and slow rhythms, could be well-suited to apply in clinical settings for CV patients.

Clinical settings

As noted earlier, there are limitations in duplicating real symptoms in an artificially created laboratory setting. Studies which use experimentally induced pain cannot fully replicate all the interactions of physical, psychological and social factors that are so much part of the real-life pain experience (Mitchell & MacDonald, 2012). Testing hypotheses on patients faced with pain and anxiety in actual naturalistic hospital environments provides the researcher with insight into the clinical application of an intervention. However, challenges to recruitment and retention of participants are common when dealing with patient populations.

A randomised clinical MT trial recruited only 60 participants (10.31%) from the 582 patients who had day surgery in the unit over a twelve month period (Leardi et al., 2007). Many other researchers face similar problems recruiting sufficient patients to make their research viable within the limited time frame of a project. This is even more so where there are strict inclusion and exclusion requirements for potential participants, an issue which is discussed later in this section.

There is a growing appreciation of the benefits that music offers PC patients, both to specifically target symptoms such as pain and anxiety as well as to address broader psychosocial and QOL issues (Curtis, 2011). One of the hurdles to evaluating suitable interventions is the vulnerable nature of this population.

PC patients can be experiencing multiple demands and losses, and poor levels of physical and cognitive functioning (Ryan, Gallagher, Wright, & Casiddy, 2011). The Hippocratic philosophy of doing no harm is a salient consideration for researchers designing studies in PC settings. It should inform their methodology, protocols and recruitment policy.

Recruitment of participants

Researchers aim to maximise participation rates in their studies for optimal rigour and validity. Achieving positive responses from potential participants, indicating they are interested and willing to be part of a project, can depend on how they are approached initially. Recruitment methods need to be tailored to the population from which the sample is being drawn. Decisions are also necessary on whether to rely on altruism, or to offer incentives such as course credits, cash, or store vouchers.

The information provided in many studies is sparse or absent regarding recruitment processes. Over half of the studies in a recent review failed to provide details explaining the exclusion of potentially eligible participants (Ryan et al., 2011). The authors recommended that recruitment information be routinely supplied in research papers.

Ryan and colleagues (2011) identified the main methodological challenge of studies with advanced cancer patients was recruiting a large and representative sample. Convenience samples of available participants are viewed by some as possibly not representing the wider population being studied (e.g., Stuckey & Nobel, 2010). Smaller studies typically draw from one single source, such as a particular campus or hospital, thus also potentially compromising external validity (e.g., Khalaila et al., 2014). The reality is that there is little that can be done to avoid these issues in small scale studies.

Student participant recruitment

Utilising readily available, accessible and willing students as participants is regarded as convenience sampling. However, getting them to the starting block of a study requires effective recruitment strategies. This may include direct approach, as well as advertising on notice boards, via university websites and social media.

It is worth noting that participants recruited at universities are by nature self-selecting. Only those interested in the topic and nature of the project, and with a level of altruism or curiosity, are likely to volunteer.

Patient recruitment

As with student participants, an anticipated issue in a clinical study of this nature is self-selection, with some potential participants declining for a variety of reasons (Mitchell, 2003). In her study using music to moderate anxiety in cardiac catheterisation patients, Mathern Ghetti (2011) documented a consent rate of 53 (58.88%) of the 90 eligible patients approached. Of the 37 who declined (41.11%), 10 gave no reason, and others cited a preference for family contact, television, silence or rest; or feeling fine so not needing an intervention; or not liking music. De Marco and her team had a higher rate of around two-thirds non-participation in their study of music with cosmetic surgery patients (De Marco et al., 2012). Of the 112 patients identified as eligible, 74 declined to participate (66.07%) so only 38 consenting participants were recruited (33.93%). Examples of reasons given for declining were lack of time, not anticipating being anxious, or disinterest in the research. Further attrition occurred with 12 (10.71%) of the consenting patients failing to complete the requirements of the study, leaving a final sample of 26 participants (23.21%).

A high rate of people declining may skew the demographics of remaining participants, creating a biased sample. Unfortunately, in most articles there is little or no information supplied to inform the reader about recruitment procedures and rates of participation (e.g., Bringman et al., 2009; Pearson et al., 2005; Wang et al., 2002). Invasive methods such as blood sampling may put off potential participants. The alternative of donating saliva for the research cause should facilitate a higher rate of compliance and participation (King & Hegadoren, 2002).

Options available for recruitment include providing verbal and written information about the project plus invitations to participate: before or at the time of admission, leaving such materials in public areas of the hospital, or approaching patients once they are in a waiting room or on the ward. One study of preoperative patients recruited participants from an operating room waiting area, where the music interventions also took place (Lee et al., 2011). In another

study potential participants were approached and recruited during the first 30 minutes of their three hour chemotherapy treatments (Ferrer, 2007). Procedures for booking and admitting surgery patients limit opportunities to approach and recruit participants before they arrive at the hospital. Therefore, recruitment often needs to happen on the wards or in the waiting or treatment areas.

The same constraints apply to PC patients: admissions to the PC unit are not generally planned with much lead up time. On admission, assessment by the clinical team takes priority over a researcher's access to patients. In PC, the new patient is typically very unwell and has low endurance for extra interactions. Finding the right moment to approach the patient about a study may be challenging, and is best delayed for the first 24 hours after admission.

Short stay surgery patients, on the other hand, are usually less affected by general malaise, and the tedium of waiting before surgery can make them more receptive to a researcher's approach. Currently, the growing trend is to admit surgery patients on the morning of their surgery rather than the evening before. This creates a limited window of time to gain access to a surgery patient, recruit them, and carry out interventions and assessments before they leave the ward for the operating suite (Mitchell, 2003). Bringman and his colleagues found that, due to insufficient waiting time, the first patient scheduled each day for surgery could not be included in their study examining relaxing music as an alternative premed treatment (Bringman et al., 2009).

Inclusion and exclusion criteria

Although PC is usually associated with patients who are terminally ill from cancer, this is not necessarily the case. Those with other illnesses, such as CVD, degenerative neurological diseases, and dementia may all be referred to PC. However, for a research study the internal validity is improved by stipulating parameters that participants need to meet for inclusion.

Cancer itself is a large group of around 200 diseases that are categorised by the development of abnormal cells that proliferate and invade the body's healthy tissues (Harrington, 2013). Many studies have focused on one type of cancer, or one type of surgery in the case of surgical patients. However, this

severely limits the number of participants available for a study, and it can be argued that it also compromises external validity.

Studies involving music require participants to have sufficient cognitive and sensory functions as well as language skills to consent to, perceive, and respond to – and perhaps also reflect on – the interventions being assessed (e.g., Curtis, 2011). PC patients are usually very unwell, and may also, due to age or the effects of their illnesses or medications, have cognitive and sensory impairments. To a lesser degree, some of these factors may arise in surgical settings also.

There can be a significant degree of flexibility, and therefore variability, in defining who does and does not qualify for a study (Ryan et al., 2011). Most studies stipulate basic requirements, such as being aged 18 years or over, being cognitively aware of details about themselves and their situation, and having adequate hearing and language skills (e.g., Mathern Ghetti, 2011). Dislike of music was added to the list of exclusions in a day surgery music study (Cooke et al., 2005). Some studies looking at music's effect on anxiety also excluded those who had consumed caffeine, sedatives, premeds, or medications for CV symptoms (e.g., Lee et al., 2012).

A study of anxiety in MRI patients excluded those who scored zero on the pre-test VAS for anxiety, as well as those taking anxiolytic medication (Walworth, 2010). Considering she had additional outcome measures showing the positive effects of live compared to recorded music — such as less requested breaks, and fewer repeated scans necessitated by movement — Walworth may have excluded patients who could have still provided her with useful data.

The days on, and hours between which recruitment occurred were also specified in some studies, as well as limits such as the least amount of time patients were likely to be waiting before surgery (e.g., Fredriksson, Hellström, & Nilsson, 2009; Lee et al., 2012). This was necessary to allow enough opportunity to carry out the intervention and data collection.

Due to possible interactions and moderating effects, studies using salivary biomarkers tend to have strict exclusion criteria for participants. A study using salivary pH as a marker of depression had clear criteria of no chronic illness, such as diabetes and kidney disease, and no medications that might interfere with pH, such as proton pump inhibitors and histamine 2 inhibitors used for

gastric symptoms (Khalaila et al., 2014). Another study, measuring IL-1β in grieving women, excluded smokers as well as those with Axis 1 disorders such as major depression, or with autoimmune illnesses such as rheumatoid arthritis, which could impact on pro-inflammatory cytokines (O'Connor, Irwin, & Wellisch, 2009).

Other studies went as far as excluding all with chronic diseases; and all women, as the effect of varying sex hormone levels on α-amylase stress response was unknown (Rohleder, Wolf, Maldonado, & Kirschbaum, 2006); or restricting women to be tested during days 4 to 10 of their menstrual cycle (Thoma et al., 2013). Whilst the reasoning for them may well be justified, a down side of such strict exclusion policies is that the external validity of a study becomes severely compromised. Furthermore, rigour may likewise be affected due to having insufficient participants to achieve the necessary statistical power.

Where a study uses pre- and post-test measures, the emphasis is on ascertaining the difference between these time points rather than establishing an absolute measure. Each participant is controlling for their own variables, such as those that were deemed necessary as exclusion criteria in the above studies. Less stringent criteria can therefore be applied.

Allocation of participants

Random allocation of participants to various treatment and control groups is generally regarded as the preferred way to balance confounding variables, such as demographics and health status. Randomised controlled trials are considered the benchmark for quantitative research. However, randomisation can compromise external validity which, as just explained, is further exacerbated by strict inclusion and exclusion criteria. Additionally, randomisation is not always appropriate for psychological interventions (Pothoulaki et al., 2006).

In some study designs it is not possible to randomise all participants. Where a live music presentation is being recorded, for later participants to view or listen to, the live intervention needs to occur first. Random allocation of participants can still happen for all but some initial live presentations necessary to get the study started. Such quasi-random allocation accommodates the

requirements of a study design whilst still applying the benefits of random allocation wherever possible.

Methods for randomisation include use of random number generators or lists (e.g., Leardi et al., 2007; Walworth, 2010); or even more complex randomisation that ensures equal numbers of males and females in each group (e.g., Cooke et al., 2005; Fredriksson et al., 2009); or a simple method of allocation to either experimental or control group by using odd or even numbered birth dates of participants (Lee et al., 2012). However, most authors do not specify the details of randomisation. A review of 42 music intervention studies targeting anxiety or pain found only eight reported truly random allocation, with the remainder utilising either semi-secure techniques such as flipping a coin, or non-secure methods such as allocation on random days or weeks, or unspecified means of allocation (Nilsson, 2008).

Recruitment of presenters

Some studies have used professional musicians or tertiary music students to provide the musical material (e.g., Curtis, 2011). The location and nature of the study's setting, as well as other factors such as the standard of musicianship required, and the availability and costs of hiring musicians, will determine where the musicians are sourced from. Similar considerations apply to story readers.

Attributes of presenters

Musicians and other performers or presenters involved in an evaluative study such as this one require an adequate level of skills and maturity, including musical and presentation skills, as well as the ability to build rapport with listeners (Preti, 2009). These attributes are especially relevant when working in what could be confronting settings of terminally ill patients, or those marred physically or emotionally by their illnesses. The most important criteria they need to meet are a desire to work in a clinical setting, and to subscribe to the nature of the research they are participating in (Chémali, 2010; Curtis, 2011). The symphony orchestra players who accepted an invitation to be involved in a recent PC research project reportedly did so due to their interest in that collaborative study (Curtis, 2011).

Willingness is not necessarily preparedness. Ethical issues need to be considered, such as possible psychological harm to people who may not be aware of the potential emotional impact of their encounter with a terminally ill patient. Preti and Welch (2012) have documented the physical and emotional demands that professional musicians working in paediatric settings reported. However, there is little available data on musicians working in other clinical settings (Preti & Welch, 2013).

In their role as musician or reader, presenters do not need to know all the detailed clinical information of the patient; but they should be under the direct supervision of the researcher or a clinician who is privy to such confidential background details (Daykin, 2012), and who can also provide opportunities to discuss the collaborators' experiences and refer them on for further debriefing if required.

Another attribute required of presenters is flexibility, to both situation and schedules (Trythall, 2006). Only tentative arrangements and appointments can be made with hospitalised patients as changes to their schedules, health status, desire to participate, and other unforeseen circumstances may necessitate changes of plans and even cancellations. To some degree, this may also be the case with student participants.

Professional or student presenters?

Requirements for a study using students differ from those for a clinical study. Preliminary studies using healthy participants are opportunities to test methodologies and hypotheses prior to launching into a real-life setting with potentially vulnerable participants. Whilst the best quality and highest standard of musical performance or reading of stories is the aim for all studies, the limited availability of suitably mature and willing presenters may lead to prioritising these for the clinical phase of a project. Those perhaps with less developed musicianship and life skills, such as tertiary music students, may still be suitable for a student study. Careful selection should still take place, bearing in mind that musicianship and presentation skills can be variable in tertiary students.

Practical considerations mean that allocation of musicians and readers is likely to be on an availability basis, rather than some type of randomisation. As

long as no systematic or predetermined matching of presenters to participants occurs, this should not pose a threat to the integrity of the study.

Live versus recorded music as interventions

When he'd finished his work for the day
the full, rich sounds of his violin
would float up into the sky. . . .
All those who heard it were entranced.
It was...magic.

(Allen, 2009)

Jeremy Wallach (2003) questions the prevailing and enduring romantic notion that music's communication is only possible when live musicians play to live audiences. He does not consider recordings to be second rate substitutes for live musical experiences, but sees them as meaningful cultural objects in their own right. He goes further, suggesting that a visual component is unnecessary for recorded music. However, music videos and films of live concerts are a popular medium for engaging with music as an alternative, or in addition to attending a live performance or listening to an audio recording.

Whilst claims are made by some reviewers of the therapeutic superiority of live music (Staricoff, 2004), there is little systematic research comparing live music with other modes of presentation (Finnäs, 2001), and even less of such research in clinical environments. A recent study compared live vocal and guitar music — played by the music therapist researcher — to recorded music, both of which were played via headphones to patients (N = 88) undergoing MRI scans (Walworth, 2010). The therapist was able to entrain the rhythm of her playing to the rhythmic pulses of the MRI machine, heightening the masking effect of the music. Results indicated more positive perceptions of the MRI procedure, fewer scans repeated due to movement, and less requested breaks from the scan in the patients receiving the live music intervention compared to the standard protocol of listening to recorded music.

As pointed out before, dual therapist-researcher roles, as occurred in Walworth's study, are at risk of introducing bias. Also, the recorded music condition in the study was not matched to the material of the live presentation. In order to reduce the possibilities of confounding variables to the minimum, the performances presented to participants should be the same in every way except their mode of presentation. This is only possible if the live interventions are recorded and played back to subsequent participants.

The terms *music* and *music intervention* are generally assumed to mean the same in the literature. However, it could be considered that *music* refers to the actual musical sounds being perceived by the participant, whilst *music intervention* refers to the whole package: the music, plus the human and technology factors necessary for the presentation of the music, and collection of data. We cannot have the former without the latter and, by the very nature of how live and recorded music are conveyed, there are going to be differences between these two conditions. What this study set out to clarify was whether the differences between live and recorded music are reflected in a superior therapeutic response to live music, as has been suggested in the literature (e.g., Chémali, 2010).

Music selection

. . . the unexpected semitone
hauls at fabric,
the dense community of pitch,
insistent and
puncturing
for a bar or two
the membrane of a scale which is
thin, suddenly
itself incidental and
gasping at the shock of somewhere
sharp, and new –

and then plunging down again while
the threaded texture of resolve
unfolds, its
tumbling arrival like
slipping
quietly
into sunshine
on a moody, complicated day.

(Lucas, 2013)

An obvious variable in any music study is the material selected to present to participants. What genre(s) should be used? What if the listener doesn't like the music? How long should the listening session be? What instruments should be played? These and other factors need careful consideration when choosing the music for a study. Added to the preceding questions are a researcher's concerns

regarding internal and external validity of the study. For instance, whilst ecological validity and emotional responses may be stronger with self-selected music, pre-selection of music is required for standardisation of the musical stimuli (Kreutz et al., 2008). So should the music be selected by the researcher, the musicians, or the listeners?

Preferred versus researcher-selected music

Debate about the differential effectiveness of preferred music compared to researcher-selected music is ongoing. Listening to preferred music led to participants tolerating induced pain for significantly longer times, and reporting more control over it, than those who listened to specially designed relaxation music (Mitchell & MacDonald, 2006). Other studies have demonstrated the efficacy of specifically selected music in promoting recovery from induced stress (e.g., Chafin et al., 2004; Thoma et al., 2013). A meta-analysis on music for decreasing arousal noted that researcher selected music had a greater ability to reduce arousal than participant preferred music. The author suggested that music preferred by the participant may be more distracting, or attention drawing, and therefore stimulating to the listener (Pelletier, 2004).

Understandably, a vast range of musical tastes and preferences exists, influenced by familiarity, personality, social and many other factors (North, 2010; Schubert et al., 2014). Whilst liking a piece of music may contribute to the emotions expressed by it, the degree of pleasantness of the music was shown to be a more useful predictor of emotions (Ritossa & Rickard, 2004). Where some people may prefer heavy metal or techno, these genres have none of the demonstrated health benefits observed with other genres, such as classical and baroque (Trappe, 2012).

The superior effectiveness of preferred music in some studies may be attributable to common structural features of the participant-selected music. A recent study used post hoc acoustic analysis of pieces chosen by participants in three earlier experimentally-induced pain studies (Knox et al., 2011). This novel approach uncovered some commonalities in characteristics of participant-selected music. The pieces predominantly expressed contentment, with lower intensity and slower tempo. They were generally of brighter timbre and tended more towards major modalities. Timbral features were found to be most

important, both to the perception of pain and the degree of pain reduction. Pain tolerance also was greater for music with less pitch variation and less prominent harmonic changes. These results highlight the importance of both content and structure of music in eliciting emotional responses in the listener (Knox et al., 2011).

Several other authors have noted the inherent qualities of music chosen, rather than who selected it, as being most important to the outcomes the music provided. Nilsson (2008) singled out tempo as being the crucial element of the music, whilst Iwanaga and Moroki (1999) demonstrated that emotional response was determined more by type (excitative versus sedative) than preference. Similarly, stimulative music was shown to arouse physiological responses as well as positive feelings such as joy and elation, whilst sedative music induced both aroused and sedative emotions as well as increased HR (Lingham & Theorell, 2009). It seems that the differential arousing effects of these two categories of music is not straightforward.

Categorising music

Care needs to be taken not to oversimplify categorisation, such as sedative versus stimulative music, when selecting music. Other factors such as familiarity, preference, current mood, musical training, and so on, can all affect a person's emotional response to music (Knight & Rickard, 2001). How pleasing, aesthetic and familiar music is may also be important to emotional response.

A frequently used labelling is pleasant versus unpleasant. One study compared pleasant pieces, namely Bach's *Brandenburg Concerti*, Mozart's *Eine Kleine Nachtmuzik* and the Bizet *Symphony in C min*, to unpleasant and often dissonant 20th century pieces: Penderecki *Symphony No* 1, Ligetti's *Cello Concerto*, and *Notations II* by Boulez (Silvestrini et al., 2011). Although the unpleasant music still proved to have the distractive power to moderate experimental pain, the pleasant music was superior in reducing pain ratings and increasing pain tolerance. On the physiological level, unpleasant music — again by Penderecki — was found to induce increased release and decreased peripheral content of serotonin, where those listening to pleasant music — by Brahms — had higher serotonin levels in their blood platelets (Evers & Suhr, 2000). Based on this empirical evidence, it appears advisable to avoid dissonant

20th century compositions and favour music by composers from the earlier baroque, classical and romantic periods covering the 17th through to the late 19th and early 20th centuries.

Genre

. . . it can be assumed that many of the compositions in western music between 1600 and 1900 were designed to communicate and induce emotions in ordinary listeners.

(Kreutz, Ott, Teichmann, Osawa, & Vaitl, 2008, p. 104)

Western art music, commonly called classical music, has been the music of choice for many studies. Thoma and her colleagues found Allegri's *Miserere,* from the 17th century baroque period, compared favourably to both sounds of rippling water and no acoustic stimulation in response to, and recovery from, a stressor (Thoma et al., 2013). Chafin and her group also tested recorded baroque music, by Pachelbel and Vivaldi, in their stress recovery study (Chafin et al., 2004). The baroque music — but not the jazz, popular music or silence to which it was compared — induced significantly lower post-task BP, indicating superior recovery from stress. The authors did raise concerns about whether one could generalise the results to include other classical music genres.

Slow movements from piano sonatas, by celebrated 18th century composer Mozart, were played through headphones to critically ill patients in a neurotrauma intensive care unit (To et al., 2013). This standardised, but again narrow, selection met the criteria of relaxing music: predictable dynamics, slow tempo, low pitch, and simple repetitive rhythms. The authors concluded their results supported music's potential as a non-pharmacological intervention for reducing agitation in critically ill patients.

It also appears that classical music is liked by the majority of listeners. In a study looking at the effects of different types of music on vital signs, the participants rated examples of fast classical and slow classical music as first and second preferences, followed in order by rap, raga, techno and finally dodecaphonic (dissonant) music (Bernardi et al., 2006). The 24 participants were colleagues of the researchers, or medical students, so may not accurately reflect the tastes of the wider community. However, these results do suggest that classical music is a genre that would appeal to the majority of participants in a planned study.

Cultural considerations

A multicultural country such as Australia poses possible challenges in selecting culturally appropriate music that all listeners can relate to. A Turkish study presented men awaiting urogenital surgery with their choice of Turkish classical, popular, folk or art music, resulting in statistically significant lowering of anxiety scores compared to the control group (Arslan, Őzer, & Őzyurt, 2008). Similarly, a Taiwanese study of preoperative anxiety found both broadcast and headphone-delivered folk songs and light popular music to be effective anxiolytics (Lee et al., 2011).

To further illustrate the relevance of familiarity and appropriate selections of music, a paediatric study used familiar nursery rhymes, play songs and lullabies to measurably improve the little patients' wellbeing (Longhi et al., 2013). On the other hand, familiarity with musical material was demonstrated to exert no systematic influences on subjective valence and arousal in some studies, so having only minor effects on induced emotions (Kreutz et al., 2008; Ritossa & Rickard, 2004). Therefore, familiarity with a particular genre may not be a necessary prerequisite in music selection.

Although there could be culturally determined preferential differences for participants enrolled in this study, all those taking part will have developed, along with their English language skills, vicarious experiences and enculturation of Western tonal music. With the ever-growing ubiquity of music, everyday life inadvertently exposes people to a vast array of genres and music from many cultures, broadcast through television, film, radio, the internet, and whilst shopping, dancing or exercising (North & Hargreaves, 2009; Sloboda et al., 2001). Even in non-Western cultures, Western music has been disseminated through the increasing globalisation of media (Thompson & Balkwill, 2010) as well as historical factors such as imperialism. As an example, a trial of Chinese men awaiting prostate surgery in a Hong Kong hospital found they exhibited no distinct preference for Chinese music over the Western genres offered, with the music tapes overall providing effective relief from symptoms of preoperative anxiety (Yung, Chui-Kam, French, & Chan, 2002).

Whilst listeners may have varying degrees of exposure and familiarity with the music selected for a study, their perception of emotions in the music is due to a combination of universal psychophysical cues and cultural-specific cues.

The universal cues include the basic structural features of music, such as melodic and rhythmic complexities, timbral and dynamic factors, pitch and tempo (Thompson & Balkwill, 2010). These musical features can trigger universal responses because psychophysical cues are embedded in evolutionary processes: emotions can be viewed as biological mechanisms of preparedness, and therefore a vital necessity for survival (Thompson & Balkwill, 2010). This is also evidenced developmentally, with infants responding consistently to a number of sound features found in music across cultures (Staricoff, 2004).

Instrumentation

His station is there; and he works on the crowd,
He sways them with harmony merry and loud;
He fills with his power all their hearts to the brim –
Was aught ever heard like his fiddle and him?

William Wordsworth, 1807 (Stillinger, 1965)

The above discussion has focussed on instrumental music. As was established in the preceding chapter, the use of songs can confound a study due to the distracting elements of the lyrics (Krout, 2007). In order to focus on the effects of music in its own right, only instrumental music should be selected. The aim of any music intervention is to draw the listener into the experience in order to maximise its effects. Instrumental music has been demonstrated to be effective in its ability to absorb the listener and thereby induce basic emotions (Kreutz et al., 2008).

The types of musical instruments used in a clinical setting need to be carefully considered (Staricoff, 2004). Some wind instruments such as the oboe, due to their more penetrative timbres, would not be suitable for a bedside intervention. String instruments, which can be played through a wide dynamic range and also have the option to be muted, are more suitable for such intimate settings, especially where the possibly intrusive bleeding of sound beyond the immediate space around the patient needs to be taken into consideration. The collaborative study using professional symphony orchestra players used only string instruments in their PC setting, although this was due to self-selection of musicians rather than study protocols (Curtis, 2011).

Length of intervention

Once decisions have been made about genre and instrumentation, the length of the music intervention needs to be established. Music interventions in Nilsson's (2008) review ranged from 5 minutes to 4 hours, with most lasting from 15 to 30 minutes. Even short exposure to music has been shown to precipitate measurable physiological outcomes (Bernardi et al., 2006). Ilie and Thompson (2011) decided that seven minutes of music or speech was a "long exposure length that ensured full and authentic induction of emotion". They explained that a briefer exposure may allow a listener to perceive emotional content but not necessarily result in affective change.

Idiosyncratic decisions on intervention duration appear mostly to be made arbitrarily rather than empirically. For instance, after being unable to find a recommended length for optimum benefits, one study settled on 20 minutes of recorded music as it fitted in with the surgery schedule (De Marco et al., 2012). Other studies had widely varying durations, such as Curtis's (2011) study with symphony orchestra players which ranged from 15 to 60 minutes. However, most authors did not justify why they chose their particular length of music exposure (e.g., Cooke et al., 2005).

The intervention needs to be long enough to allow the listener to become engaged with the stimulus provided, but not so long that boredom occurs. Disengagement from the experience is less likely with a program that provides variety and interest to the listener.

Selection of pieces: creating a balanced program

Regular concert goers will recognise the familiar pattern of programming where contrast is created through alternating fast and slow, major and minor, joyous and introspective, and so forth. Even within one piece such contrasts can be evident, as in a typical sonata where each movement has a different tempo and often different modalities; or a short minuet with a major first section followed by a slower middle part, possibly in a minor key, and finishing with a recapitulation of the first section.

Similar structures are relevant when planning the music program for a research study. To avoid overstimulation of SNS activity, it is recommended to alternate fast and slow rhythms, and to include pauses between pieces to induce

relaxation (Bernardi et al., 2006). A program of 5 to 6 contrasting instrumental pieces, played for around 20 minutes, would fit in with the guidelines discussed so far. Such a program could be played live to participants, or played back as an audiovisual or audio recording.

Presentation of music

Music fills the infinite between two souls.

(Tagore, 1921, p. 64)

Music experiences are individual, and may be shared or private (Olofsson & Fossum, 2009). When emitted, sound waves bridge objects and people, by collapsing the distance between them, resulting in the perception of being close together (Wallach, 2003). This applies to recorded sound as well as sounds produced live within a discrete space such as a room or concert hall. However, each listener will perceive the same music in their unique way, coloured by all the environmental and biopsychosocial factors discussed so far.

Where a direct comparison is required between modes of presentation, the same music, musicians, and ideally the same performance, should be used for each mode. The live presentation can be audiovisually recorded, and then played back as AV and audio (A) recordings. This way each live presentation is repeated in both the AV and A conditions. The environments in which these various conditions are experienced by the participants also need to be consistent (Finnäs, 2001).

To date, no study has been found that follows such a protocol. Existing studies have compromised on the duplication of the live condition. For instance, a MT experiment tested the differential effects of live versus taped music on orientation and agitation of posttraumatic amnesia patients (Baker, 2001). Each participant was exposed to popular music, with the researcher using an electric piano and voice as the live condition, and cassette tapes of original artists' recordings of the same songs for the taped condition. Although overall the music, compared to no music, did reduce agitation and enhance orientation, significant differences were not found between the music conditions. This is not surprising, as there would have been variability in quality of production as well as musicianship and presentation skills between the researcher and the

professional recording artists, all potentially moderating the effects of the live music.

Live music

From the moment that the first note was struck the audience became completely spellbound. And as for James, never had he heard such beautiful music as this!

(Dahl, 1967, p. 83)

Bedside music is provided by musicians in a variety of hospital and hospice settings, using instruments such as harp (e.g., Sand-Jecklin & Emerson, 2010), guitar (e.g., Segall, 2007), bowed string instruments (e.g., Curtis, 2011), keyboard (e.g., O'Callaghan, 2001), and voice (e.g., Arnon et al., 2006). Rather than being formal concerts, they are mostly interactive musical experiences, usually presented on a one-to-one basis.

Recreating such informal and two-way processes within a controlled research protocol can pose some challenges. Even when present, a researcher has no ultimate control over any communication which spontaneously occurs between the musician and listener. Whilst capturing a live presentation on videotape, interactions specific to the synergy of the initial musician and listener are also recorded. Some editing may be required to remove individual responses before presenting recordings to subsequent participants.

Recorded music

I was listening to Mozart. And such *Mozart you would not believe. It was Mozart of the angels. The piano concertos played so perfectly, it was* beyond. *I could see the face of God in the sound.*

(Goldsworthy, 2011, p. 237)

A recording is in some respects a disembodied representation of a musical event. The music has been separated from many of the salient elements of a live musical experience. However, an audio recording can provide the listener with an aural focus without visual stimuli to detract or distract from the listening experience, such as incongruities in the appearance or expressions of a musician (Finnäs, 2001).

In an AV recording, those factors are still present, but the human elements of the immediacy and intimacy of the person creating the music in a shared space have been taken out of the equation. Platz and Kopiez (2012) concluded, in their meta-analysis of AV presentations, that the visual component is an

integral factor of communicating meaning in music, in particular through complex interactions with auditory stimuli. So potentially there should be measurable differences in responses to AV compared to A recordings. Indeed, their meta-analysis did reveal an average weighted medium effect size of d = 0.51 standard deviations for the visual component when evaluating music for liking, expressiveness and quality (Platz & Kopiez, 2012). Cross-modal interactions were also demonstrated between the auditory and visual components of music in a study using electrodermal activity as a measure of emotional response, with significantly higher amplitudes resulting from exposure to AV compared to audio-only or visual-only conditions (Chapados & Levitin, 2008).

Sound and visual quality need consideration when choosing equipment for the AV and A conditions. Various options exist for playing back a recording to participants. Headphones can provide high quality sound but, as discussed before, introduce the confounding variable of masking environmental noises. There is also a potential infection risk with the use of non-disposable headphones (Lee et al., 2011). Portable speakers may be a compromise for sound quality, but are practical and realistic in terms of what might be used in a clinical program. Similarly, a large screen projection of AV material is not tenable in a small hospital room. Small screens such as a television or laptop are more workable, and a laptop in particular provides portability and standardisation of presentations. The sound can be enhanced by the same portable speakers used for the audio playback, thereby removing another potential confounding variable.

Stories as a control condition

. . . both music and language consist of sounds organized in time.

(Lerdahl, 2001, p. 337)

An important question to ask when examining music's potential to influence health and wellbeing outcomes is whether music is unique in its processes and efficacy (Mitchell & MacDonald, 2012). Is it the music per se or the general calming acoustic stimulation that brings about relaxation and other positive outcomes (Thoma et al., 2013)? Or perhaps outcomes are due to the social context associated with the delivery of the music, such as the presence of the musician and/or researcher decreasing feelings of isolation (Linnemann, Strahler & Nater, 2016; Magill Bailey, 1983)?

Ethical issues have been raised regarding the use of control groups that deny participants the likely benefits of a music intervention by assigning them to a no-music-intervention control group (Jones, 2006; Pothoulaki et al., 2006). One way of overcoming such concerns is to provide an alternative intervention that does not have any musical properties, but which can control for the psychosocial factors associated with presenting the music (Chanda & Levitin, 2013).

Stories have been shown to provide many of the same positive psychosocial benefits as music, with both self-selected audiobooks and music listening — over a period of 2 months — providing refreshing stimulation and evoking memories about the past in patients recovering from strokes (Forsblom et al., 2010). Results of the study also highlighted differential effects, with only music specifically promoting better relaxation, increased motor activity and improved moods.

Selection of stories

At night he is never tired enough to sleep. She reads to him
from whatever book she is able to find in the library downstairs.
. . . He listens to her, swallowing her words like water.

(Ondaatje, 1992, p. 5)

Story readings appear suitable as a control condition for music interventions, assuming that psychosocial factors are equalised in both conditions. This allows inferences to be drawn on specific effects of the music, without the numerous other factors associated with the interventions confounding the outcomes.

In order to reliably use stories, they need to be carefully selected to match the length, affect and global structural attributes of the music program. The texts chosen should not include poems as the rhythm, prosody and contour of poetry are quasi-musical. An evolutionary explanation is that poetry straddles the divergence of music and language, retaining the musical elements of metrical and timbral patterning as well as language-specific syntax and word meaning (Lerdahl, 2001).

Music is often consumed in both AV and A formats, and as live music. Stories or books are generally listened to as audio books, or someone reading to another person, but not as AV experiences. It is therefore not relevant to include an AV story condition in a study comparing live to recorded story readings as a control for the three music conditions.

Medley: a mixed-method approach to assessing outcomes

An important and highly fruitful trend is likely to be the fusing of many areas of research.

(Hallam, Cross, & Thaut, 2009, p. 566)

A vast range of studies has been reviewed, some of which only used one outcome measure, such as cortisol, or a VAS, or a questionnaire, and so on. The majority of studies though have used two or more instruments to measure the effects of their interventions. Many have combined self-report measures, such as anxiety scales, with objective readings of vital signs or biomarker levels (e.g., Robles et al., 2011), allowing comparisons between outcome measures whilst simultaneously improving validity and rigour of the studies.

A clearer picture emerges of processes involved in music listening when numerous outcome measures can target different aspects of music processing. Inconsistencies between various emotional response systems may be clarified by the use of multiple outcome measures to encapsulate as many psychophysiological responses to music interventions as possible (Sandstrom & Russo, 2010). Biomarkers have variable time courses, responding in milliseconds, or over minutes or longer, depending on the systems they reflect (Engert et al., 2011).

As well as using multiple outcome measures, it is advisable to take these at more than one time point. The standard baseline and post-intervention measures taken in most studies may, or may not, indicate an immediate effectiveness of a music intervention, but the duration of that effect is not established (Lee et al., 2012). To address this gap, the addition of a third measure would capture any residual or delayed effects. As an example, a study looking at mood induction through both mental recall and music found that sIgA levels increased with both positive and negative moods, but more for the happy moods than sad moods. What is relevant here is that these levels were sustained for at least 30 minutes after the end of the interventions, as evidenced from the third saliva sample taken (Hucklebridge et al., 2000).

Blinding participants and researchers

Ignorance is bliss

Thomas Gray, 1716-1771

The ideal scenario for optimal validity and rigour in a study is for participants to be unaware of the specific nature of the outcomes being measured, and data collectors and analysts to be unaware of the intervention to which the participant they are assessing was exposed to. In reality, such blinding is not feasible in many music psychology studies. This is particularly so for studies using live music (Sand-Jecklin & Emerson, 2010). Of the 42 studies in her review of music interventions, Nilsson (2008) found only two were double-blind, that is, for both participants and researchers, and nine were single-blind.

Blinding participants

Blinding of participants is a challenge in music psychology research. In most instances, participants are informed that the nature of the study is to assess some type of music intervention. In some studies participants are asked about their musical preferences prior to the interventions (e.g., Silvestrini et al., 2011; Walworth, 2010).

The frequently used repeated measures design requires pre-test collection of baseline measures, alerting participants to the nature of the outcomes being focussed on. Where these are self-reported anxiety or pain, the participant is enlightened as to at least some aspects of the study (Bradt & Dileo, 2011). Once a participant is allocated to a specific intervention they are no longer blind to what they are being exposed to, unlike a drug trial where de-identified drug or placebo may be given.

Blinding of data collectors

As the data collector is often present during the intervention it is not possible for them to be blind to each participant's treatment group. Bias is therefore a possible confound, of which the researcher needs to be ever vigilant. This is especially so where the data collector is also the researcher, as in this current study, where there is personal and professional investment in the project.

Reliability and validity of assessment tools

The reliability and validity of instruments and equipment used was not reported in some studies in the Nilsson (2008) review of music interventions. Similar concerns were raised in another review of methodological issues in music intervention studies (Pothoulaki et al., 2006). As the following discussion will demonstrate, the battery of instruments chosen for this study is made up mostly of validated and reliable assessment tools.

Subjective outcome measures

All that we see or seem
Is but a dream within a dream.

Edgar Allan Poe (Fox, 2012, p. 8)

Measuring more than one psychological construct will provide a more comprehensive overview of how music impacts on participants (Fancourt et al., 2014). The method employed to measure such constructs also needs to be appropriate for the population targeted in the study.

Most studies in Nilsson's (2008) review used observational or subjective self-reports as outcome measures to assess the effects of music interventions on patients' anxiety and pain. The most commonly used measure of anxiety was the STAI, which requires participants to answer an initial 20 questions, and then 10 questions for each of the post-intervention measures. Other studies used the simple VAS for anxiety. The VAS was also the most popular measure for pain studies in the review.

It is unrealistic, unethical, burdensome, and unfair to patients, to administer long drawn out pre- and post-test instruments in PC and surgical units (Pearson, Todd, & Futcher, 2007). Wherever possible an outcome should be measured with a quickly administered tool rather than a long questionnaire. Consideration should also be given to the versatility of the instrument: can the responses be verbal as well as written, and can it be administered to a patient lying down?

Questionnaires

I don't play accurately — anyone can play accurately —
but I play with wonderful expression.

(Wilde, 1895)

Demographics

Basic demographic information, such as age and gender, should be gathered for a study to test for any possible confounding effects. In addition, it is useful in student studies to have information about their academic pursuits and health status; and for clinical studies, diagnostic information is relevant.

Salivary biomarkers are sensitive to possible interactions with foods and medicines consumed prior to sampling (Morse et al., 1986), so such information should be requested from the participant at the same time as the demographic details in case of any anomalies that show up during assaying of the saliva (Granger et al., 2012).

There is evidence in the literature of differential effects of emotional responses to music between musicians and non-musicians (e.g., Bernardi et al., 2006; Staum & Brotons, 2000). On the other hand, music education was shown to be less relevant than affective attitude in influencing changes in the neurotransmitter serotonin during music listening (Evers & Suhr, 2000). Nevertheless, such information is useful to have up front.

Enough has been said already about musical preferences to indicate that there may be interactions between these and emotional responses to music. Again, such information supplied by the participant before their intervention is of possible use later in the analysis stage of the study.

Affect scales

In addition to the questions asked of participants beforehand, there is relevant feedback to be gleaned post-intervention. This includes whether the listener actually liked the music or stories presented to them, which ties in with the previous issue of preferences. Sandstrom and Russo (2010) used a four-point Likert-type scale to ascertain how much their participants liked the music they were exposed to.

Liking the music may also be influenced by the delivery. Anyone who has listened to MIDI music generated from an electronic score will appreciate that real musicians perform more than an exact reading of the notes and other markings on that musical score. Their ability to make the dots and dashes on the page become alive and expressive depends on how they vary the volumes, timing of onset and length of notes, and even bending of the pitches of notes, to trigger emotions in the listener (Scheirer, 1995). The same concept applies to the reading of stories, with a wooden or robotic monotone voice not conveying the same emotion as one that varies speed of delivery, has gaps to create tension or emphasis, and can vary pitch up or down through a wide range.

With more than one performer, and possible variations even between the same performer's multiple presentations, it is important to get feedback from the listeners on their perceptions of the level of expressiveness, and also how much emotion they felt in response to the music or stories they heard. Answers to all these questions can be in the form of a simple linear numbered and labelled scale.

Absorption scale

Not everyone engages with music to the same degree. Individual differences are likely in the level of absorption in a musical experience (Kreutz et al., 2008), adding a possible confounding variable. Furthermore, where multiple musicians and readers are employed, their differing skills and emotional expressiveness may influence levels of engagement of listeners (Sandstrom & Russo, 2011).

The central premise of this study is that there are differences in the therapeutic benefits derived from listening to live compared to recorded music. Cognitive and emotional factors, as discussed in earlier chapters, are important considerations in explaining any individual differences in the effects of music. These in turn both influence and are influenced by how immersed or absorbed a person is in a musical experience, that is, how willing they are to be drawn into the moment fully, without distraction (Sandstrom & Russo, 2011).

It is therefore useful to have some measure of absorption as an outcome measure. This could be in the form of a questionnaire, or more simply as a numerical or linear scale as for the previous affect questions.

Visual analogue scales (VAS)

Visual analogue scales (see Figure 2) are particularly suited to the measurement of phenomena that are subjective — such as pain and anxiety — and so best quantified by the participant (Cox & Davidson, 2005). The VAS also meets the trifecta of simplicity, ease of use, and speed, making it an attractive research tool, especially with vulnerable populations such as PC patients. The VAS is versatile, so can be applied to a wide range of phenomena, including pain, mood, and anxiety, providing a quantitative variable for statistical analysis in research (Cox & Davidson, 2005).

Figure 2. Visual analogue scale – pain

Importantly for researchers, the VAS has been validated as a tool for the measurement of pain as well as anxiety in numerous studies, so the user can be assured that the scale is measuring what it is supposed to measure (Cox & Davidson, 2005). A caveat to this concerns semantics: the constructs of pain and anxiety may have divergent meanings for different people, so a single-item tool such as the VAS may not always be measuring exactly the same outcome. It may be helpful to add the word *stress* to the descriptor or instructions as it is commonly used interchangeably with *anxiety*.

VAS for pain (VASP)

Widely used in nursing care, the VASP provides snapshots of pain levels to assist in providing appropriate analgesic support to patients. This pain measure consists of a horizontal 10 cm line marked on paper, with clear end points each underscored with a short descriptor: to the left of the scale are typically the words, "No pain", and on the right, "Worst pain imaginable" (see Figure 2). The patient is asked to mark a point on the line that best represents how they are feeling at that moment in time (Hornblow & Kidson, 1976).

Whilst the VASP does not provide an absolute value, it is useful for repeated measurements, giving feedback on treatments in individuals as well as the possibility of comparing quantitative scores from different research groups (Cox & Davidson, 2005). A comparative clinical study reported a fairly good correlation between the VASP compared to the often used McGill pain questionnaire (Bodian, Freedman, Hossain, Eisenkraft, & Beilin, 2001). Spearman rank correlation coefficients were 0.69, 0.69 and 0.54 respectively for the morning measures, afternoon measures and differences between the two time points.

The most salient advantage of the VASP over a questionnaire-based pain instrument is the minimal length of time and effort required to complete it: the VAS takes only seconds to complete, where a questionnaire can take many minutes of concentrated effort.

Demand characteristics may occur where a numerical pain scale is used. Such a scale has evenly spaced numbers along the line, typically 1 through to 10 on the same 10 cm line as for a VASP. One disadvantage is that respondents tend to gravitate to the numbers 5, 10 and 15 on numerical scales (Cox & Davidson, 2005). Also, memory for a previous entry on an unnumbered VAS line is harder to quantify than for a numbered scale, so is less likely to interfere with repeated measures. Even viewing their earlier VAS form did not influence patient's subsequent scoring on the VAS in the clinical study cited earlier (Bodian et al., 2001). However, there is less likelihood of a participant second-guessing their instinctive response on the VAS if they mark it without reference to their earlier scored VAS.

VAS for anxiety (VASA)

The State Trait Anxiety Inventory (STAI), a two-part 20 item questionnaire, has been used in thousands of empirical studies since the early 1970s (Cox & Davidson, 2005). It is the most frequently used instrument for measuring anxiety (Vaughn et al., 2007). Also widely used since its introduction in 1976 (Facco et al., 2011), the VASA is identical to the VASP, but with the references to pain replaced with anxiety-related descriptors.

Numerous studies have demonstrated significant correlations between the standardised STAI (state section) and the VASA (Cox & Davidson, 2005; Hornblow & Kidson, 1976; Pritchard, 2010). In addition, the VASA has been validated against other standardised tools such as the Hamilton Rating Scale for Anxiety, and the Anxiety Subscale of the Hospital Anxiety and Depression Scale (Williams, Morlock, & Feltner, 2010), further supporting the validity of the VASA for the measurement of anxiety.

A person scoring above 5 cm on the VASA could be regarded as anxious (Facco et al., 2011), but the instrument is more suited for comparisons rather than giving absolute values (Cox & Davidson, 2005). Again, the VASA has the advantages of ease of application and comprehension, as well as being very

quick to administer. Alternatives such as the state section of the STAI are far more burdensome for a participant to complete, both in time and effort (Williams et al., 2010).

One word

Spontaneous one-word verbal responses have been shown to be reliable indicators of creative cognition (Prabhakaran, Green, & Gray, 2014). A one-word answer could therefore provide a condensed summary of each participant's experience if they are requested to provide feedback on an intervention.

Unsolicited comments

Patients in the MRI study comparing live to recorded music were offered the opportunity to make narrative comments after their participation. Only those who heard the live music chose to make any positive comments, with 90% of their comments being positive. Those listening to the recorded music only made negative comments, mostly about not liking the music chosen for them to listen to (Walworth, 2010).

Even when no formal feedback is requested, participants may provide unsolicited commentary on their thoughts about the study in general, or their particular experiences. Keeping a written record of such comments can provide further insights into individual experiences and processes of listening to music and stories.

Objective outcome measures

Stress is a multidimensional construct. To accurately represent stress physiology, multiple stress measures across multiple stress-related systems should be assessed.

(Engert et al., 2011)

Multidimensional assessments

Subjective outcome measures have always presented challenges for researchers, in particular in terms of the reliability of self-reported anxiety and pain. Although frequently used to measure these constructs, self-assessments may reflect inaccurate interpretations of somatic sensations (King & Hegadoren, 2002). Where demand characteristics and other factors could distort subjective evaluations, the use of additional objective measures can greatly improve the validity of the results.

Biomarkers offer an accurate and objective tool for measuring therapeutic outcomes of interventions (King & Hegadoren, 2002). They may also help to explain discrepancies sometimes observed between subjective and other objective outcomes, such as vital signs. Knight and Rickard (2001) found stress-induced increases to CV measures of HPA and SNS activity from a cognitive stressor task were moderated by listening to music. This was despite the participants' failure to report their own stress. Such results highlight the importance of multidimensional assessments of outcomes (King & Hegadoren, 2002).

Physiological evidence of stress and recovery

The physiological expression of stress can be measured at various points along the stress axis. The most salient sensations experienced by a person when stressed are increased HR and RR, as well as visceral sensations. Also measureable are changes in BP.

Underlying these somatic variables is the domino effect of observable hormone releases in the HPA axis triggered by a stressor. A stressor causes the hypothalamus to release corticotrophin-releasing hormone (CRH), which binds with corticotrophs in the anterior pituitary gland, synthesising and releasing

adrenal corticotrophin hormone (ACTH) into the circulation. The ACTH then binds to receptors on the adrenal cortex, culminating in the synthesis and release of cortisol into the bloodstream (Kalman & Grahn, 2004). Cortisol is thus a direct and objective indicator of a stress response.

In addition to cortisol, many studies use biomarkers such as α-amylase, immunoglobulin-A, and other immune markers such as cytokines, as indicators of stress and recovery from stress. The growing field of PNE research is favouring biomarkers over vital sign measurements in music psychology research as they offer more reliability in detecting psychophysiological changes precipitated by music. Measuring PNE changes provide a direct path to observing the changes occurring in the brain and elsewhere in the body during music processing and the ensuing emotional responses (Kreutz et al., 2012).

CV measures of recovery from stress

BP has been chosen by some researchers as an indicator of post-stress recovery when assessing the efficacy of a relaxation facilitator such as music. Chafin and her colleagues (2014) found that participants who listened to 10 minutes of baroque music (by composers Pachelbel and Vivaldi) whilst recovering from a challenging mental arithmetic task had significantly lower systolic BP levels than those who recovered in silence or whilst listening to jazz or pop music. BP results significantly correlated with the STAI, showing a moderate relationship between self-reported anxiety and delayed CV recovery.

Live classical piano music was found to moderate mean arterial BP, HR and RR for patients undergoing ophthalmic surgery, with those exposed to the live music (n = 115) showing statistically significant decreases in these vital signs when compared to the control group not exposed to the music (n = 88). In contrast, this group showed statistically significant increases in the same vital signs (Camara et al., 2008).

Other studies monitoring vital signs have yielded inconsistent outcomes. The trilogy of BP, HR and RR was supplemented by self-reported anxiety of 20 women listening to music whilst awaiting breast biopsies (Haun et al., 2001). Only the RR and state anxiety were significantly lower in the post-test music group compared to those that had no music intervention. BP and HR were not significantly different between the two groups. These results highlight the

problems associated with measuring vital signs in the context of music interventions. As explained in previous chapters, music may be relaxing whilst at the same time arousing, and so could stimulate the increase of vital signs despite the fact that the listener may report feeling less anxious.

Other physiological parameters of stress and relaxation

A rich source of data about physiological effects of analgesic and relaxation interventions, such as music, can be gleaned from biomarkers of the endocrine and immune systems. Biomarkers are present in all body fluids, including cerebrospinal fluid, urine and saliva, as well as blood, sweat and tears. The following discussion will explain the benefits of using the PNE approach of measuring biomarkers, in particular when accessing biomarkers in the readily available oral fluid, saliva.

Stress and the immune system

The biological stress response is an elegant choreography of neuroendocrine, autonomic, metabolic, and immune system activity that involves multiple feedback loops at the level of the central and peripheral nervous systems.

(Chanda & Levitin, 2013, p. 183)

A meta-analysis of over 300 empirical articles about human psychological stress and the immune system (Segerstrom & Miller, 2004) highlighted the differential effects of acute as compared to chronic stressors. Acute time-limited stressors, such as public speaking, are associated with potentially adaptive up-regulation of natural immunity and down-regulation of some aspects of specific (acquired) immunity. Brief naturalistic stressors, such as exams, are likely to suppress cellular, but not humoral, immunity, whilst chronic stressors tend to suppress both these aspects of acquired immunity by altering patterns of cytokine secretion. Cellular immunity targets intracellular pathogens such as viruses, where humoral immunity protects against extracellular bacteria and parasites (Segerstrom & Miller, 2004).

Whilst knowledge of the effects of stress is substantial, few studies have examined how positive emotional states, such as those induced by music listening, may impact on the immune system (Hucklebridge et al., 2000).

Indicators of stress, relaxation and immune system function are available in measurable quantities in saliva.

Saliva

Oral fluid, often called the 'mirror of the body', is a perfect medium to be explored for health and disease surveillance.

(Segal & Wong, 2008)

Oral fluid is generally called saliva, although technically it also contains a fraction of serum through leakage from the cleft area between teeth and gums (Granger et al., 2012). Saliva is secreted by glands located in or around the oral cavity (Nguyen & Wong, 2007) innervated by both sympathetic and parasympathetic nerves (Nater et al., 2005). Saliva is composed mostly of 99% water (Henson, 2007) which contains electrolytes and organic molecules, such as amino acids, proteins and lipids. These largely mirror those found in systemic circulation (Miller et al., 2010).

In addition to being necessary for digestion and speech, saliva — by forming a protective coating on oral mucosa (Henson, 2007) — provides the body's first line of defence against microbes entering the mouth (Park, 2007). Further along the digestive tract, saliva continues its immune surveillance role (Henson, 2007). Oral fluid is rich in uric acid as well as other antioxidants, such as albumin, α-tocopherol, β-carotene and ascorbic acid, which help to combat free radicals (Henson, 2007).

Saliva for diagnosis: past, present and future

Saliva has been used as a diagnostic fluid for thousands of years. The Ancient Chinese believed saliva shared its origin with blood, and examined its appearance, viscosity, smell and taste (Hu, 2007). Exploration of the biochemical and physiological properties of saliva goes back more than 100 years (Hu, 2007). Developments by the late 1980s of highly sensitive test procedures — able to detect low concentrations of hormones, drugs and microbes as well as DNA in saliva (Hu, 2007) — opened up the many diagnostic possibilities that saliva may offer.

Since that time there has been a rapid development of microfluidics technology allowing mobile bedside or chair side diagnostics (Herr et al., 2007; Park, 2007). Using credit card sized disposable microchips read by a compact hand-held reader, these bioassay innovations promise to circumvent the need for expensive and time consuming laboratory assaying (Herr et al., 2007; Miller et al., 2010; Segal & Wong, 2008). However, currently a lack of commercial availability of the new technology is limiting its access for the wider research community.

Saliva for research

Saliva is a rich source of biomarkers (Nguyen & Wong, 2007). In addition to some that are secreted by salivary glands, marker proteins found in blood are passed to saliva through fluid leakage at the gum line (Palanisamy & Wong, 2007).

The ease with which saliva can be collected is appealing for researchers. However, those working with saliva do need to be mindful of the fact that saliva is a human body fluid, with the capacity to carry serious pathogens such as tuberculosis bacterium (Nguyen & Wong, 2007) and the viruses causing herpes simplex, Epstein-Barr, meningitis, and hepatitis B (Granger et al., 2012). Therefore, ethical issues related to handling of the specimens, as well as patient confidentiality, need to be considered at all times (Tabak, 2001). That said, the non-invasive nature of saliva sampling exposes both the participant and the person taking the samples to less physical and emotional risk than does extracting blood (Palanisamy & Wong, 2007).

No specific courses are required for saliva sampling, unlike the training necessary for phlebotomists (blood collectors). Whilst care needs to be taken to limit variations in the integrity of samples (Chiappin, Antonelli, Gatti, & De Palo, 2007), handling and storage of saliva have less rigid protocols than those for blood specimens (Kirschbaum & Hellhammer, 1999). This means that saliva sampling is more readily available to a wider range of researchers than drawing blood samples.

Another benefit to the researcher is that the less stressful collection process for saliva avoids the potential confound of the actual sampling affecting stress marker levels (Chiappin et al., 2007). A further advantage is that salivary

biomarkers reflect real time levels. Biomarkers measured in other bodily fluids are stored (urine) or are in circulation (blood), so may be indicating delayed physiological responses (Koh & Koh, 2007).

Conditions affecting saliva

Healthy adults usually produce 500 to 1500 ml of saliva daily, at a rate of around 0.5 ml per minute (Chiappin et al., 2007). Both the flow rate and viscosity of saliva may be affected by emotional states, circadian rhythm, anticipation of pleasure or food, eating, conditioning, diseases, drugs, radiation and chemotherapy, age, dehydration, stress/relaxation, and strenuous exercise (Morse et al., 1986; Morse, Schacterle, Furst, Esposito, & Zaydenburg, 1983). Preoperative fasting, including withholding fluids, is another consideration affecting saliva flow in surgical patients (Liddle, 2014). PC patients may also be consuming little or no food or fluids, with similar consequences. Low flow rates due to any of the above factors can be an impediment to successful collection of saliva samples (Miller et al., 2010).

PNS stimulation increases the flow of watery, amylase-rich saliva, whereas activation of the SNS inhibits this secretion from the parotid and sublingual glands (Morse et al., 1983). Typical stress-related changes to saliva include decreased volume and levels of α-amylase and pH, and increased viscosity, opacity and protein; whilst meditation sessions have been shown to increase translucency, and decrease protein and bacterial levels of saliva (Morse et al., 1986). Some previous studies have found salivary biomarker findings positively correlated with CV measures and subjective evaluations of stress and relaxation (Morse et al., 1986). But as noted earlier, others have not demonstrated such clear agreement between measures.

Methods of collection

Many different collection methods are employed in saliva-based studies. These include the use of cotton, rayon or polyester dental rolls to collect what is usually pooled sublingual fluid (Hucklebridge et al., 2000); stimulated saliva activated by biting or chewing on a collection swab or cottonwool ball (Kalman & Grahn, 2004), or chewing on wax, gum, or citric acid before expectorating whole saliva (Lu, 2003); or whole unstimulated saliva expectorated into a small

receptacle (Khalaila et al., 2014), or passively drooled directly (Christodoulides et al., 2007) or via a straw into a collection tube (Lu, 2003).

The advantage of whole saliva is that it represents a mix of secretions from the major parotid, submandibular and sublingual glands, as well as from numerous minor glands in the oral mucosa, the crevicular fluid, and from mucosal seepage (Tabak, 2001). However, stimulating the saliva may alter the composition of the oral fluids, or dilute the target markers through increased saliva flow (Granger et al., 2012).

Use of dental rolls or swabs can be problematic for some biomarkers: sC binds to cotton wool, so rayon is preferable; and sIgA levels may be artificially low using this method (Chiappin et al., 2007). Another issue with using rolls or swabs is that they require centrifuging to extract the saliva before assaying (Koh & Koh, 2007).

To avoid such issues, the most straight forward way of collecting samples is passive drooling of unstimulated whole saliva into a receptacle. This is also preferable to spitting, as the latter greatly increases bacteria levels that may adversely affect storage and analysis of the samples (Chiappin et al., 2007). Additionally, the issue of social barriers to spitting (Gröschl, 2008; Nguyen & Wong, 2007) points to the drooling method, especially if mediated via a straw, as the preferable — and cheapest — means of collecting saliva (Granger et al., 2012).

In terms of detectible levels, passive drooling was also found to be the best of three methods trialled for a range of markers for Alzheimer's disease (AD), including sAA, sIL-1β, and salivary beta-amyloid (sAβ). All markers were found to be elevated in those with AD. However, sAβ was not detected in the cotton swabs, whilst other markers were lower in the cotton compared to polyester swabs. Overall the passive drool method yielded higher levels of markers (Singhal & Anand, 2013).

The time of day that samples are collected can also affect their reliability. Most biomarkers are subject to regular 24 hour circadian rhythms, with levels fluctuating in a repeated daily pattern. It is therefore widely recommended that collections should occur at the same time of day for each participant to avoid introducing an additional confounding variable. However, these circadian rhythms are not the same for all markers. Whilst sC typically exhibits declining

levels in the morning, sAA has the reverse pattern, with lower levels in the morning which increase in the afternoon (Granger et al., 2012). The optimum time to sample is when the biomarkers are at their most stable, which for the majority of markers occurs mid-morning to early afternoon (Hucklebridge et al., 2000; Kalman & Grahn, 2004; King & Hegadoren, 2002; Koh & Koh, 2007).

There are also numerous recommended guidelines for what can and cannot be ingested, or even come into contact with the oral cavity, before sampling. Some of the published guidelines are stricter than others. For example, for sIgA testing it is suggested that samples be taken at least one to two hours after eating, smoking or exercise, over three hours after tooth brushing, and over 24 hours after any alcohol consumption (Lu, 2003). Other articles set down shorter withholding periods, such as 30 minutes for brushing teeth, fluids other than water, and food or chewing gum (Chiappin et al., 2007).

Most authors also recommend rinsing the mouth ten minutes before sampling (e.g., Lu, 2003), preferably with distilled water (Chiappin et al., 2007). Rinsing with water may dilute the target markers in saliva, so a ten minute gap between rinsing and saliva collection allows the saliva flow and concentration to recover (Granger et al., 2012).

Considering all the above, the optimum time for collection for a study with multiple biomarkers is mid to late morning, allowing for circadian rhythms as well as the withholding period after breakfast. Participants need to be informed of the restrictions to their intake beforehand to ensure maximum compliance with the protocols.

Handling and storage

Saliva is a bodily fluid and as such should be handled in the same way as any other potentially infectious fluid such as blood, with researchers using gloves and disposing of collection materials and equipment in a safe manner in accordance with best practice for handling biological waste. Saliva can harbor many serious infectious agents, as well as more common pathogens (Granger et al., 2012). However, as pointed out earlier, risks associated with saliva are much lower for both the participant and sample collector than with invasive venipuncture for blood sampling.

Steroids such as cortisol are generally very stable, whilst peptides, such as the cytokine IL-1β, are less stable and more susceptible to deterioration in storage (Gröschl, 2008). Specific considerations for each marker are raised in the following section. Generally, the handling and storage of saliva samples during collection as well as throughout the transport, storage and assaying phases is critical to achieving sound specimens and optimising the integrity of the results.

Most articles recommend saliva samples be stored on ice, refrigerated, or frozen immediately on collection. Some biomarkers, such as sC and sAA, can withstand at least three freeze-thaw cycles (Granger et al., 2012). However, it is best to avoid repeated freeze-thaw cycles at the early collection and storage phases as some freeze-thaw cycles are unavoidable during the subsequent sample preparation and assaying processes.

Recommended freezing temperatures vary from minus 20° C (Lu, 2003) to minus 80° C (e.g., Christodoulides et al., 2007). Some markers, such as sIgA, are stable at room temperature for up to five days (Lu, 2003); others, such as sC, remain unchanged at 5° C for up to three months (Chiappin et al., 2007); but for most markers the saliva should be frozen as soon as possible after transporting samples on ice to the freezer destination. For longer term storage, lasting days or months, freezer temperatures of minus 80° C are recommended (Chiappin et al., 2007).

Assaying

Analysis of saliva can occur at the cellular level, with biologically active compounds available compared to the mostly protein-bound compounds found in blood (Palanisamy & Wong, 2007). Immunoassays are the most common choice for laboratories when assessing levels of biomarkers in saliva (Granger et al., 2012). They are relatively simple to use, with kits containing all the necessary chemical components being provided by the manufacturers. Also, only tiny quantities of saliva ($\leq 100\ \mu L$) are required for each test (Gröschl, 2008).

Prior to assaying, the samples should be carefully prepared by centrifuging to break down viscosity and remove any particulates that may contaminate them, such as remnants of food (Granger et al., 2012). Where more than one

marker is being measured, the raw samples also need to be aliquoted, that is, separated into smaller quantities for the individual assays required for each biomarker.

Biomarkers

Biomarkers are defined as quantifiable biological indicators of a particular physiological process, whether normal or pathophysiologic, or of the risk of developing a disease.

(Khalaila, Cohen, & Zidan, 2014, p. 71)

There is reason to be optimistic regarding the emergent field of PNE, with substantial and growing evidence of the importance of psychological factors influencing immunity, wellbeing and health (Gruzelier, 2002). However, the complexities of the processes and inter-system interactions involved lead to difficulties in accurately predicting patterns or models of immune up- and down-regulation across various immune parameters (Gruzelier, 2002).

Perplexing inconsistencies between different physiological outcome measures of music interventions have already been described. In particular, vital signs such as BP and HR have not been reliable as outcome measures, perhaps in part as music may be arousing the listener. PNE offers the researcher alternative tools to measure physiological changes within short time frames as well as possible delayed and residual responses to an intervention.

In addition, use of a variety of biomarkers provides a multidimensional picture of responses from the various elements of the nervous and immune systems, such as the HPA axis, SAM system, and natural and acquired immune systems. Following now is a discussion on how specific biomarkers may reflect these more discrete responses, as well as practical considerations associated with each marker. The detailed information is summarised in Table 1 at the end of the section.

Cortisol

The steroid hormone cortisol is the most frequently measured neuroendocrine marker in research related to stress (King & Hegadoren, 2002). It is secreted by the adrenal cortex of the adrenal gland, situated above the kidneys. A review of the PNI effects of music reported that twenty-nine of the thirty-two studies which examined hormonal changes employed cortisol as an outcome measure (Fancourt et al., 2014). All but two of the cortisol studies in the review noted

reduced levels of the marker in response to music, and these two studies both observed increases in the treatment groups that were less than for the control groups.

Salivary cortisol (sC) is now widely accepted as an alternative to plasma or serum cortisol measurement (Chiappin et al., 2007). Measurement of sC is a validated indicator of HPA stress axis activity (Lu, 2003). Levels of free cortisol in the saliva do not appear to be dependent on salivary flow rate (Chiappin et al., 2007). Due to its small molecular size and high lipid solubility, cortisol can readily diffuse through cell membranes into the saliva (King & Hegadoren, 2002).

Salivary cortisol has the advantage of being 100% unbound — compared to less than 10% in plasma — and biologically active (King & Hegadoren, 2002). However, there are often significant individual underlying variations in cortical response which may confound measurements of sC (Granger et al., 2012). Built into the HPA system is a feedback loop, with cortisol providing negative feedback through intrinsic receptors which keep the HPA axis activity in check (Kalman & Grahn, 2004). These glucocorticoid receptors, located in the hypothalamus and pituitary gland, gradually become down-regulated (Koh & Koh, 2007). As chronic stress blunts the feedback effects, abnormal cortisol levels can result (King & Hegadoren, 2002).

Such changes in cortisol levels are most apparent in a flattening of the usual diurnal curve, with less variation in levels observed throughout the day (Koh & Koh, 2007). Chronic stress amplifies the normal early morning rising level of sC, and inhibits its usual circadian decline in the afternoon (Kirschbaum & Hellhammer, 1999). Salivary cortisol levels normally peak at about 30 minutes after waking. Levels then steadily decline to their lowest around midnight (King & Hegadoren, 2002). Illness, such as cancer, can alter the normal circadian rhythm of sC (Tabak, 2001), probably in part due to the associated chronic stress. Considering the circadian fluctuations usually observed, it is generally advised to take baseline samples for sC in the afternoon or early morning when levels are more stable (Kalman & Grahn, 2004).

Whilst normal levels of cortisol suppress allergic responses and stimulate the immune system, excessive cortisol can suppress the immune system whilst simultaneously triggering an over reactive response via cytokine activity (King

& Hegadoren, 2002; Segerstrom & Miller, 2004). Chronic stress, associated with HPA dysregulation and its resultant prolonged secretion of cortisol, reduces the capacity of white blood cells to respond to anti-inflammatory signals. As a result inflammatory responses, mediated by cytokines, may flourish and express themselves in autoimmune illnesses such as multiple sclerosis, rheumatoid arthritis and CV disease (Segerstrom & Miller, 2004). Varying levels of chronic stress as an unmeasured variable may therefore confound results (Thoma et al., 2013).

Cortisol levels are known to increase with negative affect (Euler, Schimpf, Hennig, & Brosig, 2005). Acute stressors result in increasing levels of sC for 15 to 20 min after cessation, before levels begin to fall again (King & Hegadoren, 2002). Activation of the HPA axis can increase sC levels ten-fold (King & Hegadoren, 2002). Acute pain, as a stressor, also increases sC levels. However, chronic pain leads to cortisol suppression, reflected in lower sC levels (King & Hegadoren, 2002).

Whilst much of the literature concentrates on the stress response, this current study was focussed more on the relaxation response. It is thought that the adrenal cascade, triggered by stress and initiated in the hypothalamus, may be inhibited by listening to music (Krout, 2007). Such an effect should be reflected in lower sC levels, or no expected diurnal increase, after a music intervention, as was reported earlier in the review of PNI music studies (Fancourt et al., 2014). However, PC patients, and some surgical patients, are likely to have disturbed stress responses due to chronic illness and so may display atypical sC responses.

Even for normal populations, the literature describes a complex cortisol stress response that is characterised by heterogeneity and inconsistencies (Kirschbaum & Hellhammer, 1999). In particular, gender differences have been observed, with female hormones blunting the cortisol response in some cases, and social support buffering against stress for males more than females (Kirschbaum & Hellhammer, 1999). Discrepancies in sC levels reported in the literature may in part also be explained by enzyme action which deactivates cortisol, resulting in false readings of sC levels (Gröschl, 2008). Given the unpredictable nature of sC levels in response to stress, it is advisable to also measure other stress markers, such as α-amylase.

α-Amylase (AA)

Salivary AA (sAA), also known as ptyalin (Hu, 2007), is an important digestive enzyme, in particular for carbohydrates. Levels of sAA increase with the ingestion of starch, salt and acid (Hu, 2007). Together with sIgA, sAA also provides an important innate defence against pathogens on mucosal surfaces (Fortes, Diment, Di Felice, & Walsh, 2012). Salivary AA is produced by serous cells of the parotid and submaxillary salivary glands, and accounts for around 50% of the total proteins in saliva (Morse et al., 1986).

Acute stress leads to a rapid increase in sAA levels, indicating activation of the SNS (Strahler, Mueller, Rosenloecher, Kirschbaum, & Rohleder, 2010). The SAM axis is the primary fight and flight system (Harrington, 2013), which explains its immediate engagement when a stressor is detected. It appears that stress-induced increases in sAA levels, like sC, are not confounded by saliva flow rates (Rohleder, Wolf, Maldonado, et al., 2006). However, the diurnal pattern — with lowest levels in the morning and highest in late afternoon (Koh & Koh, 2007) — does need to be considered.

Measures of sAA have been shown to relate positively to self-reported current distress, reflecting momentary fluctuations in mood over short periods of time (Robles et al., 2011). This makes sAA a suitable marker for snapshots of stress levels. Indeed, sAA was shown to be an effective marker of a relaxation response in stressed surgery patients (Minowa & Koitabashi, 2012).

A significant correlation was demonstrated between sAA levels and the VAS for pain, suggesting that sAA can also be a useful objective measure of pain intensity (Shirasaki et al., 2007). This is not surprising considering that pain precipitates neuroendocrine responses, triggering the same circuits as stress, and culminating in the release of stress markers (Vaughn et al., 2007).

Observed changes in sAA levels reflect ANS activity, specifically the SAM system (Nater et al., 2005). The relaxation response observable in sAA levels is evidence of the PNS arm of the ANS restoring homeostasis. However, this may be due partly to the rapid activation and recovery pattern that typifies the SNS response (Granger et al., 2007) rather than only the intervention that is applied.

Chronic stress may give false-negative results for sAA, just as with sC. Repeated exposure to stress leads to lack of adaptation to stressors, resulting in reduced rather than elevated levels of the marker (Robles et al., 2011).

Cortisol versus α-amylase as markers of stress

Several studies have shown dissociations between responses of cortisol and α-amylase to musical interventions (Thoma et al., 2013). A much more immediate response to stress, and a larger change in levels, can be detected in sAA compared to sC. The peak of sAA activity occurs immediately after an acute stressor and levels recover to baseline rapidly, whereas sC shows a delayed increase, with levels remaining significantly elevated from baseline levels even 20 minutes later (Maruyama et al., 2012; Nater et al., 2005). This delay may moderate the detection through sC of any relaxation response emanating from a music intervention.

Dissociation was also demonstrated between sC and sAA in participants' reactions to challenge, with sAA not responding to stress signals related to the HPA axis (Granger et al., 2007). In another study, healthy young adults were presented with mild psychological and physical stressors to compare sAA with sC responses (van Stegeren, Wolf, & Kindt, 2008). Findings supported sAA as a sensitive marker for both acute stressors, whilst sC changes were only observed in the physical cold presser stress test. Gender differences were also noted, with men showing higher sAA levels than women at all points of measurement, although this did not affect their comparative responsiveness to the tasks.

A comparison of gender differences of sC and sAA levels in response to an acute psychological stressor found no differences between males and females for sAA levels in either the high- or low-anxiety participants (Takai et al., 2007). In contrast, sC levels were significantly lower in highly anxious females than in their male counterparts, indicating a blunted HPA response to acute psychological stress in females with high trait anxiety.

As explained previously, stress responsiveness is regulated by both the HPA axis and the SAM system. The activity of these two systems can be differentiated by measuring sC for the HPA axis and sAA for the SAM system. Activation of the systems is triggered differentially, with the HPA axis responding to negative affect associated with stress, including fear and frustration, whilst the SAM system responds to effort, which is non-specific regarding valence (Gordis et al., 2006).

Differential relaxation responses have also been observed when comparing sC and sAA. In a study looking at the effects of music on these markers, those

listening to relaxing music prior to induced psychological stress had the higher concentration of sC, but baseline levels of sAA were reached considerably faster than those who were not exposed to music (Thoma et al., 2013). The researchers concluded from their results that the music listening acted predominantly on the ANS, as observed in the faster recovery of sAA levels.

Demonstrated asymmetries in the two stress markers underscore the need to look at multiple markers to draw an integrated picture of the whole physiological response (Gordis et al., 2006). Biomarkers of the immune system can provide a clearer understanding of how music affects both the stress and relaxation responses as well as triggering changes in the immune function of the listener.

Immunoglobulin-A (IgA)

IgA is an antibody (Harrington, 2013) produced by B-lymphocytes situated near the salivary glands (Chiappin et al., 2007). IgA, a protein molecule, recognises and binds to a specific antigen, preventing it from causing infection (Bennett Herbert & Cohen, 1993). Salivary IgA (sIgA) is an indicator of mucosal immunity (Hucklebridge et al., 2000), providing the oral cavity and digestive tract with its initial barrier to bacteria and viruses (Henson, 2007). Higher sIgA levels are significantly associated with enhanced immunity, demonstrated by fewer colds and other infections (Lu, 2003).

Negative and positive thought processes and behaviour patterns can directly influence sIgA levels (Lu, 2003). Also, levels of sIgA negatively correlate with self-perceived stress (Koh & Koh, 2007), meaning that immunity is reduced as stress increases. Therefore, increased levels of sIgA, as observed in some music studies, are an indicator of enhanced immunity (Krout, 2007). Eight out of twelve studies which used IgA reported increased levels following a range of musical interventions, whilst only one study in the review showed a significant decrease in IgA levels (Fancourt et al., 2014).

The sIgA production cycle of several days is a longer process than that of sC and, in particular, sAA. So any rapid changes observed as a result of a short intervention are likely to be transported from an existing accumulation of IgA across the epithelium into the saliva (Knight & Rickard, 2001; Segerstrom & Miller, 2004). Levels of sIgA may therefore not reflect the immediate stress or

relaxation response being evaluated. Additionally, salivary flow, which is also influenced by stress, may affect concentration levels of sIgA (Lu, 2003).

Like sC, sIgA levels peak about 30 minutes after awakening and then declines in the morning in day-active individuals (Hucklebridge et al., 2000). Salivary IgA has the advantage of being more stable, with a longer biological half-life, than sC (Henningsen et al., 1992). However, careful handling of specimens is required as sIgA is vulnerable to degradation at room temperature from bacterial proteases (Chiappin et al., 2007).

Interleukin-1beta (IL-1β)

Neural pathways that directly communicate local inflammation to the brain are mediated through the activities of cytokines (O'Connor et al., 2009), which are polypeptides (Bartlett et al., 1993). For example, the gut and brain are linked via the vagus nerve, and the oral cavity and brain via the trigeminal nerve. Both gingivitis and gut problems have been linked with depression, whilst life stresses such as grief have been associated with episodes of inflammatory conditions in the mouth and gut (O'Connor et al., 2009; Patterson, 2011).

Other possible pathways which facilitate interactions between the CNS and immune systems are a leaky blood-brain barrier; active transport via saturable transport molecules; and activation of endothelial cells, which line cerebral vasculature and produce cytokines (Miller, Maletic, et al., 2009).

Microglial cells are the primary source of proinflammatory cytokines in the brain, which can in turn stimulate the HPA axis (Miller, Maletic, et al., 2009). This bidirectional communication between the CNS and immune systems is central to the concept of PNE, which encapsulates the neuroimmune interactions expressed in the release of both stress markers and immune markers such as cytokines (Patterson, 2011).

IL-1β is a cytokine, and as such is an inflammatory marker, indicating a physiological reaction to acute stress with rising levels of sIL-1β. Inflammation is typified by both local and systemic swelling, pain, heat and redness (Harrington, 2013). Chronic stress can lead to chronic activation of an inflammatory response, both in the CNS and peripherally, linked to the cortisol dysregulation described earlier (Miller, Maletic, et al., 2009). Elevated levels of sIL-1β may therefore indicate both its antiviral property in infectious disease

conditions, such as gastroenteritis, and general inflammation in non-infectious conditions, such as Crohn's disease. In addition to its non-specific role in infection resistance, IL-1β mediates inflammation (Sommer, 2002). Considering all the complex and opposing actions of this cytokine, a relaxation response elicited by music may increase sIL-1β levels, indicating an increase in natural immune system robustness.

Cytokines, in particular IL-1, have rarely been used as markers in music psychology research. An early study in this field demonstrated that a 15 minute music listening intervention significantly increased plasma IL-1 levels overall, although the direction of change in levels was mixed in the small (n = 10) experimental group (Bartlett et al., 1993). In their recent review of the PNI effects of music, Fancourt, Ockelford and Belai (2014) discussed eight studies which investigated cytokines. Reductions in IL-6 in response to music were reported in four of the five studies in which it was tested, whilst one study found no significant changes in IL-1 levels. The only other study they reported using IL-1 was the Bartlett and colleagues (1993) study just discussed. Another study measuring plasma IL-1β reported that levels were unchanged after listening to relaxing music compared to the control group (Stefano et al., 2004). However, no IL-1β had been detected in any of the plasma samples, so no comparisons were actually possible. IL-1β is sometimes at such low levels in plasma that it is difficult to detect, whereas it is usually in higher concentrations in saliva, making the latter a better source for comparing levels of this cytokine (Brailo et al., 2012).

IgA versus IL-1β as markers of the immune system

When the brain sends its neuroendocrine stress response messages to the immune system via the SNS, it initially stimulates the innate or natural immune system, triggering a quick inflammatory response via the spleen and lymph nodes, whilst at the same time suppressing the adaptive or acquired immune system (Patterson, 2011). This two-part differential immune reaction sees the inflammatory response of the natural immune system reflected in increased release of cytokines such as IL-1β, whilst the suppressed acquired immune system is identified by decreased IgA levels.

Music interventions, by promoting a relaxation response, should exert the opposite effect, namely decreasing inflammatory markers such as IL-1β whilst increasing the body's defence to infection through higher IgA levels (Gruzelier, 2002). However, the response to a relaxation intervention is more complex, with both branches of the immune system being activated, thus possibly increasing levels of both IgA and IL-1β. By measuring both these markers, the responses of both the natural and acquired immune systems can be gauged. IgA has been shown to be particularly responsive to music, whereas IL-1β has, through lack of studies, not yet built up a track record with music interventions (Fancourt et al., 2014).

Salivary pH as a barometer of stress and relaxation

There is a direct inverse relationship between anxiety and salivary pH (spH), with increased stress or anxiety levels being reflected in a lowering, or more acidic, pH level. The acid-alkaline balance, or pH, is an expression of the relative concentration of hydrogen ions in the substance being measured (Sandin & Chorot, 1985). A pH of 7.0 is neutral, with increasing pH indicating alkalinity and lower than 7.0 regarded as acidic. Stress causes a decrease in the amount of bicarbonate secreted into saliva, thereby resulting in increased acidity and a lower pH (Cohen & Khalaila, 2014).

Optimum pH levels for saliva are 6.5 to 7.5 (Cohen & Khalaila, 2014). Salivary pH levels are regulated by the neuroendocrine system (Khalaila et al., 2014), and in particular reflect SNS activity (Sandin & Chorot, 1985), just as sAA does. Like the other biomarkers, pH is variable throughout the day, being lowest at night, increasing in alkalinity during eating and decreasing again rapidly after food (Morse et al., 1986).

The use of pH as an outcome measure in stress research was pursued in the 1980s by several research groups. Sandin and Chorot (1985) used a pH electrode to measure the pH of saliva, skin and urine. Their pH meter had a repeatability of ±0.05 pH unit, which was sensitive enough to measure significant reductions from baseline in skin, salivary and urinary pH during the real-life oral exam stress condition.

The hiatus in this line of enquiry lasting several decades came to an end only in the past few years with a fresh examination of the potentials of spH in

psychosocial research. Technological advances have seen the development of more sensitive, more affordable, and easy to use electronic pH meters facilitating this research. Cohen and Khalaila (2014) tested the spH of 83 nursing students on the morning of their written exam as well as three months later. They used a small commercially available electronic pH meter with sensors that were dipped into a receptacle of saliva. A limitation of the type of electrode used is that it needs to be immersed in around a centimetre of fluid, so requires quite a few millilitres of saliva. Accuracy of this meter was a more refined ±0.01 pH unit. Resulting lower pH levels were found to be a significant predictor of exam performance.

In a recent study of spouses caring for cancer patients, low levels of perceived stress in both carers and controls were contradicted by their actual stress scores, which for carers were over double that of the control group (Khalaila et al., 2014). Salivary pH levels verified the stress scores, supporting the usefulness of pH measurements to provide an objective assessment of stress where self reports may not be reliable.

Only a few studies have been carried out to examine the effects of stress or relaxation on spH levels (Cohen & Khalaila, 2014); and as noted earlier, only one such study has been found to date assessing a music intervention (Hanaoka et al., 2010). Measuring spH does not require expertise or the expensive and time consuming assaying that is necessary for more routinely measured biomarkers. It can also be carried out immediately, without the need to store the samples. However, the pH of saliva increases rapidly when exposed to air due to the dissipation of CO_2 (Morse et al., 1986). Unless the pH is tested immediately, the container of saliva needs to be sealed and stored on ice for transportation to the freezer.

A more acidic pH may lead to dysregulation of other salivary biomarkers of stress (Cohen & Khalaila, 2014). For instance, saliva with low pH readings can lead to falsely elevated sC levels (King & Hegadoren, 2002). So apart from the direct information about stress levels that pH data can provide, knowledge of spH may be useful where there are inconsistencies in other biomarker readings.

Which biomarkers should be measured?

As should now be apparent from the information outlined so far, there are many factors to be considered in selecting which markers to use for a particular study.

Table 1. *Comparison of potential salivary biomarkers*

	α-AMYLASE (sAA)	CORTISOL (sC)	IMMUNOGLOBULIN-A (sIgA)	INTERLEUKIN 1β (sIL-1β)	pH (spH)
DESCRIPTION	enzyme	steroid	antibody	cytokine	level of H ions
ORIGIN	salivary glands pancreas digestive system	adrenal cortex	B-lymphocytes near salivary glands	microglia in brain immune lymphocytes	
FUNCTION	digestion of carbs & starch clear oral bacteria	↑ blood sugar metabolism suppress inflammation	mucosal immunity	cell signalling balance immune response	acid / base balance
PNE ACTIVITY	SNS (SAM system) PNS	HPA axis	acquired immunity	natural immunity	SNS
ACTION	relaxation →↓ stress →↑ chronic stress → false ↓ faster than sC larger change than sC	music → ↓ levels delayed response delayed recovery blunt in chronic stress	music →↑ levels delayed response	music →↑ or ↓ levels stress can →↑ levels ++ fast reaction	music →↑ spH stress →↓ spH
DIURNAL VARIATION	yes – distinct trough in AM then ↗ through day	yes – distinct peak early AM then ↘ music → flatter cycle	yes – distinct peak early AM then ↘	not established	variable lowest at night ↑ during eating ↓+ after food
USE IN MUSIC STUDIES	very few	most common	yes	none for salivary IL-1 only one with blood	only one found

Note. The arrows indicate the following: → = results in; ↑ = increased levels; ↓ = decreased levels; ↗ = gradually increasing; ↘ = gradually decreasing; + = much; ++ = very much

Each marker measures a different aspect of the stress and relaxation responses and immune system functioning, thus providing a more multifaceted picture of what is occurring in an individual's psychophysiology as a result of an intervention. Whilst sC is a measure of HPA axis activity, both sAA and spH reflect processes of the SAM system, and therefore the SNS.

Stress markers are also indicators of pain intensity, as was shown with the correlation between sAA and the VASP (Shirasaki et al., 2007), although it is still unclear exactly how stressors that cause pain interact with the HPA and SAM systems (Maruyama et al., 2012). Similarly, immune markers are indirect stress markers. However, sIgA specifically indicates the function of the acquired immune system, whilst the inflammatory processes of the natural immune system are observable in levels of IL-1β.

In the specific area of music psychology, some salivary markers, such as sC and sIgA, have a proven track record of use, where others, such as sIL-1β and spH, have yet to be assessed for their potential broader application in this field. A widespread rollout of this methodology has been in part limited by the high costs associated with the specialist assaying of samples, which are multiplied where the study design includes numerous markers and pre- and post-testing. These costs and specialist training requirements are circumvented with spH measurements, which hold the potential for music psychology researchers to access PNE research methodology more widely. Table 1 summarises the attributes and activities of each marker, as well as other factors to consider when selecting biomarkers, such as previous application in music studies.

Breakthrough medications

Some studies have chosen to monitor the amount of sedatives and analgesics that patients request or self-administer as evidence of the efficacy of music interventions. An intra-operative investigation found that urological patients who were randomly assigned to the music intervention required significantly less of the sedative propofol than the control group. In the second part of the study, randomly assigned music listeners used significantly less patient controlled intravenous opioid analgesia than those in the no-music group (Koch et al., 1998).

In a clinical trial of day surgery patients who received no general anaesthetic or analgesics, those who listened to music before and during surgery had decreasing levels of plasma cortisol during surgery, whereas the no-music control group showed rising levels of the marker (Leardi et al., 2007). However, there were no significant differences between groups for pain scores and postoperative analgesia consumption. The authors attributed the results to low levels of postoperative pain in both groups due in part to the use of local anaesthesia and low invasive procedures.

PC patients are often on a regular regime of medication which includes the option of additional medications for breakthrough pain or anxiety as required or requested (Barnard & Gwyther, 2006). As there are likely to be variations in the uptake of the optional extra medications based on need, breakthrough analgesics and anxiolytics can be monitored in the 24 hours before and again after the intervention to assess whether there has been a reduction in frequency or dosages.

Many other factors will contribute to changes in breakthrough medication requirements over the 48 hour period, such as general deterioration close to end-of-life, receiving bad news, getting the previously persistent pain under control, or having stressful or comforting family encounters, and so on. Therefore, changes cannot be solely attributed to the intervention being tested. Also, where baseline levels of pain and anxiety are low, due to effective management, there is likely to be little change in this variable over the 48 hours.

However, this data routinely recorded by clinical staff may provide some information on residual effects of an intervention which persist beyond the post-test measurements of other variables. Patients need to provide their written consent to allow the researcher to access their individual medical records for the purposes of the study. Similarly, the hospital also must agree to the researcher’s use of such confidential data.

Length of hospital stay

Medical records may also provide useful data for surgical patients. Some studies have noted that patients who took part in music programs had shorter hospital stays compared to the control groups. A correlation between preoperative

anxiety and postoperative pain, as well as increased analgesia and anaesthetic requirements, results in delayed recovery and discharge where these symptoms are not addressed (Arslan et al., 2008). It therefore follows that music interventions could assist with promoting faster recovery and earlier discharge.

No significant differences in length of stay were found in one study comparing elective brain surgery patients receiving live MT to those who did not receive the music intervention (Walworth et al., 2008). However, others suggest music applied in clinical settings offers potential cost savings through reduced medication use and duration of hospitalisation (Spintge, 2012). Several reviews have stipulated that clinical music interventions can result in reduced length of hospital stay (Staricoff, 2004; Staricoff & Clift, 2011).

As with the previous outcome measure of breakthrough medications, this measure may not yield any significant differences, but as the data is already recorded by the clinical institution, it can be included in a study as a possible useful variable without imposing additional demands on participants.

Data analysis

In short, the reason that your evil statistics lecturer is forcing you to learn statistics is because it is an intrinsic part of the research process and it gives you enormous power to answer questions that are interesting . . .

(Field, 2009, p. 28)

Once all the data is collected, the task of drawing inferences and meaning from the numerical and qualitative data can be onerous. Multiple outcome measures have the advantage of enabling cross-referencing of results, but can also create the issues of too much data and possible conflicting results. Each type of data requires its own specific method of analysis, as well as offering the possibility of being included in multivariate analyses.

Subjective data

Demographic information

The main purposes of collecting demographic data are to provide background information about participants, and to use the data as covariates in statistical analyses of outcome measures. Other information, such as diagnostic categories and students' enrolled courses, may also be used as covariates or simply presented as descriptive statistics, tables or graphs.

The need to take demographic and other background information into consideration is demonstrated in the literature. Some biomarkers have been shown to respond to stress in gender-specific (Takai et al., 2007; van Stegeren et al., 2008) and age-specific ways (Strahler et al., 2010). Also, musical training has been reported as a moderator of responses to music interventions (e.g., Staum & Brotons, 2000).

VAS

Once VAS forms have all been completed, the issue is how to interpret the resulting data. There can be a tendency to overestimate the clinical importance of small differences observed in the VASP (Mark, Au, Choi, & Wong, 2009). Also, although the VASA has been shown to correlate well with other measures, it

demonstrates better test-retest reliability in the middle and ends of the scale, but is not uniform along the whole 100 mm continuum (Williams et al., 2010). The distributions of raw scores tend to be skewed (Hornblow & Kidson, 1976) and may require statistical manipulation, such as logarithmic transformation, to normalise them.

Rather than using the full spectrum of measured values, or changes in value, Bodian and her colleagues recommend grouping the final VASP scores into small numbers of categories to provide greater clinical relevance for comparison (Bodian et al., 2001). In a similar approach, Kelly (2001) pre-defined VASP pain scores into three categories for her study of emergency department patients (N = 156). She specified scores of 30 mm or less as indicating mild, 31 – 69 mm as moderate, and 70 mm or over as severe pain.

A likely issue for the current study is a low baseline pain or anxiety score, due to no symptoms being present (especially in the student population); or as a result of effective pharmacological management of symptoms; or due to underreporting of the level of symptoms. Where the latter is the case, it is anticipated that physiological measures of pain and anxiety will objectively identify any of the symptoms not disclosed, or underrated, by the participant.

Affect scales and absorption scale

The numerical scales proposed to measure affective responses to the interventions provide raw scores (1 to 10) that are ready to use in statistical tests. These scores should provide direct information about differences between groups, and can also be used as covariates in multivariate calculations.

Breakthrough medications and length of hospital stay

As there are so many different medications used by PC patients, it may not be possible to compare any changes in their consumption. One option would be to note changes observed in terms of direction (i.e., increase or decrease), and possibly also a percentage of change in dosage.

For surgical patients, length of hospitalisation can be recorded, in hours, for between group comparisons. All participants grouped together can also be compared to the average stay of patients in the surgical unit of the hospital over the same period as the data collection took place.

Laboratory matters

Assays

Enzyme-linked immunosorbent assays (ELISA) have been shown to be more sensitive, less variable, more automated and cheaper than alternative assays such as radioimmunodiffusion used for numerous biomarkers, including IgA and cortisol (Henningsen et al., 1992). ELISA assays measure levels of free cortisol present in saliva, which is widely reported to correlate highly ($\pm r = 0.90$) with free plasma cortisol (Kalman & Grahn, 2004). They are also appropriate for measuring levels of cytokines such as IL-1β in saliva, as well as sAA.

ELISA assaying is carried out by trained staff in biomedical laboratories with the necessary equipment for reading the microwell plates on which the assays take place. Despite being cheaper than some of the alternative assay methods, ELISA kits and the laboratory hours required to carry out the work are still significant costs for a research project.

Some commercial sAA handheld meters have been developed in Japan which allow immediate measurement of this biomarker in clinical or research settings without requiring laboratory assaying (e.g., Kobayashi, Park, & Miyazaki, 2012; Maruyama et al., 2012). Although not used for this study, such meters represent the future in PNE research, with results comparative to standard assaying, provided the saliva is collected through the passive drool method rather than using direct mouth measurements (Robles et al., 2013).

pH measurement

The simplicity and immediacy seen in the handheld sAA meters are also offered by the use of readily available commercial electronic pH meters. Anyone without specific laboratory training is able to apply these meters to measure the pH of saliva, with each test taking only two to three minutes.

Salivary pH is variable, with means between 5.8 for unstimulated and 7.4 for stimulated saliva (Morse et al., 1986). As with the other biomarkers, rather than the baseline levels being of particular interest, the changes from these first readings due to an intervention are the foci of researchers.

Statistical significance and clinical significance

Statistical significance does not always mean that results are meaningful or applicable to nurses; it simply indicates that the results are unlikely to be the result of chance occurrences. Clinical significance involves the reasoning and synthesis of data to decide whether they are meaningful to clinical practice – for example, whether the information will improve the interventions currently used for patients.

(Vaughn, Wichowski, & Bosworth, 2007, p. 602)

Which scores should be used?

There are various options for calculating the change in levels of biomarkers or VAS scores between the pre- and post-measures. The first is to use the raw scores. However, where there is a large variability in the baseline scores, these changes may not be meaningful. Khalaila, Cohen and Zidan (2014) reported the absolute differences between means of pH to be relatively small, although they did find large effect sizes.

An alternative is to use the percentage change from baseline. This method was used by Sandin and Chorot (1985) to assess stress related skin, salivary and urine pH changes. The same authors also transformed absolute measures to logarithmic scores to normalise distribution before performing ANOVAs and *t*-tests.

For sAA it is recommended in several papers to use square root transformations on the raw scores, rather than log transformations, to correct for the typical leptokurtic and positive skew observed in the distribution (Gordis et al., 2006; Granger et al., 2007). On the other hand, another research group found that logarithmic transformation improved the considerable right-skew in their sAA distribution, whilst square root transformation was insufficient to make the corrections (Kobayashi et al., 2012). Even after transformation of scores, there could still be a wide variation between individuals, ranging between 400 and 900 U/mL (Granger et al., 2007).

Skewed distributions have also been noted in other biomarkers, such as sC, which was addressed with square root transformations of raw scores (Gordis et al., 2006). Each study appears to have found the best solutions for their particular data sets to facilitate the subsequent statistical tests they applied.

Compared to the even distribution of STAI scores, VAS distributions, like the biomarkers noted above, have a tendency to be skewed, as well as being

trimodal in distribution (Hornblow & Kidson, 1976). This confirms an earlier comment about participants preferring the numbers 5, 10 and 15 along a numerical 100 mm trajectory (Cox & Davidson, 2005).

Where sample sizes are small, and where data is not normally distributed, studies have opted for non-parametric tests for statistical analysis to establish whether there is statistical significance in the outcomes (e.g., Lee et al., 2012; Yung et al., 2002).

Is statistical significance relevant?

A difference is a difference only if it makes a difference.

(Huff, 1954, p. 58)

The majority of quantitative research is based on statistical significance, which assesses whether the observed results of the relationship between variables are actual or could be attributed to chance (Kraemer et al., 2003). If it is deemed that the results are not due to chance alone, then researchers should be interested in how large the effect of a particular variable is, which is known as the effect size (Kraemer et al., 2003).

Statistically significant results may not be reflected in meaningful and practical impact on clinical care. A statistical difference between groups is only relevant if there is a perceived difference for a patient, or if there are other positive consequences for patient care (Leavitt, 2011). Unfortunately, such information is often neglected in the reporting of research: the focus is on demonstrating statistical significance only, with the false assumption that clinical significance is implied by the attainment of statistically significant results (Man-Son-Hing et al., 2002).

Effect size and confidence intervals

Calculating the size of the treatment effect is the first step to assessing clinical significance. Effect size (ES) provides details about both the magnitude and the direction of differences observed between outcome measures or the relationship between measures (Leavitt, 2011). There are numerous methods for assessing ES. These can be divided into three categories: the r family of correlation coefficients, for ordered variables; the d family, for binary independent (input) variables; and measures of risk potency, where all variables are binary (Kraemer et al., 2003).

Each situation where ES is calculated requires its own specific approach, although there is little consensus on which ES to apply. The correlation coefficient *r* is typically applied in survey research, whilst Cohen's *d* is most commonly used in the behavioural sciences. The latter measures the difference between means divided by the mean standard deviation (Kraemer et al., 2003). The ES then needs to be further interpreted as to whether it represents a small, medium or large effect.

Together with ES, the confidence intervals (CIs) should also be reported. CIs can clarify both statistical and clinical significance (Mantha, Thisted, Foss, Ellis, & Roizen, 1993). CIs are the estimated range within which the true effects of an intervention are likely to fall (Leavitt, 2011). Statistical significance may be inferred through a visual assessment, where the CIs of two groups do not overlap (Mantha et al., 1993). A small sample size will result in a wider CI due to greater variability in the data, which becomes more precise with a larger cohort of participants (Leavitt, 2011).

Some questions that can be asked once ES is established are whether the effects are as large as anticipated, or previously observed, and why this may be the case, as well as the clinical implications of the findings (Sloan, Symonds, Vargas-Chanes, & Fridley, 2003). For example, a percentage change in the VASP of 10 – 20% may be viewed as a small ES, whilst 30 – 36% is a medium ES, and ≥ 50% is considered a large ES (Leavitt, 2011). However, it has been suggested that there is a tendency to overestimate the clinical significance of small differences in VASP scores (Mark et al., 2009). Also, the amount of reduction in pain intensity that is meaningful to a patient increases together with baseline pain levels, so those suffering severe pain need greater reductions for the change to be considered clinically significant (Cepeda, Africano, Polo, Alcaca, & Carr, 2003).

Why evaluate clinical significance?

It is apparent from the preceding comments that there is more to evaluating clinical significance (CS) than purely looking at ES and CIs. It is important to also take into consideration, together with the clinical benefits, the issues of costs and side effects (Kraemer et al., 2003) in order to establish whether the data is

meaningful to clinical practice and has the potential to improve established approaches to managing symptoms (Vaughn et al., 2007).

Researchers using more established biomarkers, such as cytokines, have not reached a clear consensus on the clinical relevance of observed differences in mean scores, even where small differences have been statistically significant (Khalaila et al., 2014). The developing area of PNE raises new challenges in evaluating the CS of interventions based on the biomarker data collected.

How should clinical significance be established?

One method suggested by several authors is the use of a minimal clinically important difference (MCID) or minimum clinically significant difference (MCSD) to calculate CS (Kelly, 2001; Man-Son-Hing et al., 2002). The MCID is the relationship between the point estimate of treatment effects, with CIs, and an estimate of the smallest treatment effect that would result in change in patient management. This determines the amount of difference a research trial is trying to detect (Man-Son-Hing et al., 2002). More simply put, the MCID is the smallest difference in scores that the patient perceives as beneficial, and which — after considering side effects and costs — results in change in patient management (Sloan et al., 2003). Similarly, the MCSD is arrived at by calculating the mean difference between, for example, two VASP scores where the participant reports experiencing "a little worse" or "a little better" pain (Kelly, 2001).

Kelly herself arrived at a MCSD overall of 12 mm (95% CI, 9 – 15 mm), with 11 mm for the mild group, 14 mm for the moderate pain sufferers, and 10 mm for those experiencing severe pain. These scores demonstrated no statistical difference between groups, so Kelly concluded that the MCSD does not change with pain severity. Based on this method of calculation, another study established a MCSD of 17mm (95% CI, 13.6 - 20.6 mm) for VASP scores (Mark et al., 2009). The threshold of 30 mm was also considered to indicate clinically significant pain by another research group (Hartford et al., 2008). The same authors regarded a reduction of 50% between the pre- and post- measures as supporting evidence of a clinically significant change due to a drug intervention.

For anxiety, one study estimated a preliminary MCID for the VASA as clustering between 10 to 15 mm (Williams et al., 2010).

Ultimately, CS should be gauged by whether the patient notices a positive change in symptoms, be that a 10 mm change on a 100 mm VAS, or a reported relaxation effect from listening to music (Man-Son-Hing et al., 2002). A simple way of establishing CS is by asking the patient if the experience was worth the time and effort (Sloan et al., 2003).

Pain and anxiety are two salient symptoms that patients and clinicians have to deal with in PC and surgical settings. Potential interventions such as music and story readings should be assessed in a considered manner, ensuring statistical as well as clinical significance are included in the evaluation of the data. The consumers of any intervention are after all in the best position to provide the answers to research questions being asked, whether through providing their saliva for analysis, marking scale measures, or giving formal and informal verbal responses.

Research questions

The relatively new field of PNE has only recently been applied to studies assessing the potential beneficial effects of music interventions on the stress and immune responses of listeners (Thoma et al., 2013). PNE research allows opportunities to assess the comparative effectiveness of both the interventions and the outcome measures, and the methodologies associated with both.

The central question this study proposed to answer was whether there is a difference in pain, anxiety and immune response of patients with life-limiting cancer or patients awaiting surgery after a live music intervention of around 20 minutes, compared to those who watch a video or listen to an audio recording of the live presentation. Book readings, also presented live and as audio recordings, provide a non-musical comparison. The methodology was planned to first be tested on a sample of tertiary students before the clinical phase of the study.

It was anticipated that the live music interventions would be more effective than the recorded conditions in reducing pain and anxiety and increasing immune competence in the participants, as measured by objective salivary biomarker levels as well as subjective self-report instruments. A similar trend was expected in the two book reading conditions, and overall it was anticipated that the music interventions would be more effective than the book readings in achieving the above outcomes.

Chapter 4: TWO-PART INVENTION - Method

This study was conceptualised with a dual purpose: to test the hypothesis that live music produces superior pain and anxiety reducing effects and enhanced immune response to both audiovisual and audio music recordings; and to explore and evaluate the methodologies needed firstly to create the three consistent music conditions, and the stories conditions used as controls, and then to collect and analyse the salivary biomarkers chosen to measure the outcomes.

Two distinct cohorts — 50 tertiary students and 23 palliative care and surgical patients — were recruited to reflect both healthy and clinical populations.

A mix of subjective and objective instruments was chosen to measure the participants' responses to the music and stories they were exposed to. Multiple outcome measures were intended to provide greater validity and robustness to the study through capturing numerous aspects of each main outcome, and by enabling cross-validation of results.

Cohort one: students

Students are a readily available source of participants for psychology researchers. The use of this convenient cohort of listeners for the study was appropriate for the first phase of testing the methodologies associated with both the presenting of stimuli as well as data collection, before testing them on the more vulnerable clinical population.

Design and participants

A mixed-method multivariate quasi-experimental study was used, employing a within (pre- and post-tests) and between subjects design. The study was approved by the Edith Cowan University Human Research Ethics Committee before any recruitment or data collection took place.

This phase of the study was conducted using mostly undergraduate and some post-graduate research students. Ten students were quasi-randomly allocated to each of five conditions. The small sample size was considered appropriate for the first phase of an exploratory study, with further participants planned to be included with the second clinical cohort. All random selection and allocation was made according to lists of computer generated random numbers, subject to the caveat regarding live presentations explained below.

Music was presented live (ML), and as audiovisual (MAV) and audio (MA) recordings of the live presentations. Stories were read live (SL) and, as for the music, simultaneously recorded for subsequent audio presentations (SA). Participants acted as their own control, with baseline measures taken before and measures taken immediately after the interventions. Several studies have indicated that a significant reduction in symptoms was not apparent during or at the completion of a music intervention, but were detectable after 30 minutes (e.g., Arnon et al., 2006), so further measures were taken around 25 minutes following the end of the interventions. All interventions were presented to individuals rather than in group situations to eliminate possible confounding social effects, and to model the bedside interventions in the clinical setting.

True randomisation was not possible in this study as at least some of the live presentations needed to occur first so that the recordings could be used for

the recorded conditions. Subsequent participants were allocated to live, AV (for music only) or audio conditions according to an online computer generated list of random numbers. Live interventions were not always according to the list, but were slotted in depending on the availability of a musician or reader, or the necessity to have a live intervention to record for the next AV or audio intervention. The design ensured that each performance was controlled across all three modes of presentation. Care was taken to avoid any systematic weighting of any of the participant attributes to any particular condition.

Recruitment of student participants

Fifty volunteer university students, aged 18 years and over, were selected randomly from a register of students willing to participate in university psychology research, and through direct recruitment of students by the researcher. A random list of numbers was generated and students were approached in the order of this list in relation to their numbered position on the register. No incentives or remunerations were offered to students, and there was no obligation to participate, or course credit or other course requirements.

The student phase of the study was carried out in two parts, with the music interventions taking place first (N = 30), from May to November 2013, followed later by the story reading interventions (N = 20), between September and December 2014. The flow of potential and eventual participants through the recruitment process is illustrated in Figure 3.

Participants were not told ahead of time what type of music or stories they were going to listen to, nor whether it was live or recorded. The only information provided in advance was that the saliva sampling was going to help understanding of what changes may occur in the body when listening to music or stories.

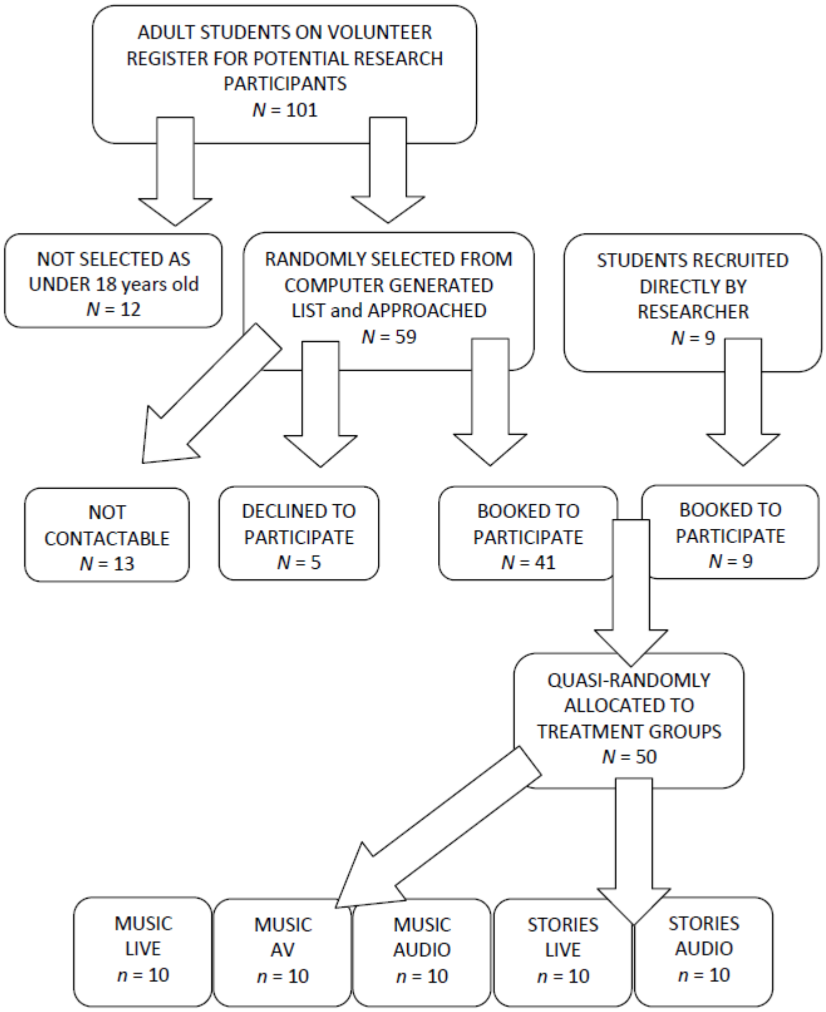

Figure 3. Flow of students through recruitment process

Selection of music

[Bach's Prelude is] *the journey of indecision*.

Female palliative care patient, 80 years old

A 25 minute program of purely instrumental music was chosen, with no vocal components such as song lyrics. Selections from the Western art music repertoire of the 18th, 19th, and early 20th centuries created a balanced mix of pleasant pieces of varying styles, modes, affect and tempi, suitable for playing in a small space such as a hospital room by a solo instrumentalist.

In view of the planned clinical setting, and also to provide some consistency of timbre, only bowed string instruments were used: namely violin, viola and cello. The list of pieces, by Bach, Mozart, Saints-Saens, Elgar and Joplin, can be viewed in Appendix B.

Whilst the programs and order of pieces were identical for each performance, the instruments and instrumentalists were not standardised in this study. Each live performance was presented as an AV and audio recording to two other participants, so each performance was heard by three participants, thus acting as its own control across the three conditions. Furthermore, the decision to not fully standardise the presentations was in part to increase external validity. Had only one presenter been used, any results could be attributed exclusively to that particular performer and instrument.

Recruitment of musicians

Musicians were recruited at the tertiary music conservatorium of the West Australian Academy of Performing Arts (WAAPA), and by direct approach from the principal researcher. All musicians received an ex gratia $40 retail gift card in appreciation of their time and effort spent in preparing and presenting the program of music. The six musicians each played for one, two, or three sessions, with all live presentations recorded for use in the non-live conditions. Four of the musicians were cellists. The remaining two were a violist and a violinist. Allocation of musicians was based on their availability on dates and times when listeners were booked in to participate, so was not randomly determined.

Musicians were provided with the sheet music in advance to allow them to prepare the program. Guidelines were given regarding tempi and style. However, it was anticipated that there would be variations in the final length of each presentation of the program, as well as variation in terms of musical interpretation and quality of technique and musicianship. Further instructions to musicians included taking time between each piece to turn pages and settle, and to avoid engaging with the listener in conversation. They were also told that this was not a formal concert, but more about sharing their music with another person in an intimate setting.

Selection of stories

Three contrasting book excerpts were selected: the first an autobiographical account of childhood memories of the author making chicken soup with his grandmother (Kosky, 2008); the second an impressionistic word picture of the sounds of a city in the depth of the night (McGregor, 2002); and the third an excerpt from a popular classical children's book (Grahame, 1908). The story

excerpts used can be found in Appendix B. The prose was considered for its content, emotional valence, broad appeal, ability to trigger memories, and lack of regular rhythmic qualities, such as that found in poetry.

In response to the feedback from some students that the music program was too long, the story readings were reduced in length to around 15 to 17 minutes by removing a section of the middle story. An AV condition was not included for stories as story readings would typically be read at a patient's bedside, or listened to as audio books, but not consumed in an AV format.

Recruitment of readers

In order to replicate what would likely take place in a clinical setting, where a family member, friend, carer or volunteer might read to a patient, it was decided not to use actors or acting students for the readings. Readers included friends and colleagues of the researcher as well as students who had previously been participants in the study. No remuneration or incentives were offered to readers.

Readers were chosen based on their reading and presentation skills, pleasant quality of their voice, and enthusiasm for the project. Eight different readers participated, two of whom read twice, providing a total of ten live story readings. It was anticipated that, like the music program, there would be variations in the length of time taken by each volunteer to read through the stories. However, each live reading was heard as an audio presentation by a subsequent participant, thus matching each presentation in both conditions.

As with the musicians, readers were instructed to take their time between stories to turn pages, sip water, and settle before the next story. They were also asked to not engage in conversation with the participants before, during, or after the stories.

Recording musicians

A high-definition JVC GZ-HD 40 video camera was set up on a tripod for each live music intervention, which took place in a university laboratory used for experimental cognitive psychology research. The video was directed only at the musician, with no AV recording of the participant taking place. The positioning of the video provided a view of the presenter as close as possible to the participant's view.

The video files were downloaded from the camera to a laptop computer where they were converted to Windows Media Player files for the video playback, and MP3 files for the audio playback, using Pinnacle Studio Plus Version 12 software. AV and audio recordings were played back to other participants using a Fujitsu Lifebook S Series laptop computer with sound quality enhanced by Creative Travel Sound compact stereo plug-in stereo speakers for the AV condition, and a Samsung Galaxy Tablet used for playback of the MP3 audio files, again with compact stereo speakers. Limited editing of the music recordings ensured no pre- or post-presentation vision or sound was present.

Recording readers

The stories were recorded directly onto a Samsung Galaxy tablet during the live readings. Recordings were played back to subsequent participants, unedited, from the Samsung tablet via Logitech Mini Boombox Model F-00003 compact plug-in stereo speakers.

Laboratory set-up

An on-campus experimental laboratory was used for the interventions. The windowless room was not exposed to external visual stimuli or noise. For the live music conditions participants were seated on an office chair at a small table facing the musician about three metres away. After entering the room and being briefly introduced to their participant, violinists and violists stood, whilst the cellists sat to play. Story readers were nearer to their listeners, both seated at a larger round table about a metre apart, to reflect bedside readings in hospital settings. After finishing the program of music or stories, the presenter was thanked by the researcher and left the room immediately.

The video camera recording each musician was positioned to the left and slightly behind the visual field of the participant. The researcher was seated to the left of the video camera to facilitate monitoring of the camera. The floor was marked so that each intervention could be set up in exactly the same manner even if furniture was moved between sessions.

Participants in the playback conditions were seated at the same table as those watching the live musician, with the equipment placed in front of them. Videos were played back on the laptop, and sound files were accessed from the

Samsung tablet, played through portable compact speakers placed in front of the listener. The researcher controlled the recording and playback equipment, and again sat to the left of the participants, but behind their field of vision.

Data collection

The researcher and author of this study was also the data collector. Both subjective and objective measures of pain and anxiety were taken, as well as objective measures of immune response. Interventions were timed to occur mid to late morning in consideration of the diurnal cycles of the biomarkers being measured, and to avoid being directly after breakfast or lunch. The total time for data collection and intervention with each participant was around one hour. A flow chart of the protocols is included in Appendix B.

The various outcome measures are discussed below, and scales and questionnaires may be viewed in Appendix C. Table 2 and Table 3 display summaries of all the outcome measures and other data collected in both the study with students and the clinical study.

Table 2. *Input Variables*

DEMOGRAPHICS	INTERVENTIONS	PRESENTATION	SITE
age	music live	instrument: violin, viola, cello	university
course (students)	music AV	presenter	clinical
diagnosis(patients)	music audio	length of intervention	
musical preference	stories live		
leisure activities	stories audio		

Table 3. *Outcome Measures*

SUBJECTIVE OUTCOMES	OBJECTIVE OUTCOMES
SCALES	*SALIVARY BIOMARKERS*
visual analogue scale - anxiety	cortisol
visual analogue scale - pain	α-amylase
liking	immunoglobulin-A
perceived emotion	interleukin-1β
felt emotion	pH
absorption	
OTHER	*OTHER*
elicited one-word response	hospital stay - hours (surgical patients)
spontaneous verbal response	breakthrough medications (PC patients)

Saliva sampling

Participants were emailed a consent form and general information sheet about the study together with information about the saliva collection process before their participation in the study. This outlined details regarding what and when they could and could not eat and drink prior to saliva collection, as well as mouth hygiene, and information on how the saliva samples would be taken. All information and consent forms used are included in Appendix A.

On arrival at the venue, each participant was provided with a bottle of spring water and asked to drink and swill some water around their mouth. At the same time they completed the consent form and were given a brief explanation of what was going to occur. Participants were quizzed about when

they last ate, had coffee or alcohol, and any illnesses or medications they were willing to disclose.

Whilst they filled in the demographic questionnaire and the baseline VASA and VASP, the first saliva sampling was commenced. Only at this point did participants become aware of the nature of some of the outcomes being measured. All printed measurement instruments are presented in Appendix C.

Saliva collection

Unstimulated saliva was collected using the passive drool method. A paper-covered plastic drinking straw was cut and placed cut end down into a screw top 5 ml polypropylene collection vial, with about 2 cm of the straw extending above the top edge of the vial (see Figure 4). Each participant was asked to remove the straw from its paper cover, place it back in the vial and allow whole saliva to pool in the front of the mouth so it could passively flow down the straw into the vial. Magazines with food pictures and recipes were supplied to help stimulate saliva flow.

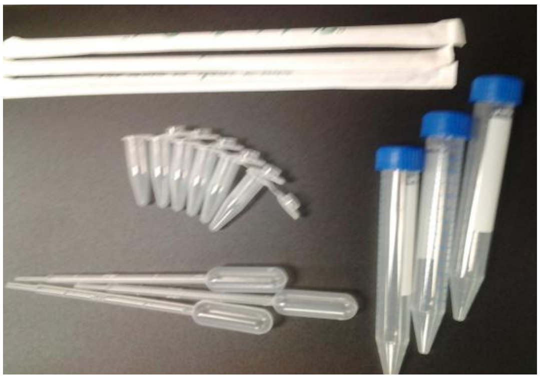

Figure 4. Equipment used for saliva collection, clockwise from top: straws, collection tubes, pipettes and microtubes

Once around 2 to 3 ml was collected, the participant removed the straw, placing it in a sealable plastic bag used for biological waste ready for disposal, screwed the top back on the vial and placed it in a second sealable bag, which was then placed by the researcher into a small icebox containing a freezer brick.

This same procedure was followed with the two subsequent saliva collections, which coincided with the second round of VAS scales and the post-

intervention questionnaire with affect scales at the end of the music or story reading, and the third round of VAS scales 25 to 30 minutes later.

Between the second round of data collection, immediately post-intervention, and the third and final round, participants either sat quietly and read magazines provided, or chatted with the researcher about their own studies and future plans. Some basic information about the study, such as its focus on live versus recorded interventions, as well as details of the music or stories heard was provided at this point. If required, participants could use the adjacent toilets during this time.

Transport and storage of saliva

After the participant left the venue, a disposable pipette was used with gloved hands to transfer each sample into two labelled 2 ml microtubes for more space-efficient storage, and to create a duplicate of each saliva sample. Tubes were then placed back into the icebox, transported to a nearby secured on-campus laboratory, and stored in a freezer at minus 80° C until assaying. All used collection materials were disposed of at the laboratory in appropriate biological waste receptacles.

Self-report scales

Two 100 mm VAS scales were used to measure pain and anxiety, with the participants asked to mark a cross on the line to represent how they were feeling at that very moment in time. Both the VASP and VASA appeared on the same A4 sheet of paper (see Appendix C), and were completed by each participant concurrently with the three saliva sample collections; that is, before the intervention, immediately after, and again 25 to 30 minutes later.

For the VASP scale, the descriptor under a smiley face at the extreme left of the 10 cm line was “No pain”, with the sad face on the right labelled “Worst pain imaginable”. Similarly, the VASA had labels “No anxiety” on the left, and “Worst anxiety imaginable” under the sad face on the right. In between the two scales were the instructions: “Please mark a cross (X) on the lines above and below to indicate how you are feeling **right now** with regards to your **pain** and **anxiety** (or stress) levels”.

Questionnaires

Pre-test questions

Participants completed a demographics questionnaire as they were giving their first saliva samples. In addition to their age and course they were studying, the students were asked if they had ever learned a musical instrument, what activities they used for relaxing or unwinding, and what styles or genres of music they listened to. They were also questioned by the researcher if they had any illnesses or injuries, when they had last eaten or consumed coffee or alcohol, and what, if any, medications they were taking.

Post-test questions

In keeping with the aims of parsimony and brevity, the affect and absorption measures designed for this study were simple numerical 10 point scales placed horizontally on the page. The first scale related to how much the listeners liked the music or stories, asking "Did you like the music/stories presented to you?" The words "really disliked it" were printed under 1 on the left of the linear scale, "neither liked nor disliked it" under 5, and "really loved it" under number 10.

The second question, measuring perceived emotion, asked, "How expressive was the person's performance?" Descriptors at 1, 5 and 10 were "extremely bland", "neither bland nor expressive", and "extremely expressive".

The third scale measured felt emotion by asking, "How much emotion did you feel?" with the bipolar descriptors of "no emotion" and "extremely emotional" under numbers 1 and 10.

The final line was an absorption scale asking, "How engaged and absorbed did you feel during the presentation?" Descriptors "extremely bored", "neither bored nor engaged", and "completely absorbed" corresponded to numbers 1, 5 and 10.

One word

Immediately after the music or story readings were finished, and the presenter had left the room in the case of live presentations, participants were asked to sum up their listening experience with one spontaneous word. The researcher asked them, "Can you think of one word that would sum up your experience of listening to the music/stories today?"

Cohort two: palliative care and surgical patients

It is far more important to know the person who has the disease,
than what disease the person has.

Hippocrates

Cancer is the leading cause of disease burden in Australia (Burney & Fletcher, 2013). Whilst 50% of cancers are treated successfully worldwide (Burney & Fletcher, 2013), the potential for their cancer to be life-threatening is still a likely outcome for many patients. Cancer patients may have surgical procedures as part of their treatment, before often ultimately requiring PC interventions in the latter stages of their illness. Whilst this study was initially conceptualised to be in a PC setting, it was extended to include surgical patients at the same hospital.

Setting for study

The clinical phase of the study recruited PC and surgical patients at a small private hospital in suburban Perth, Western Australia. The 24-bed PC unit had an average occupancy of 16 to 17 patients, with an average stay of 14 days, but ranging anywhere between a few hours to a few months. Overall, around 30 patients passed through the unit each month.

At the time of the study, the surgical unit at the hospital encompassed seven operating theatres, a 20-bed day procedure unit, and a nursing ward with 68 beds for patients that required overnight or longer hospitalisation after their procedures. Of the approximately 9500 annual admissions, about 40% of patients stayed on the ward. Patients were recruited only from this cohort due to time constraints associated with day surgery.

The philosophy of the researcher regarding working with this vulnerable population of participants was to keep in perspective that the patients always came before the research. Participants were repeatedly reminded that they could withdraw at any time from their role in the study, and the researcher was always vigilant for any signs of distress. Whilst it was preferred to not have others in the room during the interventions and data collection, there was never

pressure put on family members or friends to leave. The researcher was ever mindful of the possible intrusion that the project might have on precious time patients were spending with their family and friends.

Design and participants

The same mixed-method multivariate quasi-experimental design was used for the clinical phase as for the student study. In addition to university Human Ethics Committee approval, the Medical Advisory Committee of the hospital granted approval for this research to be carried out in their facility. This included permission to access patients, staff, and medical records where necessary.

Recruitment of participants – palliative care

Recruitment flyers and information sheets were distributed in public areas of the hospital, including hallways, family and staff areas (see Appendix A). The researcher attended weekly staff meetings where all the patients were reviewed. Staff members were informed of the nature of the study, and were asked to recommend patients that met inclusion criteria for the researcher to approach personally. All PC patients who met these criteria were possible candidates for the project.

Criteria for inclusion in the study were being 18 years of age or over, with a life-limiting cancer and no longer receiving active anticancer interventions to prolong life; being cognitively oriented in person, place and time; having adequate hearing and English language skills to listen and respond to the interventions; and being willing and well enough to participate in the study. Some potentially suitable patients had antibiotic-resistant infections, so had to be excluded due to extra infection control protocols being stipulated.

PC patients were not approached by the researcher in the first 24 to 48 hours after admission to allow them to settle into their new surroundings, and for the necessary medical and nursing assessments and interventions to be carried out to facilitate the hospital's aims of palliating and stabilising their symptoms. The researcher visited potential participants in their rooms to discuss the study with them, together with any family or friends that were present. They were supplied with written information to read and consider (see

Appendix A) before the researcher returned to book the intervention for a later time. This visit with the patient also allowed the researcher to vet for exclusion criteria such as cognitive or sensory issues.

Data was collected in the PC unit over a ten-month period, during which time 15 patients participated in the study.

Recruitment of surgical participants

Surgical participants were limited to patients of six surgeons suggested by the nursing coordinator of the surgical ward, and who agreed to allow access to their clients. These included two general surgeons who specialised in breast surgery, two urological surgeons, and two orthopaedic surgeons. Surgeons worked only on certain days, and according to a six-week rotation, further limiting the amount of potential participants available on any one day.

Surgery lists were discussed with senior nursing staff prior to the day of surgery. Potential participants who were not too early on the day's surgery list were recommended to be approached after admission. This was to ensure enough time was available for the intervention to take place before the patients were taken from the ward for their surgery.

Patients who met the inclusion criteria were then visited by the researcher whilst they were still in the waiting room or already in their private room on the ward. Criteria for inclusion in the study were the same as for PC patients, apart from the cancer diagnosis, with the additional requirement that the participant be in a single-bed room. The surgery ward had some shared rooms, whereas the PC unit only had single rooms.

Information sheets were left with patients for a short time to read and, where applicable, to discuss with their accompanying family member or friend. The researcher then returned for their decision regarding participation. Data collection on the surgical ward occurred over a period of four months, during which nine patients participated.

Selection of music

"THING THING
What is that thing?
THING SING
That thing can sing!
SONG LONG
A long, long song
Good-by, Thing
You sing too long."

(Seuss, 1957)

In response to feedback from students in the first phase of the study, the length of the interventions was reduced from 25 minutes to around 15 to 17 minutes. This required the removal from the program of the Mozart Romanza, as well as some repeats being cut from the Mozart Minuet and the Joplin piece. With these minimal changes, the basic integrity of the music program was retained.

Recruitment of musicians and readers

We are the music makers,
And we are the dreamers of dreams

Arthur O'Shaughnessy (1873)

Professional string players were recruited from the West Australian Symphony Orchestra (WASO) and the Education Department's School of Instrumental Music (SIM). The researcher attended both work places to give a brief talk about the project before signing up interested musicians. Flyers were placed on staff notice boards (See Appendix A), and emails were sent to WASO players and to SIM teachers by administrative and senior staff members. A very positive response from musicians resulted in more willing players than were required for the study. Musicians were selected based on their availability at the times that there were likely to be patients recruited for the study.

The musicians who played for the study had the maturity and interest in the clinical application of their musical skills to be suitable for the potentially emotional setting they were to come into. Information sheets provided to presenters, as well as personal discussions with the researcher, were designed to make them aware of the emotionally confronting environment they may encounter (see Appendix A). Musicians were given the music weeks in advance to allow them to prepare the program beforehand.

Readers were sourced by direct approach from the researcher to friends, acquaintances and colleagues, as well as volunteers working at the hospital. They were provided with the same information about the study as the musicians, as well as the stories for them to read through before they came in to read to a patient. Neither musicians nor readers were offered any financial incentives or remunerations for their involvement with the study.

Available musicians and readers were tentatively booked in advance, subject to confirmation or cancellation, when it was anticipated there would be a suitable and willing participant available on a certain day. Decisions to book were based on previous discussions with a PC patient, or consultation with the senior nursing staff on the surgical ward. Requirements for a live intervention to record for subsequent AV and A presentations, and the order of the random number determination of live interventions, were also considerations in booking live presenters.

After their presentations, musicians and readers were asked to wait to meet with the researcher before leaving the hospital to ensure they were not distressed, and to allow them to discuss their experiences. There was opportunity after the second round of data collection for the researcher to step outside the patient's room to chat with the presenter.

Selection of stories

The duration of the readings was reduced from its original length of nearly 20 minutes to around 12 to 16 minutes by cutting a section of the second story (McGregor, 2002). This change was made after the first two interventions as it was considered this middle story was too long to remain engaging. The reduced length of the story readings also corresponded to the shorter music program used for the clinical phase of the study. Again, the integrity of the reading program was retained by the minimal adjustment made.

Procedures and protocols for interventions

Each intervention had a unique location, that is, the patient's private hospital room. These rooms were not standardised like the laboratory used for the student interventions: variations between rooms included their size and layout, the views from the windows, carpet versus hard flooring, the amount of noise

penetration from the common areas of the ward, and so forth. However, the protocols set out for all interventions were adhered to as closely as possible to retain consistency between participants. A flow chart of the intervention protocols can be found in Appendix B.

Hospital procedures, such as the admission processes for patients by the nursing staff, delivery of meals and medications, bedside visits from surgeons and anaesthetists, presence of significant others in the room, earlier than anticipated transfer from the ward to the theatre suite, and so forth, were all anticipated as possible interruptions to the normal flow of the intervention and data collection process. In addition to working in with the staff and prioritising their needs, the door to the patient's room was closed with a sign attached to warn others that research was in progress to minimise the possibility of interruptions.

Recording musicians

Live musicians were positioned either at the foot of the bed or to one side, wherever the room layout determined, and the posture of the patient made it most comfortable for them to watch. Some patients were sitting up in bed, others were reclining, whilst some chose to sit in a chair. Adjustments to where the musician stood or sat were made accordingly.

The video was set up on a tripod in a position to most ideally capture the musician from as close as possible to the patient's perspective, whilst also allowing the researcher access to control the recording equipment.

Recording readers

Readers sat bedside or chair-side to the patient, with the Samsung tablet used as recording equipment placed nearby where it could be controlled by the researcher.

Playback of recordings

AV recordings were played back through the laptop via Logitech Mini Boombox portable speakers. Similarly, the audio stories and music were heard via these same speakers connected to the Samsung tablet.

Patients sat in a chair, or sat up or reclined in bed whilst watching and listening to the AV and A recordings. Equipment was placed in a suitable position on an adjustable table to allow optimum viewing and listening comfort.

Data collection at the hospital

Protocols for data collection mirrored those detailed earlier for the first study with students.

Saliva sampling

Inadequate saliva production was anticipated as a possible issue in the populations of PC patients, due to their illness and medications, as well as for fasting pre-operative patients. Procedures were the same as for student participants. However, at any sign that the saliva collection was causing distress to a patient — due to lack of saliva flow or any other reason — it was aborted.

With PC patients, timing needed to be precise in order to avoid collection of samples soon after the patient had consumed morning tea or coffee. All PC patients were encouraged to drink and swill their mouth with water, but surgical patients were not permitted to do so due to their nil-by-mouth fasting preparation for surgery.

Transport of saliva

As with the saliva samples from students, the patients' saliva was transported on ice to the university laboratory for freezer storage at minus 80° C within a few hours of collection.

Self-report scales and verbal responses

The same VAS scales and emotion and absorption scales used in the student study were applied in this clinical study. Similarly, patients were asked for a one-word summary of their experience after listening to the music or stories. Any additional spontaneous comments made about the intervention were written down immediately by the researcher.

Questionnaires

The only difference between student and patient demographic information collected was that patients were asked specific diagnostic details pertaining to

the reasons for their hospitalisation, but were not asked anything regarding educational history.

Medications and length of hospital stay

PC patients' charts were accessed to determine the doses of breakthrough medication consumed in the 24 hours before the intervention and the 24 hours following the music or stories. Surgical patients' lengths of hospitalisation, in hours, were recorded after their discharge.

Assaying of saliva and data analysis of outcome measures

ELISA assaying and pH testing

Saliva samples were assayed according to the protocols supplied by IBL International (Hamburg, Germany), the manufacturer of the ELISA kits used. Assaying took place in the on-campus biomedical laboratory where the samples were stored.

All assaying, but not the pH testing, was carried out by a third party not directly involved with the rest of the project, and who was blind to the individual participants' interventions. The principle researcher assisted with preparing the saliva samples for assaying, and tested all the samples for pH levels.

It is relevant to note at this point that the decision to test pH occurred after data collection had already commenced and early samples had been frozen. For consistency in the protocol, all the pH tests were carried out on thawed samples rather than the ideal procedure of testing spH immediately on fresh samples.

Preparation of samples

Before assaying, samples were thawed on ice at room temperature. Each microtube was then vortexed to bring the contents into suspension before being centrifuged at 3000g for 15 minutes in a coolroom. The supernate of each tube was then transferred via pipette into fresh microtubes, leaving any sediment behind, before again being vortexed. This process reduced the saliva's viscosity, making it more consistent for transferring to storage tubes, assaying plates and the pH meter. Finally, aliquots were prepared with the saliva samples divided into fresh microtubes in the specific quantities required for each biomarker assay: 100µl each for cortisol and IL-1β, 50µl for IgA, and 10µl for AA. Any remaining saliva was retained for measuring pH.

The microtubes of thawed saliva were kept on ice throughout procedures carried out at room temperature to keep them at the lowest possible temperature. Tubes were kept closed throughout these procedures, only being opened for pipetting, to minimise exposure of samples to the air.

Assaying for salivary α-amylase

Saliva samples were tested for sAA activity using an ELISA specifically developed for human saliva (IBL International GMBH, Hamburg). This is a liquid phase enzymatic assay in which sAA specifically metabolises the substrate. The intensity of the colour developed is proportional to the activity of AA in the saliva sample.

The laboratory work was carried out according to protocols supplied by the manufacturer. First, 10 μL of the prediluted samples along with standards and controls were pipetted into the respective wells of the microtiter plate. This was followed by adding 200 μL of the substrate solution into each well. The plate was then shaken and incubated for 3 min at room temperature. Optical density was measured at 405 nm to get the absorbance readings (reported in U/mL).

The sAA assays required some modifying in terms of dilution levels for samples that registered above the standard curve: when the dilution was increased to 50% concentration (at 1:600 instead of 1:300), most samples fell within the ideal range for absorbance readings. Those samples that still registered above the standard curve were re-assayed with a further 50% dilution (i.e., 1:1200).

Assaying for salivary cortisol

Saliva samples were assayed for levels of sC using a solid phase ELISA developed for use with human saliva or human serum (IBL International GMBH, Hamburg). This assay is based on the competition principle where an unknown amount of cortisol present in the saliva sample and a fixed amount of enzyme labelled antigen compete for the binding sites of the antibodies coated onto the wells of the microtiter plate.

The test protocol involved pipetting 50 μL of each sample including standards and controls into the respective wells of the microtiter plate. This was followed by adding 100 μL of the enzyme conjugate into each well. The plate was then incubated for 2 hrs at room temperature on a shaker. After washing the wells four times with the diluted wash buffer, 100 μL of the substrate solution was pipetted into each well before incubating for another 30 min on the shaker. The reaction was then stopped by adding 100 μL of the stop solution and the reading was taken, again at 450 nm (reported as μg/dL).

Assaying for salivary IgA

Concentration of IgA in the saliva samples was determined using an ELISA specific to human saliva (IBL International GMBH, Hamburg). The basis for this assay is the simultaneous binding of IgA to two antibodies, one immobilised in the well and the other conjugated to the horseradish peroxidase. The colour intensity is proportional to the concentration of IgA in the saliva sample.

First 25 μL of the diluted sample, along with the standards and controls, was pipetted into the respective wells of the microtiter plate. This was then incubated for one hour at room temperature. After washing the wells three times with the wash solution, 100 μL of the substrate solution was added and then again incubated for 15 min in the dark at room temperature. The reaction was stopped by adding 100 μL of the stop solution and mixing gently before reading the absorbance at 450 nm (reported in μg/mL).

Assaying for salivary IL-1β

The ELISA assay of IL-1β is based on the binding of the unknown amount of this biomarker present in the sample to the anti-human IL-1β coating antibody absorbed onto the microwells. The ELISA used for quantifying the levels of IL-1β in the saliva samples (IBL International GMBH, Hamburg) was not specified for use with saliva, but rather for general use with human cell culture supernatants, urine, serum and plasma.

Manufacturer's guidelines indicated the upper reported level of sIL-1β would exceed the range of the ELISA kit's standard curve if the recommended dilution of 1:2 was used, so it was considered that a dilution of 1:5 would be likely to capture the higher data points. The additional dilution resulted in a normal standard curve for the prepared standards.

The microtiter plates were washed with wash buffer before diluted samples, standards and controls were pipetted into the respective wells. After 50 μL of the Biotin conjugate was added to all the wells, the plate was incubated at room temperature on a shaker for 2 hrs. Next the plate was washed three times with the wash solution, after which 100 μL of streptavidin-HRP was added to the wells. After a further incubation of 1 hr, 100 μL of TMD substrate was added into each well, followed again by a 10 min incubation. Absorbance was read at 450 nm after adding 100 μL of stop solution, and the values reported as pg/mL.

pH testing of saliva

Salivary pH was measured at the time the samples were thawed and divided into smaller quantities for the individual assays. These aliquots were refrozen, and thawed when required for the subsequent assaying of the different biomarkers. Samples were not marked to indicate which intervention group they belonged to, so there was some degree of blinding.

An electronic pocket pH meter was used (Horiba Scientific Laqua Twin pH 22). The meter was first calibrated, using buffer solutions provided to calibrate to pH levels of both 7.00 and 4.00. A single drop of saliva (±100 µl) was required for each test, which measured within a pH level accuracy of ±0.01. The saliva was placed via pipette onto the flat sensor chip. The meter responded quickly: within seconds it indicated with a smiley face that the result could be read. In between each measurement, the pH meter was flushed with deionised water and the sensor gently patted dry with a fibre-free disposable cloth.

Preparing data from biomarker readings

ELISA measurements

All the raw results from the biomarker ELISA assays were recorded, and where duplicate measurements were available an average of the two readings was calculated. These figures were then entered into the Excel spreadsheet for subsequent calculations and statistical tests, as described below. Difference scores and percentage change scores were calculated for each participant to reflect the changes occurring from baseline in the second and third measurements. The difference scores were then standardised, as described below.

pH measurements

The raw measures of pH readings were recorded and similarly entered into the Excel spreadsheet. Difference scores, percentage change and standardised scores were calculated as for the assayed biomarkers.

Preparing data from non-biological measures

VAS scales

All completed VAS scales were measured with a ruler and scored in millimetres, thus providing a score out of 100. For each participant, difference measures were calculated by subtracting the baseline score from each of the subsequent two VAS scores. These differences were then converted to percentage change scores. Difference scores were also standardised to overcome the issue with percentage scores of not being able to subtract from or add to a zero baseline reading. The formula used to standardise scores is described below.

Self-report scales

Each of the four 10-point affect scales, for liking the music, perceived emotion, felt emotion, and absorption, were scored out of 10. As these scales were only applied at one time there were no further calculations required.

Breakthrough medication

Any changes in breakthrough medications were noted, as reported in the case-by-case descriptions of the PC patients in the results chapter.

Length of hospitalisation

Due to the small number of surgical patients (nine), resulting in only a maximum of two per condition, their length of stay data was not used for any statistical tests but was prepared as a table for background information.

Statistical data analysis

Numerical data was initially entered into Excel spreadsheets for subsequent transfer to the SPSS (Statistics 23, IBM) software used for all statistical tests run on the data. In addition to the raw scores for scales and pH readings, and the raw scores or average between two readings where applicable for biomarker readings, raw as well as percentage differences were calculated between the baseline readings and each of the subsequent two measures for each variable. The difference scores were also standardised, as described below.

Missing data was coded and entered on the SPSS spreadsheets for cases that were: a) not measured due to lack of time, or no saliva collection; b) insufficient saliva to assay; or c) an outlier, so left off the data set. Determinants for outliers

were idiosyncratic and are explained where relevant for an outcome measure together with the reported results.

Statistical transformation of scores

Standardised scores were calculated by subtracting the post-intervention score from the baseline score and dividing these figures by the standard deviation (SD) of the mean of the baseline scores. These calculations were made for each participant for both the immediate post-intervention measure and the delayed third measure. Students' mean scores were calculated separately from those of the hospital patients, so the standardised scores reflect these separate cohorts.

Standardised scores allowed the results to be viewed as changes from the baseline scores in either a positive or negative direction. Also, by standardising scores, comparisons could be made between variables. Changes were easy to visualise in either direction from the zero baseline.

Statistical tests

In addition to descriptive data calculations, SPSS (Version 23) was used to run ANOVAs on all the biomarker and self-report scales data. Whilst these comparisons yielded some significant differences for time of tests (i.e., first, second or third data collection round), there were no statistically significant differences detected between treatment groups to support or refute the hypotheses. Although a large number of statistical tests were carried out to test the hypotheses, only those producing significant results are reported.

Additional evaluation of data

Clinical significance

Statistical significance alone is insufficient as a measure for evaluating the efficacy of the interventions used in this study. Other evaluations of the observed differences used, such as confidence intervals, effect size and clinical significance, are outlined in the results section before being considered more fully in the ensuing discussion.

Qualitative data

Useful qualitative data, such as the one-word elicited responses as well as spontaneous comments provided by participants, add an extra dimension to the

discussion of quantitative data collected in this study. Some of this data is presented in tables whilst other contributions from participants are noted in the context of the results, and to add more meaning to the discussion of quantitative data results.

Chapter 5: RECAPITULATION - Results and Discussion

A battery of subjective and objective measures was applied to two discrete cohorts of participants to test whether there was a difference between live and recorded presentations of music as interventions for anxiety, pain and immune function. The medley of measures was also used with participants, from these same cohorts, who listened to live or audio recordings of story readings. The pre- and post-test design further multiplied the data points, resulting in a large data set from the limited number of participants (N = 73).

The intention behind the variety of outcome measures was to provide a broader picture of the biopsychosocial mechanisms underpinning the effects of listening to music, particularly in its various modes of presentation. The results and associated discussion in this chapter reveal a breadth and depth of understanding not achievable by using just one or two outcome measures.

The data, in group-form and by individual, are explored from many perspectives, including raw data, standardised differences, multiple comparisons, and presented in visual as well as written form. Despite not yielding significant statistical differences, positive indicators of clinical significant differences are discussed, as well as possible explanations for all the observed results. Overall, evidence from trends in both objective and subjective measures indicates support for the original hypotheses.

Participants and demographics

The study comprised of two discrete cohorts of participants: 50 tertiary university students and 23 hospitalised patients. Data preparation and analysis reflected the separate nature of the two groups.

Student participants

Most university participants were sourced from a list of undergraduate students enrolled in psychology units at Edith Cowan University (ECU), Western Australia, who volunteered their willingness to participate in university research projects. Other students, including some graduate students, were solicited directly by the principal researcher.

Each academic (calendar) year a new register of potential participants was created. The 2013 register contained 63 names, of which most, or 54 (85.71%), were female, with only 9 (14.29%) male students volunteering. Ages ranged from 17 to 55 years. Six 17 year olds — under the 18 year old minimum age for this study — were excluded from the pool of students used for random selection. The register for 2014 contained 42 names, with a female to male balance of 34 (80.95%) to 8 (19.05%). Six of the students had previously registered on the list the year before. Again there were six 17 year olds eliminated, and the remainder ranged in age up to 64 years old. The general student enrolments at ECU in 2013 were also predominately female (14,321, or 61.45%) compared to male (8984, or 38.55%), but the gender differences in the total student population of 23,305 were not as large as seen in this specific register.

Ages of students included in the study ranged from 18 to 64 years, with a mean age of 33 years. Of the 50 participants, 36 (72%) were female and 14 (28%) were male. The majority of 39 (78%) were undergraduate students, with 11 (22%) postgraduate students also participating. Demographic data of student participants is summarised in Table 4.

Table 4. *Student Participants: Demographics*

	AGE (YEARS)		SEX		ENROLMENT	
N = 50	≤ 20	11 (22%)	Male	14 (28%)	Under grad	39 (78%)
	21 - 30	18 (36%)	Female	36 (72%)	Post grad	11 (22%)
	31 - 40	3 (6%)				
	41 - 50	12 (24%)				
	51 - 60	5 (10%)				
	≥ 61	1 (2%)				
Mean age	33 years					

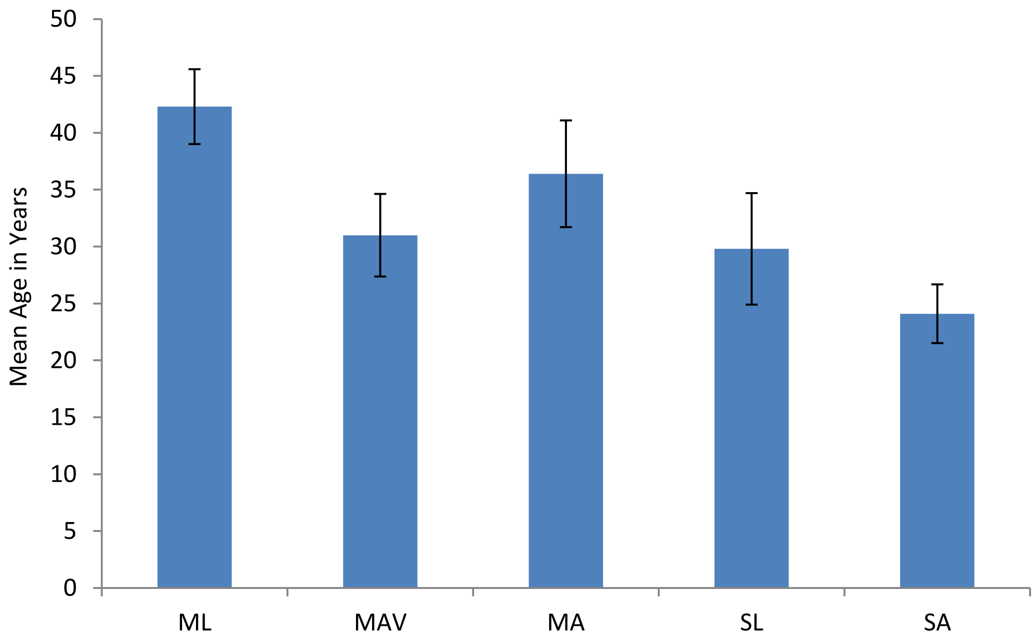

Figure 5. Mean group age (in years) of student participants, with error bars representing standard error (SE)

Experimental groups and data set

Each of the five experimental conditions, being ML, MAV, MA, SL and SA, had 10 participants. With only a limited number of missing data points, the data set for the student cohort was comprehensive and suitable for statistical analysis.

Students were allocated quasi-randomly to experimental groups, with no attempts made at matching for demographic variables. An exploratory ANOVA highlighted significant between group differences in mean ages of participants, F (4) = 3.119, p = .024, as illustrated in Figure 5. Highest mean age of 42.3 years (SD = 10.39, SE = 3.29) in the ML group contrasted to the lowest mean age of 24.1 years (SD = 8.17, SE = 2.58) in the SA group.

Clinical participants

All participants in the clinical component of this study were patients at the same private hospital in suburban Perth, Western Australia. The total of 23 participants comprised of a mix of palliative care, n = 14 (60.87%) and surgery patients, n = 9 (39.13%). Their ages ranged from 36 to 87 years, with a mean age of 67 years. Similar to the student cohort, the majority of 17 (73.91%) were female, with the remaining 6 (26.09%) being male patients.

Diagnoses of PC patients in the study covered a variety of life-limiting cancer diagnoses, including one (4.35%) with brain cancer, two (8.7%) with specific male cancers, three (13.04%) with lung cancer, four (17.39%) with specific female cancers, and four (17.39%) with cancers of the gastrointestinal system.

Surgery participants were undergoing a variety of procedures and operations, including three (13.04%) specific to males, such as prostate and urinary tract procedures, four (17.39%) specific female procedures including breast or gynaecological operations, and two (8.7%) orthopaedic operations or investigations. The nine surgery patients were under the care of six different surgeons at the hospital. The patients' demographic data described here is summarised in Table 5.

Table 5. *Clinical Participants: Demographics*

	AGE (YEARS)		SEX		DIAGNOSIS	
N = 23	≤ 40	1 (4.35%)	Male	6 (26.09%)	Ca brain	1 (4.35%)
	41 – 50	3 (13.04%)	Female	17 (73.91%)	Ca lung	3 (13.04%)
	51 – 60	4 (17.39%)			Ca male	2 (8.70%)
	61 – 70	3 (13.04%)			Ca female	4 (17.39%)
	71 - 80	8 (34.79%)			Ca GI	4 (17.39%)
	81 - 87	4 (17.39%)			Male surgery	3 (13.04%)
					Female surg'y	4 (17.39%)
Mean age	67 yrs				Orthopaedic	2 (8.70%)

Experimental groups and missing data

Due to time constraints and some obstacles to recruitment and completion of interventions, as discussed in the ensuing section, the final breakdown of numbers of clinical participants was not equal across the five experimental groups: ML n = 6, MAV n = 4, MA n = 4, SL n = 5, and SA n = 4. Unequal and small group numbers were not conducive to statistical explorations, particularly as the data set was further eroded by missing data points. Reasons for the missing data included lack of time to complete the third set of saliva collection and VAS scales due to surgery patients being transferred to the surgery suite; or the patient being too tired or unwell to persist with the third data collection; no saliva or insufficient saliva volume; or zero VAS scores or outlier biomarker results which were not used.

Full data sets were obtained from six (26.09%) of the 23 clinical participants, with a further six (26.09%) yielding some biomarker data. No useable biomarker data was obtained from the remaining eleven (47.82%). In view of these reasons, and others which are detailed below that prevented a larger and more comprehensive data set, the data for the clinical participants is presented mostly as individual cases rather than as grouped statistical data.

Rate of patient participation

In total, 23 patients participated in the study over a period of 10 months. An additional recruited PC patient commenced his intervention, but it was discontinued when he became agitated. In hindsight, it should have been apparent that he was unsuitable due to his diagnosis of brain cancer and some cognitive impairment.

The low number of only 14 PC participants, considering around 30 patients per month were admitted to the PC ward, was due to many factors. Patients' level of physical comfort and sense of wellness can influence their decision to participate in music or story sessions (Burns, Sledge, Fuller, Daggy, & Monahan, 2005). It is understandable that a patient who is feeling unwell may prefer to be left alone in silence. PC patients were often sleeping, resting, being nursed or attended to by other staff. Even after agreeing to take part, there were numerous occasions where by the next day the patient was not well enough or motivated to engage in the study, or where a family member preferred that they did not participate.

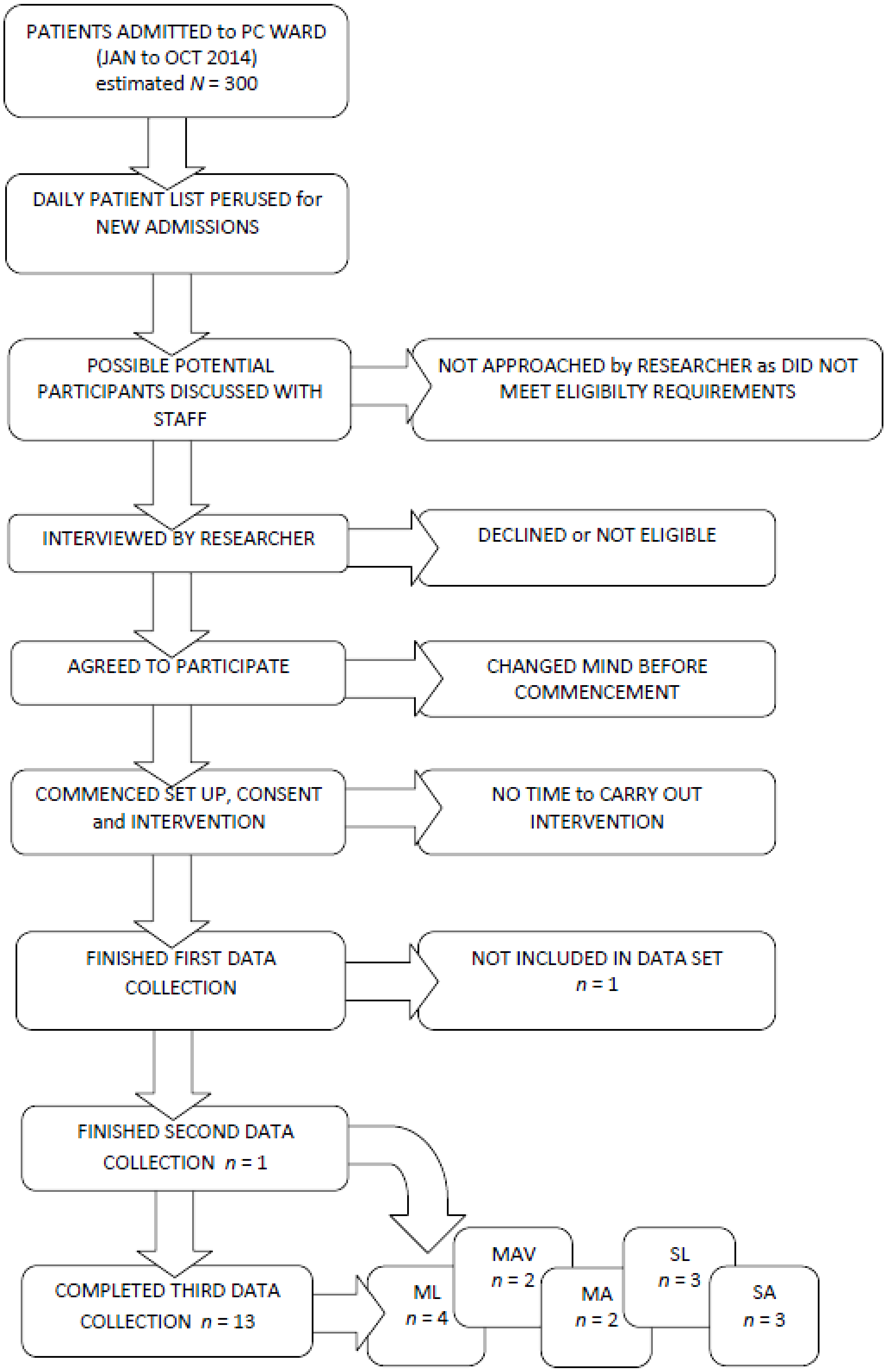

Figure 6. Flow chart of palliative care participants' recruitment

At the other end of the spectrum, some of those that were feeling comparatively well also rejected an offer of music or stories, choosing instead to perhaps talk

to visitors, read, crotchet, or go for a walk. How the final number of 14 palliative care participants was arrived at is summarised in the flow chart in Figure 6.

Recruiting surgical patients also posed many challenges, as summarised in Figure 7. It is estimated approximately 1270 patients were admitted for at least one night's stay in the 20 bed surgical ward during the months of May to August 2014. Of these only nine people eventuated as participants. The rotating surgery roster meant that one or more of the six selected surgeons were operating only on certain days each week. Surgery lists were subject to change. This resulted in shorter than predicted time windows to recruit and complete the intervention before patients left the ward for the surgery theatres. Other patients arrived in the ward later than their anticipated time. Some potential participants were excluded as they were in a shared room. Patients with their doors closed were not disturbed, whilst others were occupied with admission processes and interviews with clinical staff.

Even after agreeing to take part in the study, some interventions were interrupted by the patient being taken to the surgery suite earlier than expected, or by consultants coming in to interview their patients. In some of these cases, the third round of data collection was missed, but participants were still included in the data set where the first two rounds of data were completed. Similarly, where two PC patients were not well enough or willing to persist with the third data collection, their data was retained in the data set.

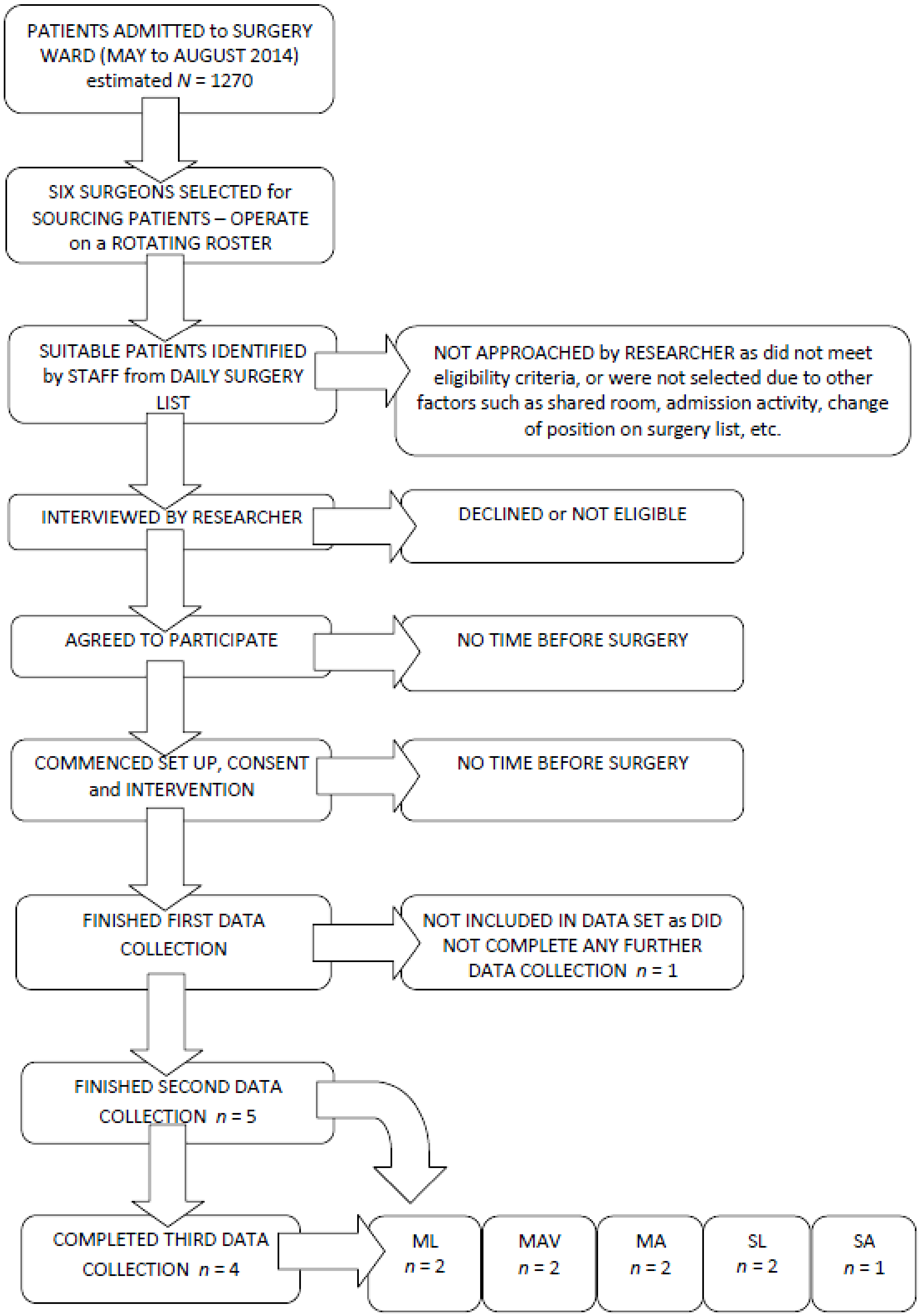

Figure 7. Flow chart of surgical participants' recruitment

Musicians and readers

No specific demographic data was collected from the presenters. Musicians playing for the students were young adult tertiary music students. Those playing at the hospital were professional musicians and so were in a more mature age group, ranging from in their thirties to sixties. Readers at both the university and hospital represented a wide age range similar to the student participants.

Length of presentations

Read him slowly, dear girl, you
must read Kipling slowly.

(Ondaatje, 1992, p. 100)

As explained in the methodology section, adjustments were made to the length of the music program for the clinical phase of the study, and the stories after the first few readings. The length of each music program and reading was also dependent on the speed at which each presenter delivered their rendition of the scored or written material.

Table 6. *Length of Music and Story Presentations*

	LENGTH OF PRESENTATIONS (minutes)				
	N	Mean	SD	SE	Range
STUDENTS					
Music	30	24.21	1.70	.3108	21.45 – 26.73
Stories	20	13.60	1.54	.3449	11.68 – 15.80
PATIENTS					
Music	14	16.09	1.48	.3944	14.23 – 17.62
Stories	9	16.22	2.44	.8138	13.18 – 19.65

Music programs for students had a mean length of 24.21 minutes. The story program had a shorter mean length of 13.60 minutes in response to the feedback from student music listeners in the first phase of the study and the

first few patients who listened to stories. Clinical music and story programs had similar mean lengths of 16.31 and 16.42 minutes respectively, but with the wider range of stories reflecting the initial longer length for the first few readings. Length of presentations data is summarised in Table 6 and Figure 8.

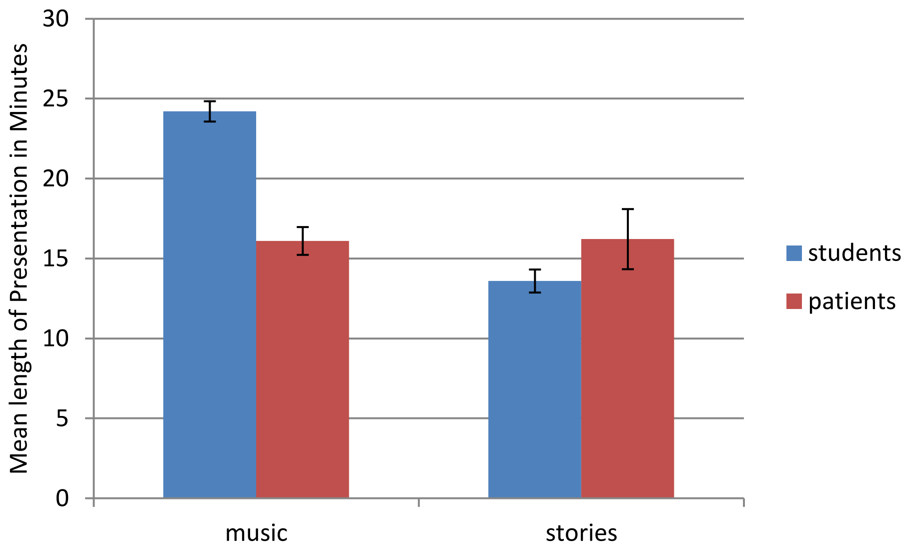

Figure 8. Mean length of music and story presentations, in minutes, with error bars representing 95% confidence intervals

Objective measures

Any measure that does not require an element of self-report is considered to be objective. All the biomarker data obtained from the saliva samples provided by both the student and clinical participants is now detailed.

Biomarker results

The 73 (50 student and 23 clinical) participants had a potential total of 219 saliva samples if each participant provided three samples. The flow chart of saliva sampling (Figure 9) illustrates the stages at which saliva was successfully collected and cases where no saliva collection occurred. Of the 181 samples collected, further data points were missing due to insufficient volume to perform some assays, or results which did not fit in the standard curves used for quantifying the assays.

In view of the restricted number of samples available from the clinical population of this study, the results of patients' assays are presented case-by-case as graphs. But first the student population results, based on a more comprehensive data set, are reported here and illustrated with tables and graphs based on intervention groups. The raw results, which were calculated directly from the recorded ELISA assay levels, are presented first, followed by the standardised results which show clearer differences from baseline levels and comparisons between the various biomarkers and other outcome measures.

ANOVAs were carried out on the student ELISA results and spH readings, both raw and standardised, comparing intervention groups and time of test. Whilst there were some significant differences over time (with all interventions grouped together), there were no significant differences detected between the intervention groups themselves. Only significant results are reported. Interpretation of outcomes is based mainly on raw results, and trends observable in graphs of standardised results which illustrate the changes from the first baseline sample to the second sample (labelled "2-1"), and from baseline to the third samples (labelled "3-1").

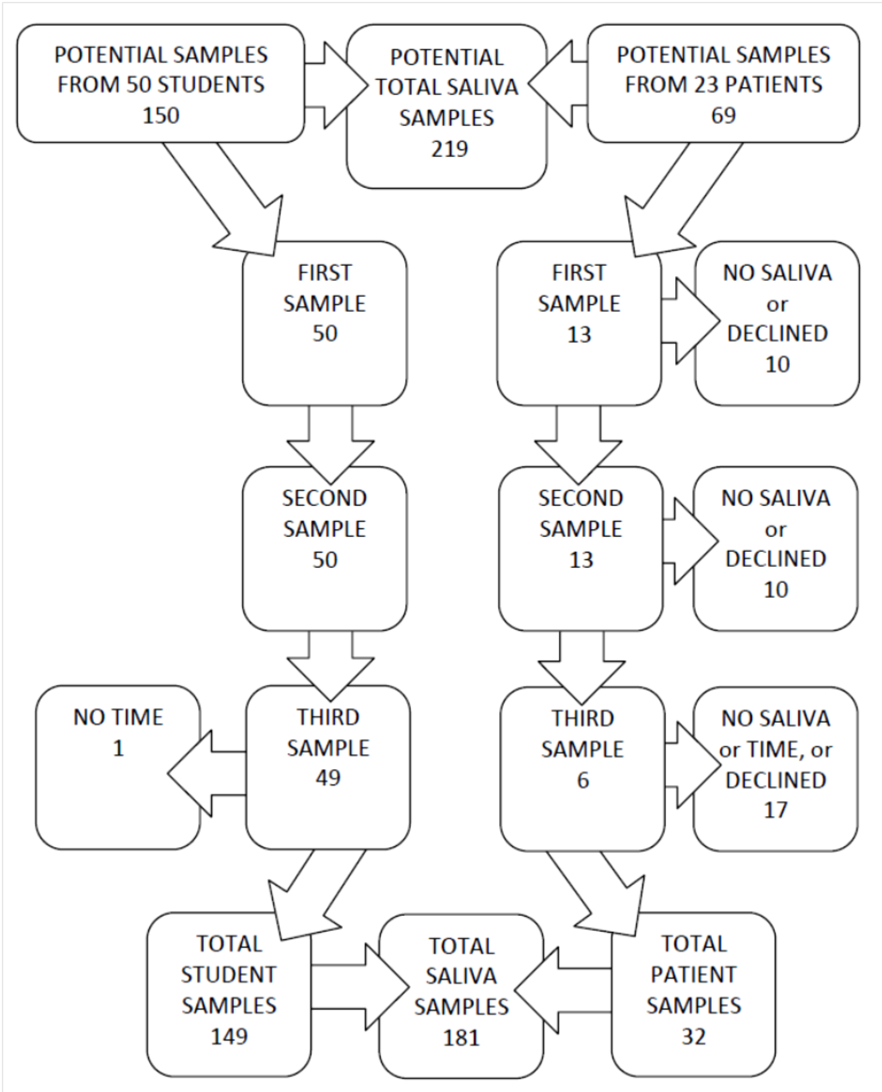

Figure 9. Flow chart of saliva sampling

Salivary α-amylase results: students

Raw results of the sAA assays from the student participants are presented in Table 7, expressed as U/mL. Samples (AA 3) for both MAV and MA rebounded beyond the baseline readings, whilst the ML levels remained below baseline levels, indicating a stronger residual anxiolytic effect from the ML compared to the recorded music interventions. For the story interventions, SL showed only minimal post-intervention change and SA had rising sAA levels after the stories, noted most in the final samples. Standard deviations (SD) of the mean results for each group highlighted large individual differences. Baseline (AA 1) means of each group, ranging from 97.72 U/mL to 200.58 U/mL, were also not equal.

The line graph of the raw result (Figure 10) illustrates the differential changes seen in response to the five interventions. All three music intervention groups had lower levels of sAA in the first samples taken immediately after listening to the music (AA 2) compared to baseline levels. Then the sAA levels in the final samples (AA 3) for both MAV and MA rebounded beyond the baseline readings, whilst the ML levels remained below baseline levels, indicating a stronger residual anxiolytic effect from the ML compared to the recorded music interventions. For the story interventions, SL showed only minimal post-intervention change and SA had rising sAA levels after the stories, noted mostly in the final samples. None of these changes was shown by the ANOVAs to be statistically significant.

Table 7. *Mean Group Raw Salivary A-Amylase Results: Students (in U/mL)*

	ML *n* = 10	**MAV** *n* = 10	**MA** *n* = 10	**SL** *n* = 9	**SA** *n* = 10	**All groups**
AA 1						
Raw	200.58	181.18	129.12	97.72	129.53	
SD	108.40	88.55	80.98	52.63	76.13	
SE	26.53	26.53	26.53	26.53	26.53	
Mean						147.63
AA 2						
Raw	180.82	163.23	123.04	105.74	133.35	
SD	86.97	83.35	66.17	55.46	84.36	
SE	24.25	24.25	24.25	24.25	24.25	
Mean						141.23
AA 3						
Raw	189.29	218.14	143.91	103.17	160.79	
SD	100.94	163.37	97.91	52.23	128.70	
SE	36.59	36.59	36.59	36.59	36.59	
Mean						163.06

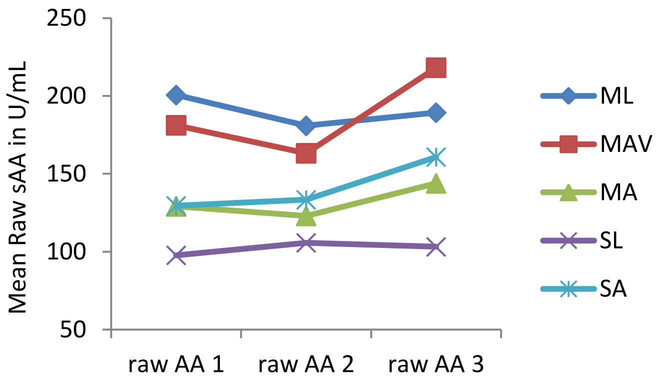

Figure 10. Mean group raw salivary α-amylase results: students

Standardised scores illustrate more clearly the differential group changes observed in sAA levels (see Figure 11). The horizontal axis at zero represents the baseline. The three music interventions all precipitated immediate lower sAA levels (AA2-1), mostly seen with the ML group levels, followed by MAV and MA. After listening to stories, students' sAA levels immediately rose, mostly after SL. The only group to show a lower than baseline level at the third sample (AA3-1), indicating a residual anxiolytic effect, was ML. All the other groups rebounded beyond the baseline levels, with sAA levels in SL being most stable of the remaining four groups. However, the 95% CIs clearly highlight the lack of statistical difference between the intervention groups as well as over time.

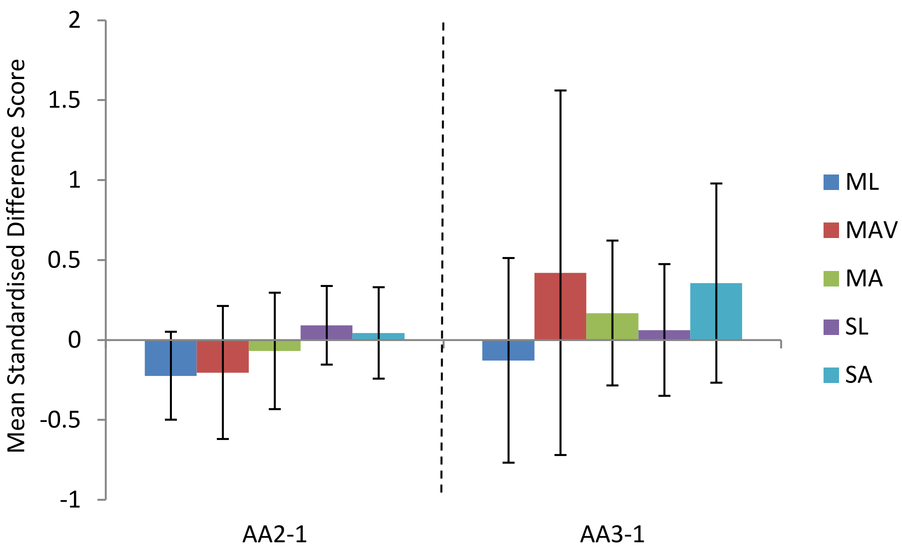

Figure 11. Mean group standardised α-amylase difference scores, with 95% confidence intervals, from baseline to post measures: students

Salivary cortisol results: students

Ten samples, taken from six students and one patient, had insufficient volumes for the sC ELISA assay, which required 100µl of saliva. Raw sC results for the students, expressed as µg/dL, are outlined here and summarised in Table 8 and Figure 12.

Table 8. *Mean Group Raw Salivary Cortisol Results: Students (in µg/dL)*

	ML *n* = 9	**MAV** *n* = 9	**MA** *n* = 7	**SL** *n* = 8	**SA** *n* = 9	**All groups**
C 1						
Raw	.747	.586	.561	.976	1.157	
SD	.413	.244	.214	1.237	.663	
SE	.222	.222	.251	.235	.235	
Mean						.806
C 2						
Raw	.651	.409	.522	.806	.802	
SD	.322	.159	.126	.903	.383	
SE	.154	.154	.174	.163	.154	
Mean						.654
C 3						
Raw	.518	.350	.475	.557	.740	
SD	.253	.101	.058	.452	.309	
SE	.092	.092	.104	.097	.092	
Mean						.528

As seen earlier with sAA, comparative mean levels of sC were not equal at baseline (C 1), with levels ranging from .561 to 1.157µg/dL. Reduced stress or anxiety was indicated by the falling post-intervention sC levels observed in all of the five groups immediately after the interventions (C 2), and the continued fall around 25 minutes later (C 3).

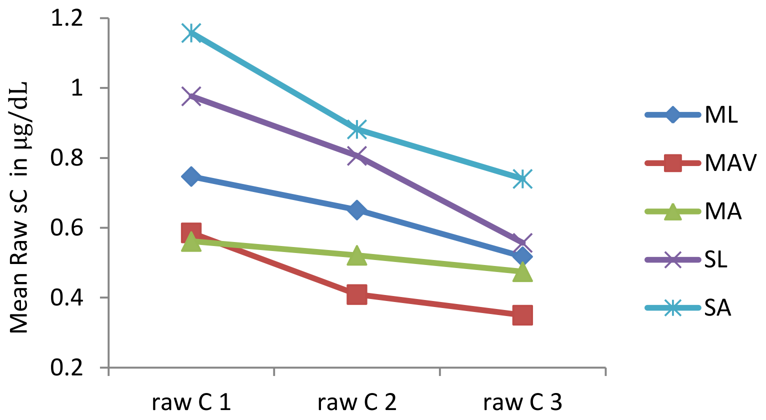

Figure 12. Mean group raw salivary cortisol results: students

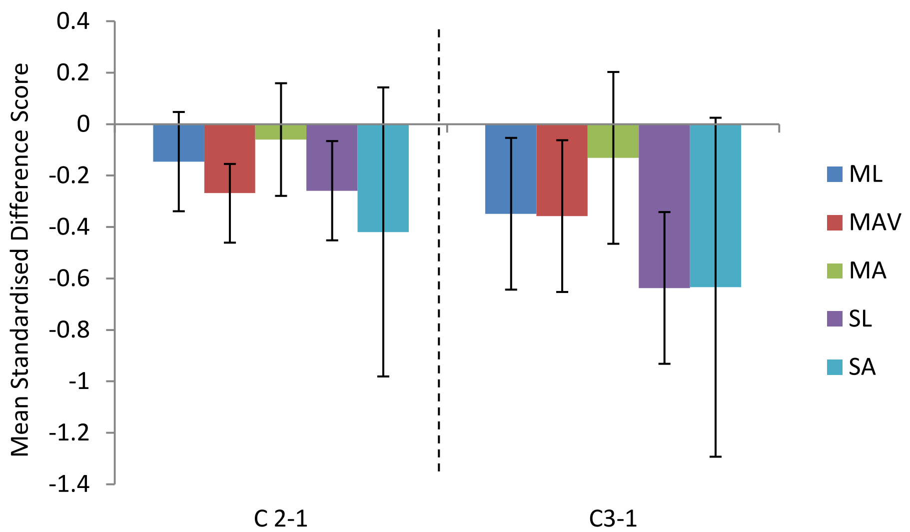

Figure 13. Mean group standardised cortisol difference scores, with 95% confidence intervals, from baseline to post measures: students

Standardised sC results clearly show the initial and continuing drop in levels across all groups (see Figure 13), with the hierarchy of the group scores remaining much the same for the third sample (C 3-1) as it was for the second (C 2-1). The slower response of sC, compared to sAA, is illustrated by the residual effect seen in the third samples, which all have lower sC levels than the second. Strongest anxiolytic effects, demonstrated by the falling cortisol levels, can be seen in the story groups, especially in the third saliva sample where the

differences between the music and story interventions increased. MA had the least impact on salivary cortisol levels of all the five interventions.

Salivary IgA results: students

An increase in sIgA levels can be interpreted as activation of the acquired immune system. Both the summary of raw sIgA results, expressed in µg/mL Table 9), and the line graph of these results (Figure 14) illustrate the differential between-group responses: levels sharply increased in the first post-intervention measure for ML, and less for MAV, whilst MA levels fell.

Table 9. *Mean Group Raw Salivary IgA Results: Students (in µg /mL)*

	ML *n* = 10	**MAV** *n* = 10	**MA** *n* = 10	**SL** *n* = 9	**SA** *n* = 10	**All groups**
IGA 1						
Raw	70.162	61.906	70.913	53.774	57.520	
SD	43.651	27.816	45.562	34.647	20.527	
SE	11.301	11.301	11.301	11.912	11.301	
Mean						62.855
IGA 2						
Raw	106.686	73.605	62.905	59.873	65.735	
SD	99.502	36.573	31.049	34.013	24.540	
SE	16.821	16.821	16.821	17.731	16.821	
Mean						74.161
IGA 3						
Raw	61.547	49.087	53.871	50.155	58.151	
SD	52.222	14.292	20.880	25.819	22.204	
SE	9.544	9.544	9.544	10.060	9.544	
Mean						54.566

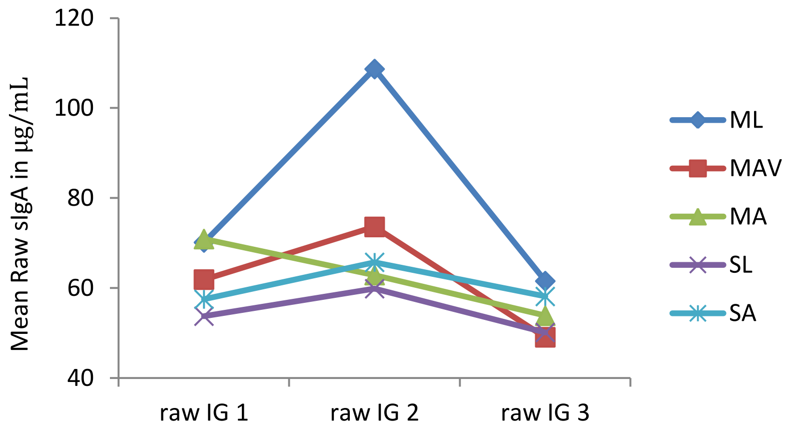

Figure 14. Mean group raw salivary IgA results: students

Standardised scores tell the same story, with the rebound below baseline in the third saliva samples levels, after initial rising levels in all but the MA group, as clearly illustrated in Figure 15. Also observable in this graph is the initial stronger sIgA response to ML when compared to the other groups.

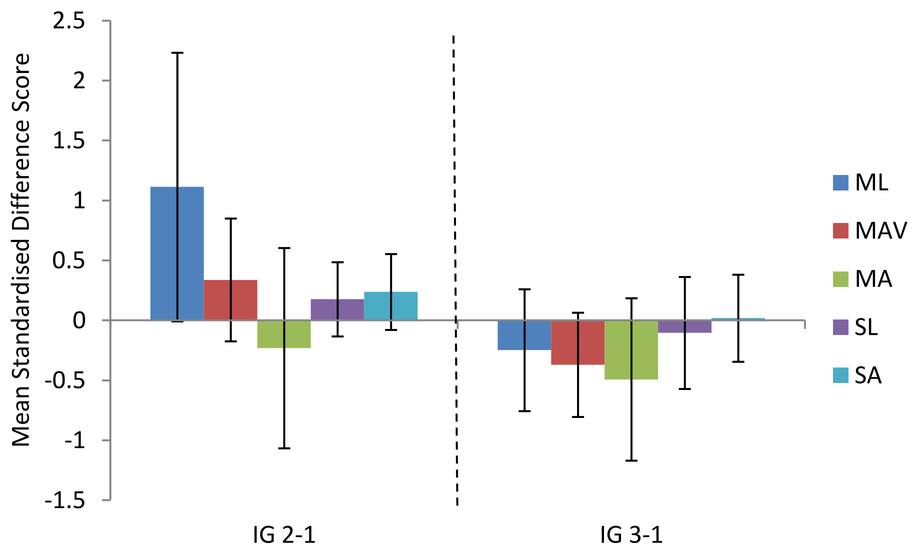

Figure 15. Mean group standardised salivary IgA difference scores, with 95% confidence intervals, from baseline to post measures: students

Salivary IL-1β results: students

Rising levels of sIL-1β, seen in the raw levels of the second saliva samples of ML, MAV and MA, are an indication of a natural immune system response. Levels of this marker, expressed in pg/mL, fell in both SL and SA in this same second sample (see Table 10 and Figure 16). In the third saliva sample, sIL-1β levels remained above the baseline readings only for ML, whilst for all other groups residual levels of this marker were lower than at baseline.

Table 10. *Mean Group Raw Salivary IL-1β Results: Students (in pg/mL)*

	ML *n* = 8	**MAV** *n* = 8	**MA** *n* = 8	**SL** *n* = 6	**SA** *n* = 9	**All groups**
IL 1						
Raw	67.587	101.959	133.539	104.012	156.223	
SD	33.539	91.618	154.211	71.973	139.386	
SE	39.034	39.034	39.034	45.072	36.801	
Mean						114.227
IL 2						
Raw	94.422	137.112	151.098	98.681	143.719	
SD	43.348	106.446	106.318	47.656	124.870	
SE	33.618	33.618	33.618	38.819	31.695	
Mean						126.836
IL 3						
Raw	103.034	97.550	85.067	78.879	129.005	
SD	64.707	78.514	40.131	27.302	85.123	
SE	23.123	23.123	23.123	26.700	21.800	
Mean						100.500

The bar graph of standardised scores (Figure 17) confirms the differential direction of IL-1β responses to music and story intervention. Music precipitated an initial rise in levels in contrast to the falling levels after listening to stories. A rebound effect was then observed in all the groups for the third sample, except for the ML condition, where levels continued to rise.

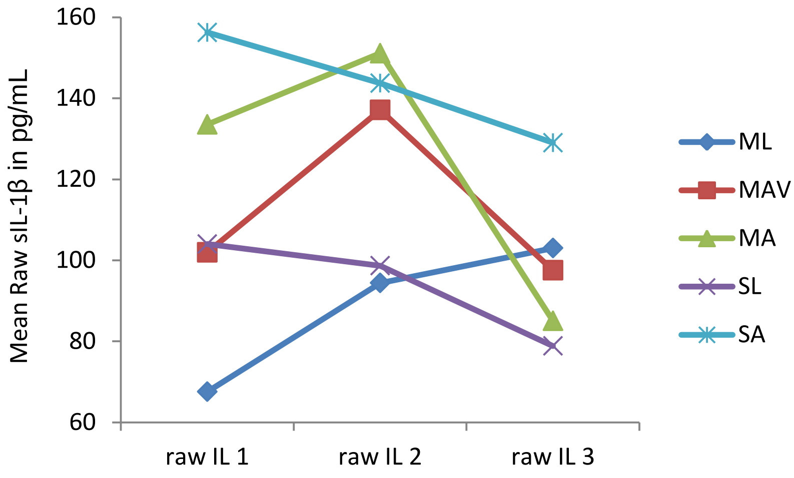

Figure 16**.** Mean group raw salivary IL-1β results: students

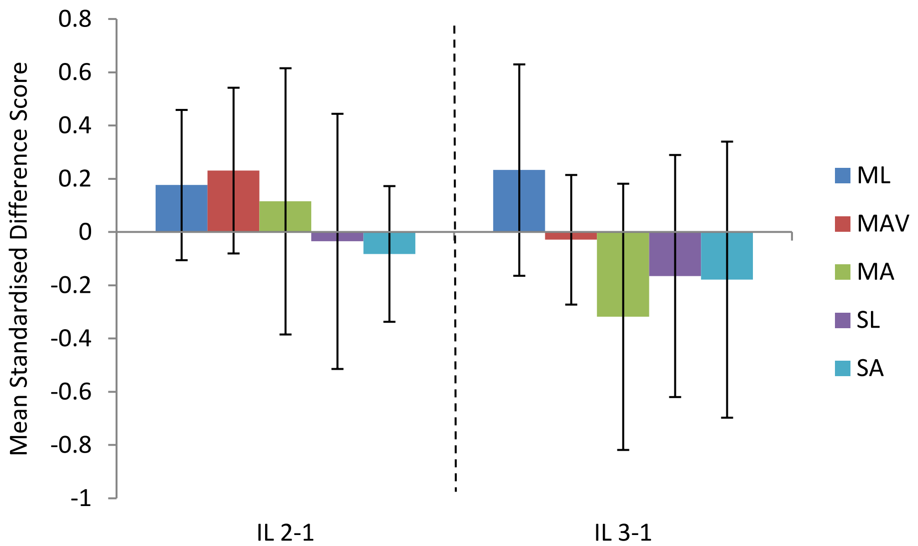

Figure 17**.** Mean group standardised salivary IL-1β difference scores, with 95% confidence intervals, from baseline to post measures: students

Salivary pH results: students

Rising salivary pH levels indicate reduced stress. This was only seen in the MA condition in the saliva sample taken immediately after the intervention (see raw results in Table 11 and Figure 18). All other groups saw spH fall at this point.

However, spH levels of all groups rose again to near or beyond baseline levels in the final saliva sample, with the sharpest fall and subsequent rebound after ML.

Table 11. *Mean Group Raw pH Results: Students*

	ML *n* = 9	**MAV** *n* = 9	**MA** *n* = 9	**SL** *n* = 9	**SA** *n* = 10	**All groups**
pH 1						
Raw	7.388	7.130	7.194	7.420	7.310	
SD	.333	.278	.325	.338	.180	
SE	.098	.098	.098	.104	.093	
Mean						7.286
pH 2						
Raw	7.086	7.124	7.317	7.430	7.258	
SD	.377	.316	.318	.473	.234	
SE	.116	.116	.116	.123	.110	
Mean						7.239
pH 3						
Raw	7.363	7.234	7.246	7.526	7.350	
SD	.307	.341	.318	.398	.333	
SE	.113	.113	.113	.120	.107	
Mean						7.340

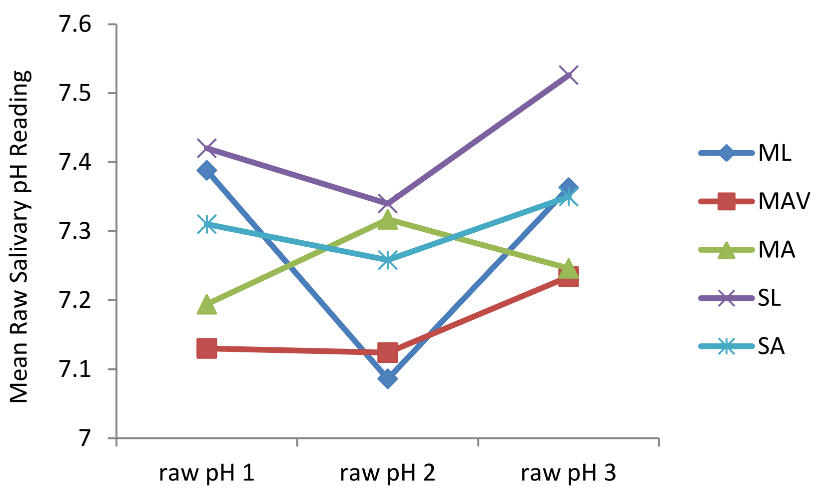

Figure 18. Mean group raw salivary pH results: students

The rebound effect at the third sampling is better illustrated in the graph of standardised scores (Figure 19). Whilst the ML group did not reach baseline levels it rebounded most of all the groups. All the other groups had spH levels higher than baseline in this third sample. Apart from MA, which had lower spH at this time point than at the second sampling, the other groups all had higher spH readings in the third sample than in the second saliva sample.

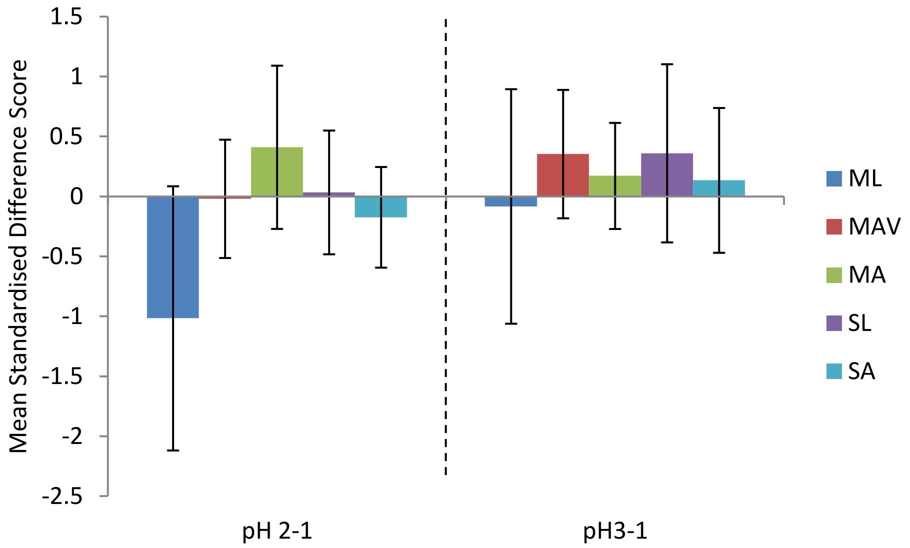

Figure 19. Mean group standardised salivary pH difference scores, with 95% confidence intervals, from baseline to post measures: students

Biomarkers: music versus stories (students)

Some differences in biomarker responses to music and stories have already been noted. Figure 20 summarises these across all the biomarkers using standardised scores of combined ML, MAV and MA, versus SL and SA.

In considering the markers of stress first: music triggered a larger fall from baseline levels in sAA than stories in the first post measure, and less increase from baseline than stories in the final sample, indicating a stronger anxiolytic effect for music. However, this was not the case for sC: levels fell more after stories than music in both of the post-intervention samples. Salivary pH readings also indicated a stronger anxiolytic effect for stories than music, with spH levels falling less after stories than music initially, and then rising more after stories than music in the final sample.

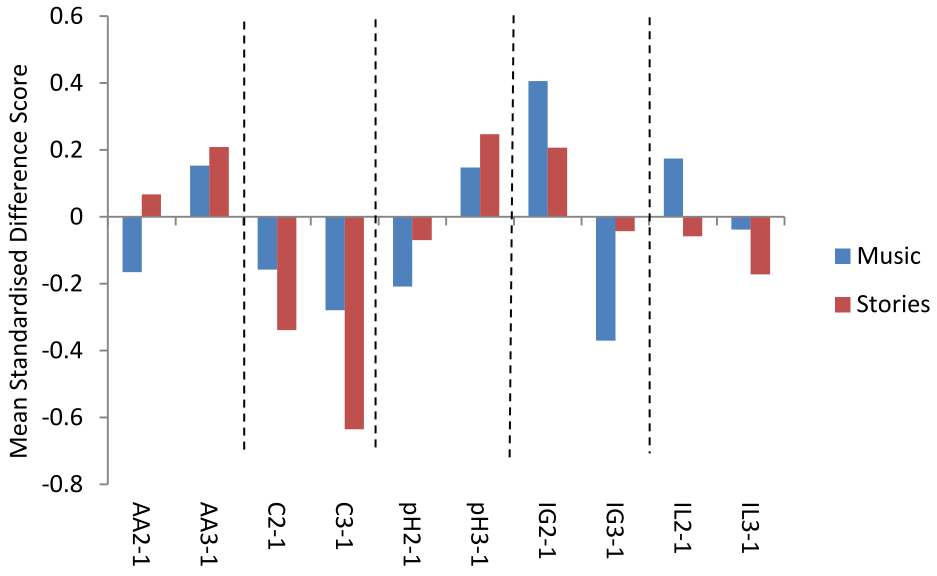

Figure 20. Contrasting music and stories using mean group standardised scores for each biomarker

Immune markers were more consistent in their differential responses to music and stories, with both markers demonstrating a stronger initial response to music than to stories. Salivary IgA levels rose higher from baseline initially, but rebounded more markedly below baseline subsequently after music. Differential effects for sIL-1β were even more marked, with levels initially rising from baseline after music, whilst falling after stories. Levels of sIL-1β were below baseline for both music and stories by the final sample, though this fall in levels from baseline was less for music than for stories, indicating a stronger residual effect after music.

Biomarkers: live versus audio (students)

In order to compare the effects of live versus recorded music on the various biomarkers the live results of the standardised ML and SL were combined for each biomarker, to be contrasted to the audio-only total standardised results of MA and SA for each biomarker. Figure 21 illustrates some noticeable differential effects of the live versus audio interventions.

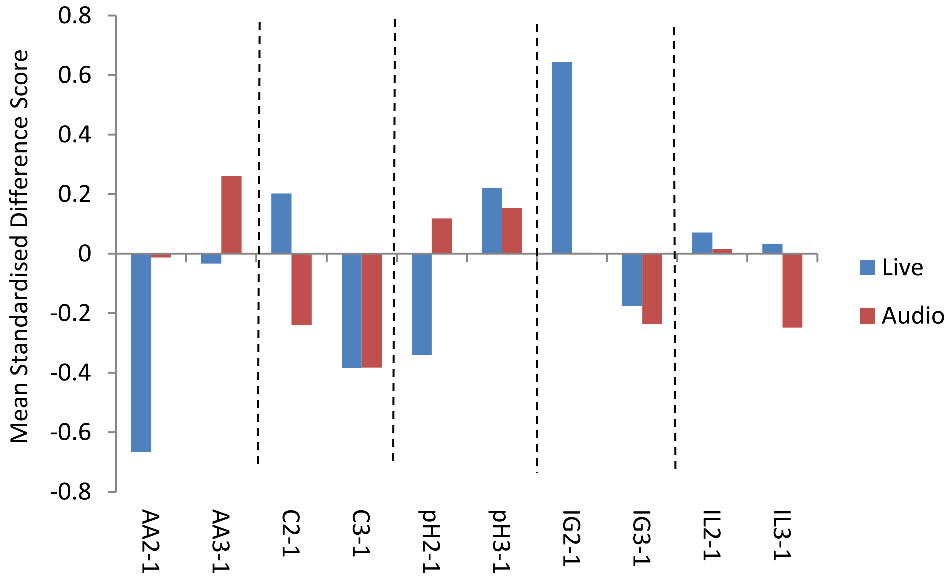

Figure 21. Live versus audio music and stories using mean group standardised scores for each biomarker

Firstly, the initial sAA response to live interventions points to a strong anxiolytic effect with a sharp fall from baseline compared to the audio groups which fell only slightly from their baseline level. The final sAA levels remained below baseline for the live groups but rose from baseline after audio interventions. The initial sC response to live interventions was an increase in levels, whilst the audio interventions precipitated a fall from baseline. However, the final sC samples' fall from baseline was equal for both live and audio, indicating a universal residual anxiolytic response. A similar pattern occurred in the differential spH response. Audio interventions triggered an initial anxiolytic response, seen in spH above baseline, which was maintained in the third samples. In contrast, after an initial fall in spH after live interventions — an indication of increased stress or arousal — spH rebounded above baseline in the third samples, finishing higher than the levels of those who listened to the audio music or stories.

For both the immune markers sIgA and sIL-1β, live interventions initially precipitated more robust immune responses than audio interventions, particularly sIgA. Residual levels of sIgA rebounded for both live and audio, and levels of sIL-1β rebounded below baseline only for audio listeners.

Case-by-case results: patients

The data set representing the patient participants in this study had too many missing data points, in particular those relating to the biomarkers, to allow meaningful statistical manipulation, or even grouped graphs, of the results. A full data set was obtained from 6 (26.09%) of the 23 participants, whilst there were some gaps in the biomarker data in a further 6 (26.09%). For the remaining 11 (47.82%) no biomarker data was obtained. Outcomes of patients' assays, together with VAS scores, are therefore now presented case-by-case as graphs. VAS scores were reviewed statistically, results of which are outlined and illustrated in the section on subjective measures which follows.

Although no comparative statistical data is available for the clinical biomarker results, the graphs of each patient provide an opportunity for gaining insights from an individual case-by-case perspective. Complex interactions between the stress and immune systems and their relevant markers may disguise subtle individual differences when looking at an overall pattern of a group output (Mowlah, Niblett, Blackburn, & Harris, 2014). Plotting individual response profiles of all the variables may reveal such interactions.

Individual cases are shown in order, depending on which intervention group they belong to, starting with ML, then MAV, MA, SL, and finally SA. Each case is identified with their participant number (PC for palliative care and S for surgery patients) and group, as well as the one-word response each participant gave at the end of their intervention. All results shown in the graphs are raw results for each of the three sample points, namely the pre-test (baseline) and the two post-measures. These raw results are summarised in Table 12. Results of some of the biomarkers were either divided or multiplied by a factor of 10, or in one case by 100 (as marked on the graphs), allowing all the data to be displayed clearly on a single bar graph, with a common Y-axis that is labelled "Comparison Score".

Did her father struggle into his death or die calm? Did he lie the way the English patient reposes grandly on his cot? Was he nursed by a stranger? . . . Did he move towards his death with the same casual sense of being there at an accident? Or in fury?

(Ondaatje, 1992, p. 96-97)

Table 12. *Raw Individual Biomarker and VAS Results: Patients*

ID	GRP	VASA (mm)			VASP (mm)			AA (U/mL)			C (µg/dL)			IgA (µg/mL)			IL (pg/mL)			pH		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
PC4	**ML**	4.5	2.0	2.5	2.0	3.5	4.0	86.91	151.65	108.14	0.91	0.78	0.66	34.29	58.71	32.05	210.23	318.40	249.29	7.27	7.11	7.60
PC5	**ML**	5.0	3.0	2.0	15.0	14.0	3.5				0.18			59.40			84.91					
PC6	**ML**	10.0	7.0	8.0	6.5	9.0	6.5	531.08	782.74	452.51	1.29	1.31	1.04	17.83	45.29	38.24	16.61	132.24	159.45	6.34	6.42	6.87
PC8	**ML**	0	0	0	0	0	0															
S1	**ML**	43.0	11.5	3.0	19.5	13.0	6.5	506.43	320.14	398.15	0.89	0.92	0.69	48.98	57.93	55.27	508.68	673.24	595.14	7.56	7.73	7.70
S4	**ML**	28.5	26.0		23.5	28.5																
PC9	**MAV**	32.0	26.0	69.0	42.5	27.0	29.0															
PC11	**MAV**	5.5	6.0	8.0	23.5	6.0	54.0	389.31	385.39	292.19	0.80	0.74	0.49	114.78	194.66	69.01	72.85	241.42	34.72	6.59	6.54	6.70
S2	**MAV**	49.0	2.0	27.0	48.0	2.0	8.0	77.05	110.41	98.17	0.78	0.62	0.43	33.68	44.56	26.53	32.10	108.12	374.42	8.20	8.13	8.02
S8	**MAV**	13.0	4.0	4.5	2.0	2.5	1.5	233.99	258.69		0.76	0.58		120.61	144.71		495.40	991.43		7.77	7.48	
PC7	**MA**	3.5	2.0	2.0	3.0	3.0	2.0															
PC14	**MA**	0	0		0	0		201.00	260.60					231.76	350.34					6.77	6.71	
S3	**MA**	5.0	70.0		3.5	66.0		152.11	122.71		0.83	0.65		183.34	217.67		967.75	892.92		8.26	8.17	
S7	**MA**	65.0	70.5		39.0	35.5		62.37	90.50		0.47	0.56		73.60	150.07		815.16	955.47		7.81	7.76	
PC2	**SL**	10.0		0	7.0		0															
PC3	**SL**	28.0	28.0	30.0	22.0	30.0	29.0															
PC13	**SL**	14.0	0	0	43.0	23.0	21.5															
S5	**SL**	53.0	12.0	5.5	9.0	12.0	10.0															
S9	**SL**	8.5	8.5		12.0	17.0		209.46	206.17		0.71	0.51		67.85	73.70		255.82	320.03		8.06	8.02	
PC10	**SA**	4.0	2.0	3.5	38.0	43.0	35.0															
PC12	**SA**	7.5	0	0	26.5	30.0	24.0	26.61	29.61	36.08	0.19	0.20	0.17	31.77	41.58	26.87	20.64	28.79	21.69	7.34	7.13	7.38
PC15	**SA**	7.0	3.5	31.5	70.0	37.5	8.0															
S6	**SA**	6.0	5.0		4.5	5.0		19.80	23.19		0.55	0.45		92.70	119.01		1192.72	1397.66		8.06	7.99	

A simple guide to interpreting the graphs is that a decrease (in the second and third bars from the first baseline reading) in any of the first four variables, namely the VAS scales and the stress markers AA and C, indicates a relaxation response or decreased pain. For the remaining three variables, an increase from the baseline indicates a positive immune response in the case of IgA and IL-1β and a relaxation response in the case of an increase in pH. (The numbers "1", "2" and "3" in the graphs' legends represent the three sampling time points.)

Patient cases: live music

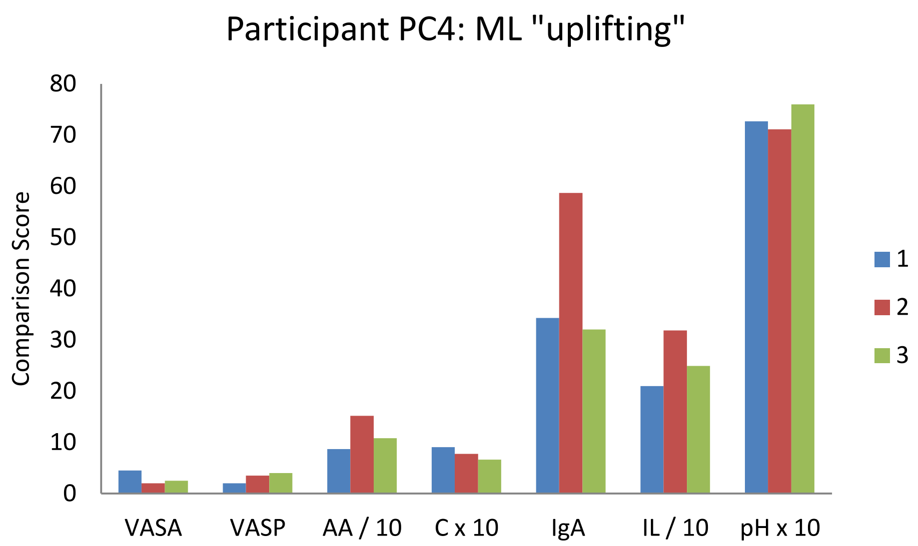

Figure 22. Palliative care participant PC4: anxiety, pain and immune outcome measures

PC4, a 54 year old woman with cervical cancer whose favourite genre was Celtic music, had a live violinist play in her room (Figure 22). She found the experience "uplifiting", and gave the maximum score of 10 for all four affect scales: for liking the music, perceived and felt emotion, and absorption. Her baseline self-reported anxiety and pain levels were low, at 4.5 mm and 2.0 mm on the VASA and VASP. Whilst there was a slight fall from the baseline in her subsequent self-reported anxiety (2.0 mm and 2.5 mm) and a slight rise in self-reported pain (3.5 mm and 4.0 mm), such small changes on a 100 mm scale are not considered to be clinically significant (CS). However, a doubling in the dose of paracetamol to 2 x 1 gm as breakthrough medication in the 24 hrs after the intervention, from 1 x 1 gm in the 24 hrs prior to her participation, is an indication of increased pain over this longer time period.

A full set of saliva samples was collected, revealing differential results for the stress markers. Whilst sC levels fell from baseline and continued to fall in the third sample (0.91 μg/dL, 0.78 μg/dL, and 0.66 μg/dL), the sAA levels rose initially after music before starting to stabilise again in the third sample (86.91 U/mL, 151.65 U/mL, and 108 U/mL). Salivary pH levels fell from baseline initially before rising above baseline levels in the third reading (7.27, 7.11, and 7.60), indicating a delayed relaxation response.

A clear initial immune response was seen in both sIgA (34.29 μg/dL, 58.71 μg/dL, and 32.05 μg/dL) and sIL-1β (210.23 pg/mL, 318.40 pg/mL, and 249.29 pg/mL), with levels rising from baseline before stabilising again in the third sample.

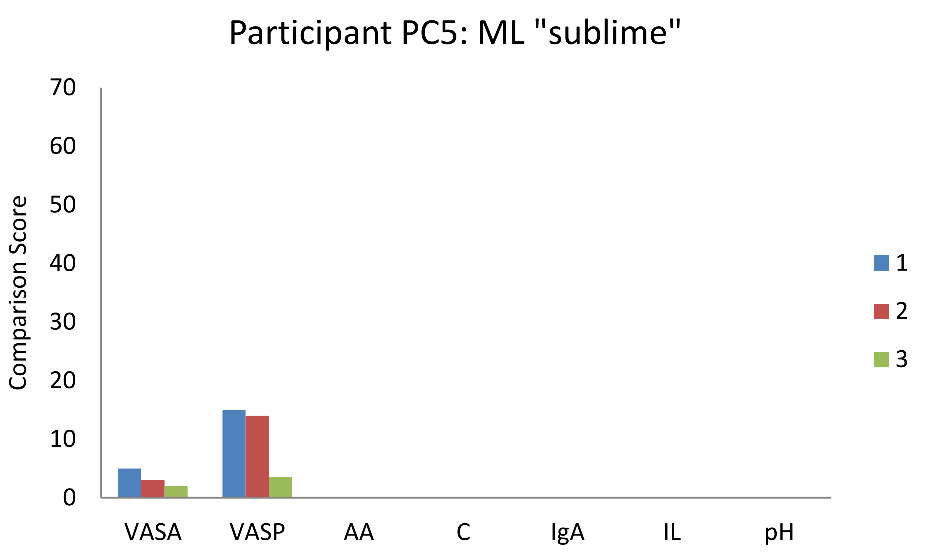

Figure 23. Palliative care participant PC5: anxiety and pain outcome measures

The second participant experiencing live music was PC5, a 76 year old female with breast cancer (Figure 23). She recorded classical music and trad jazz as her preferred genres, and summed up as “sublime” the experience of listening to a violinist playing the program for her. Ratings were high for the affect scales: 9 for liking, 10 for expressiveness (perceived emotion), 8 for felt emotion, and 10 for absorption.

Although a first saliva sample was collected successfully, the second sample lacked sufficient volume and, with the patient appearing reticent, no further

attempt was made to collect a third sample. Consequently, no meaningful biomarker data is available for this participant.

Self-reported anxiety and pain did fall from baselines with each subsequent VASA and VASP. The baseline VASA started low, at 5.0 mm, and fell to 3.0 mm and then 2.0 mm in the post-intervention measures. These changes are not considered to be clinically significant. The baseline VASP was higher, but at 15.0 mm still in the mild range. An initial minimal fall to 14.0 mm was followed by a larger reduction in reported pain to the final VASP of 3.5 mm. The final overall difference of 11.5 mm (76.66%) is considered to be clinically significant for the mild reported baseline pain (Kelly, 2001).

The patient's reduced requirements for breakthrough medication after the intervention support the VAS results. Whilst she was administered 1 x 1 mg of the analgesic hydromorphone and 1 x 0.5 mg of lorazepam for anxiety prior to the live music, no breakthrough medication was given in the following 24 hrs.

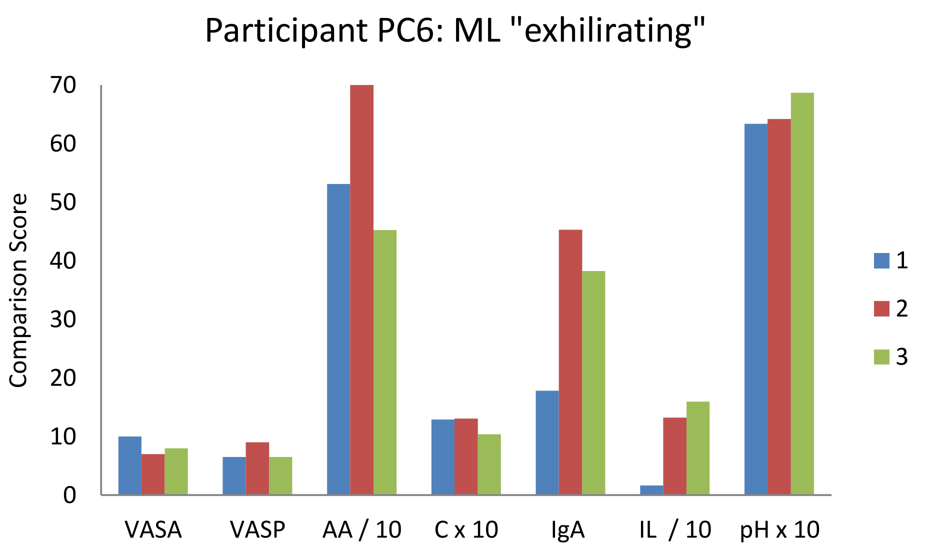

Figure 24. Palliative care participant PC6: anxiety, pain and immune outcome measures

PC6 also listened to live music provided by a violinist (Figure 24). This 76 year old man with prostate cancer, who preferred light classical music, described the experience as "exhilarating", rating all four affect scales at 10 out of 10. Levels of both sAA and sC rose initially, before falling below baseline levels in the third sample. Although all three sAA readings of 531.08 U/mL, 782.74 U/mL, and

452.51 U/mL were considered to be outliers, falling above the standard curve, they have been included in this graph. The sC readings were 1.29 μg/dL, 1.21 μg/dL, and 1.04 μg/dL. These indications of a relaxation response, in particular the lower levels seen in the third sample, were supported by the rising spH levels seen in both the second samples, and more so in the third sample.

The VASA results also are consistent with lower anxiety, with both the second and third ratings (7.0 mm and 8.0 mm) being below the initially low baseline level of 10 mm. However, these small variations from a low initial level of anxiety are not considered to be clinically significant. Similarly, the VASP increased slightly to 9.0 mm in the second rating, before returning to the low baseline level of 6.5 mm again. Breakthrough medications were the same for both the day before and the day after the music.

The immune biomarkers sIgA and sIL-1β both rose sharply from baseline levels in the second sample, and maintained higher than baseline levels in the third sample, indicating both a strong initial and residual immune response to the live music. Levels of sIgA for the three samples were 17.83 μg/mL, 45.29 μg/mL, and 38.24 μg/mL. The samples provided sIL-1β levels of 16.61 pg/mL, 132.24 pg/mL, and 159.45 pg/mL.

No graph is shown for PC8, an 84 year old woman with ampullary (duodenal) carcinoma, as her VAS scales were all rated at zero, and saliva samples were not collected. Her stated preferred genre was semi-classical music, and her response to a live violinist playing for her was “absolutely bliss”. She rated the affect scales at 7 for liking the music, 8 for perceived emotion, 7 for felt emotion, and 8 for absorption. Breakthrough medications administered did indicate a reduction in anxiety post intervention, with 10 mg temazepam taken in the 24 hours before, but no breakthrough medications administered in the 24 hours after the music.

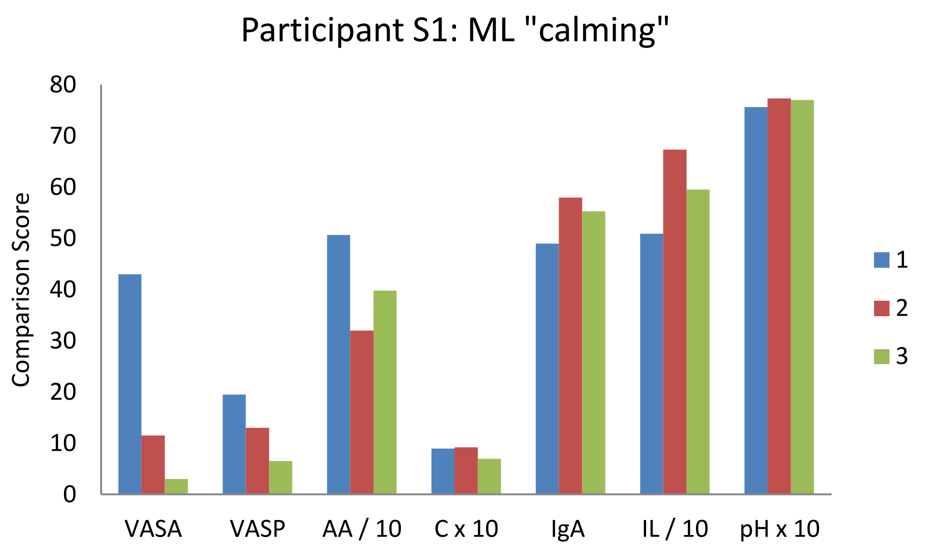

Figure 25. Surgical participant S1: anxiety, pain and immune outcome measures

S1, a 43 year old woman who listened to a cellist play in her room whilst waiting for breast surgery, explained she liked all types of music (Figure 25). She described the experience as "calming", and rated all the affect scales at the maximum 10. A full set of saliva samples revealed a relaxation response, seen in levels of sAA falling below baseline levels immediately after the music, and then rising but remaining below baseline in the third sample (506.43 U/mL, 320.14 U/mL, and 398.15 U/mL). The baseline reading fell above the standard curve, so is considered an outlier. Initially the sC levels remained steady (0.89 µg/dL and 0.92 µg/dL) before falling in the final sample (0.69 µg/dL), consistent with a relaxation response. Changes in spH also were in the direction expected with a relaxation response, rising from baseline of 7.56 to 7.73 after the music before settling at 7.70 in the third saliva sample.

The VASA and VASP support the biomarker results, with levels well below baseline in the second and third ratings. In particular, the VASA fall from 43.0 mm to 11.5 mm, and then further to 3.0 mm, is a clinically significant improvement (Williams et al., 2010). VASP levels fell from the baseline 19.5 mm to 13.0 mm and then down to 6.5 mm, which again is a clinically significant reduction in symptoms from the initial mild pain reported (Kelly, 2001).

Levels of both immune markers sIgA (48.98 µg/mL, 57.93 µg/mL, and 55.27 µg/mL) and sIL-1β (506.68 pg/mL, 673.24 pg/mL, and 595.14 pg/mL) rose

immediately after the live music, then fell but stayed above baseline levels in the third sample, indicating both initial and residual immune responses.

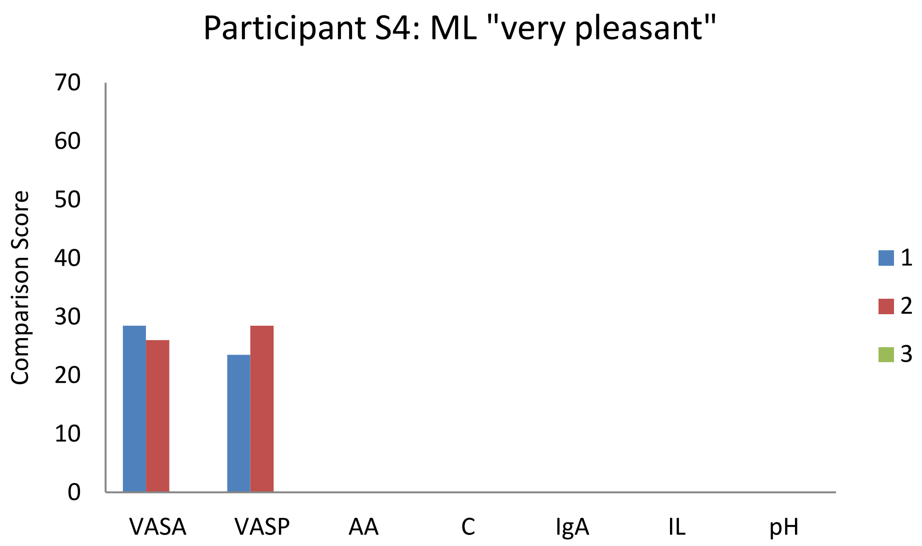

Figure 26. Surgical participant S4: anxiety and pain outcome measures

S4 was an 81 year old woman admitted for a shoulder arthroscopy (Figure 26). Her preferred genres were light classical and Dixieland jazz. She summed up her experience of a violist playing the program in her room as "very pleasant". Her ratings on the affect scale were mixed, with a 7 each for liking the music and perceived emotion, 5 for felt emotion, and 8 for absorption. The graph provides only limited information as no saliva was collected and the third VASs were not rated before the patient was transferred to the surgery suite. The VASA fell from the baseline rating of 28.5 mm to 26.0 mm, whilst the VASP rose from 23.5 mm to 28.5 mm, both insignificant changes.

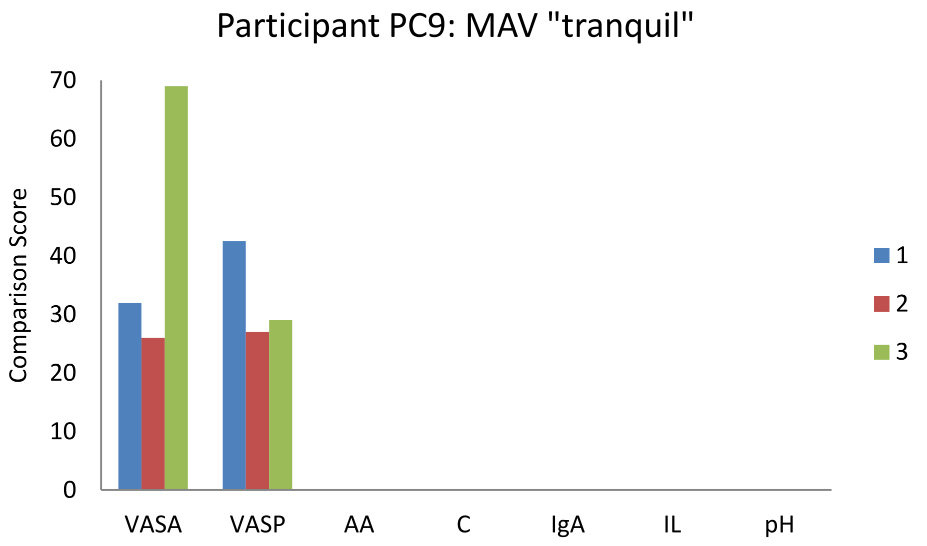

Figure 27. Palliative care participant PC9: anxiety and pain outcome measures

PC9 was a 68 year old female with metastatic liver cancer who had eclectic music taste, including jazz and classical (Figure 27). She described her watching the video of a violinist as "tranquil", rating liking at 7, perceived emotion at 8, felt emotion at 7, and absorption at 8. The participant was unable to produce any saliva. However, the breakthrough opiate oxycodone dosage of 1 x 30 mg in the 24 hours after the music was lower than the 3 x 30 mg administered in the 24 hours before the intervention, indicating reduced pain.

The patient's ratings of the VASP also indicate a clinically significant reduction in pain from the moderate baseline level of 42.5 mm to a mild 27.0 mm and 29.0 mm in the subsequent measures (Kelly, 2001). In contrast, the VASA fell initially from the baseline 32.0 mm to 26.0 mm before rising sharply to 69.0 mm which, at over 50 mm, is regarded as indicating anxiety (Facco et al., 2011). The third round of data collection was possibly contaminated as the patient's BP was taken and dressing refreshed in between the second and third data rounds. She also became very upset when recounting a distressing incident she had experienced at another hospital.

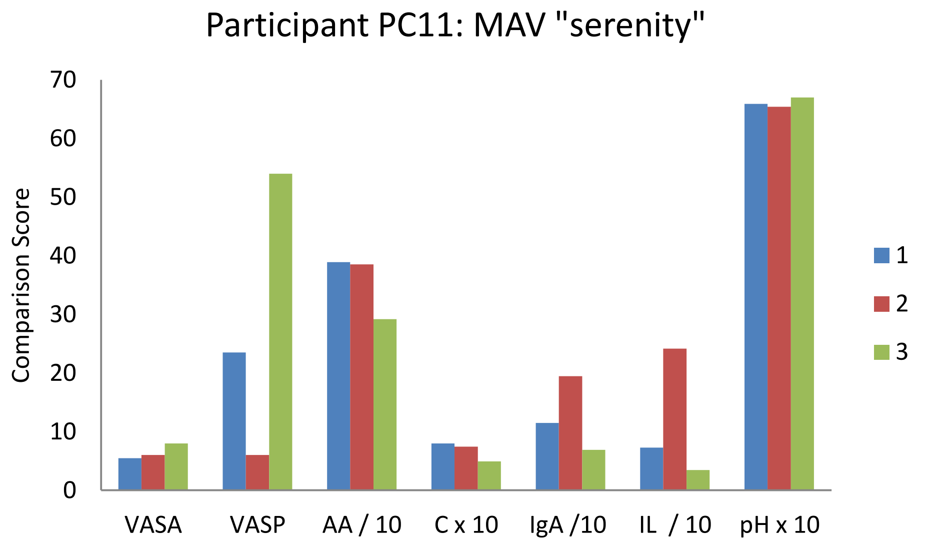

Figure 28. Palliative care participant PC11: anxiety, pain and immune outcome measures

PC11, a 58 year old woman with breast cancer who preferred religious and easy listening music, summed up watching a video of a violinist on the laptop as "serenity" (Figure 28). She rated her liking the music at 6, perceived emotion at 7, felt emotion at 6, and absorption at 7. A full set of saliva samples yielded levels of sAA falling slightly from the baseline 389.31 U/mL down to 385.39 U/mL, and further to 292.19 U/mL. Levels of sC also were lower than the baseline 0.80 µg/dL in the two subsequent samples (0.74 µg/dL, and 0.49 µg/dL). Salivary pH readings ultimately rose to 6.70 from the baseline 6.59, after firstly dropping below baseline levels to 6.54. The direction of change in these three markers indicates a residual relaxation response.

In contrast, the VASA changed in the opposite direction, rising from 5.5 mm to 6.0 mm, and then to 8.0 mm. However, these small fluctuations are unlikely to indicate any meaningful change to anxiety levels. On the other hand, the VASP fell from the mild baseline 23.5 mm to 6.0 mm, before rising in the third measure to a moderate pain reading of 54.0 mm, which is over double the original reported pain level. Breakthrough medications remained fairly constant, with the 10 mg dose of temazepam administered prior to the intervention repeated in the following 24 hours, but oxycodon reduced from 4 x 20 mg to 3 x 20 mg.

The immune markers both indicate an initial immune response, but no residual immune effect, with levels of both markers falling below the baseline readings in the final sample. The levels of sIgA were 114.78 µg/mL, 194.66 µg/mL, and 69.01 µg/mL, and for sIL-1β they measured 72.85 pg/mL, 241.42 pg/mL, and 34.72 pg/mL for the three samples.

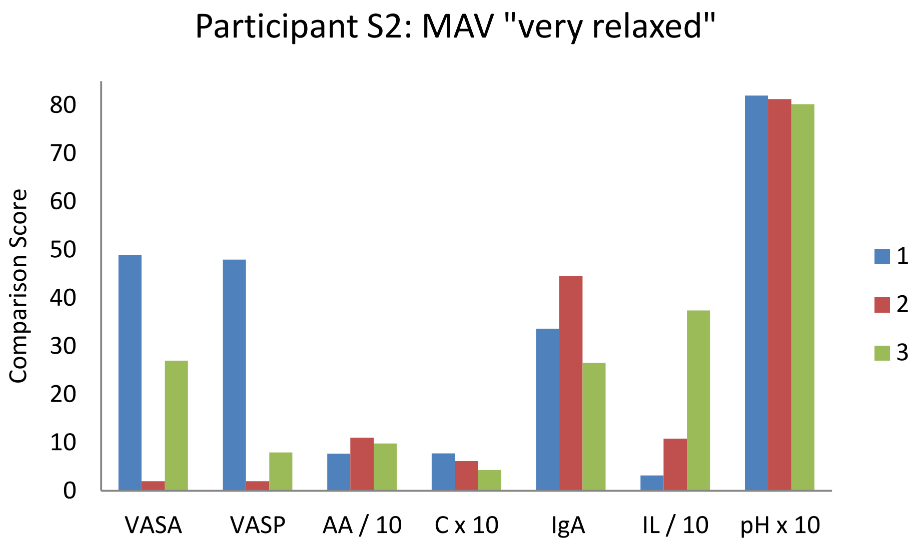

Figure 29. Surgical participant S2: anxiety, pain and immune outcome measures

S2, a 49 year old woman waiting for breast reconstructive surgery, said she had an eclectic music taste (Figure 29). After watching a video of a cellist playing, she summed up her experience as "very relaxed", scoring the affect scales at 9 each for liking and perceived emotion, contrasted with 2 for felt emotion and 6 for absorption. Both her baseline VAS scales were marked around halfway along the 100 mm line, at 49.0 mm for VASA and 48.0 mm for VASP, indicating the presence of both pain and anxiety. Immediately after the MAV the patient reported negligible pain and anxiety, with both scales scored at 2.0 mm. Anxiety levels then rose to 27.0 mm, around half of the baseline level, whilst pain levels remained low at 8.0 mm for the final rating. These changes in both VASs are regarded overall as being clinically significant.

Whilst the fall in sC levels from the baseline 0.78 µg/dL to 0.60 µg/dL and then 0.42 µg/dL indicated a reduction in anxiety, the sAA readings showed an opposite trend of increasing initially from the baseline 77.05 U/mL to 110.40 U/mL before beginning to fall again to 98.17 U/mL by the third sample.

Similarly, falling spH levels from baseline 8.20 to 8.13 and then further to 8.02 do not suggest a relaxation response.

More consistency is seen between the immune markers in this participant. Both sIgA and sIL-1β rose from their baseline levels with an initial immune response, but the response was residual only in the sIL-1β. Levels for these markers in the three samples were as follows: 33.68 μg/mL, 44.56 μg/mL and 26.53 μg/mL for sIgA, and 32.10 pg/mL, 108.12 pg/mL and 374.42 pg/mL for sIL-1β.

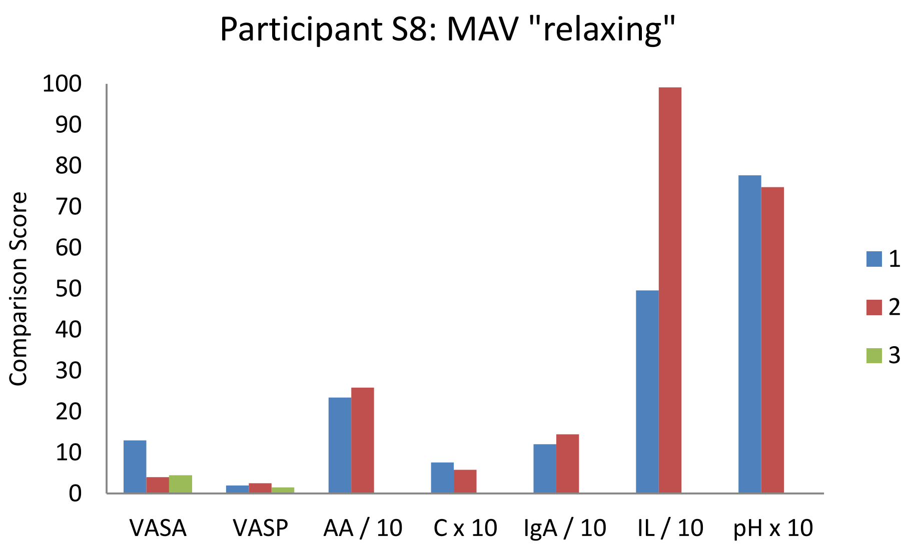

Figure 30. Surgical participant S8: anxiety, pain and immune outcome measures

The final clinical participant allocated to the MAV intervention was S8, a 70 year old man admitted for urogenital surgery (Figure 30). He listed blues and Americana as his preferred musical genres, and his ratings on the affect scales were 9 each for liking and absorption, 7 for perceived emotion, and 5 for felt emotion. His overall summary of the experience was “relaxing”. Saliva was assayed from the first and second samples, but unfortunately there was no time to collect a third sample before the patient was transferred to the surgery suite.

Whilst there was a fall in the VASA score, from a low baseline 13.0 mm to 4.0 mm, and then 4.5 mm for the final scale, the biomarker results were not all consistent with these reduced self reported anxiety levels. Levels of sAA rose from 233.99 U/mL to 258.69 U/mL, which could be a sign of increased stress or anxiety, whilst sC levels fell from 0.76 μg/dL to 0.58 μg/dL, consistent with the

VASA. At the same time the spH readings fell, from 7.77 to 7.48, indicating an increase in stress or anxiety levels. And for pain, the initial VASP level (2.0 mm) remained low after the intervention (2.5 mm and 1.5 mm). Small changes from low baseline levels, such as reported by this participant, are not considered to be clinically significant.

Both immune markers increased after the interventions, particularly sIL-1β which doubled from a baseline of 495.40 pg/mL to 991.43 pg/mL. Levels of sIgA rose from 120.61 μg/mL to 144.71 μg/mL.

Patient cases: audio music

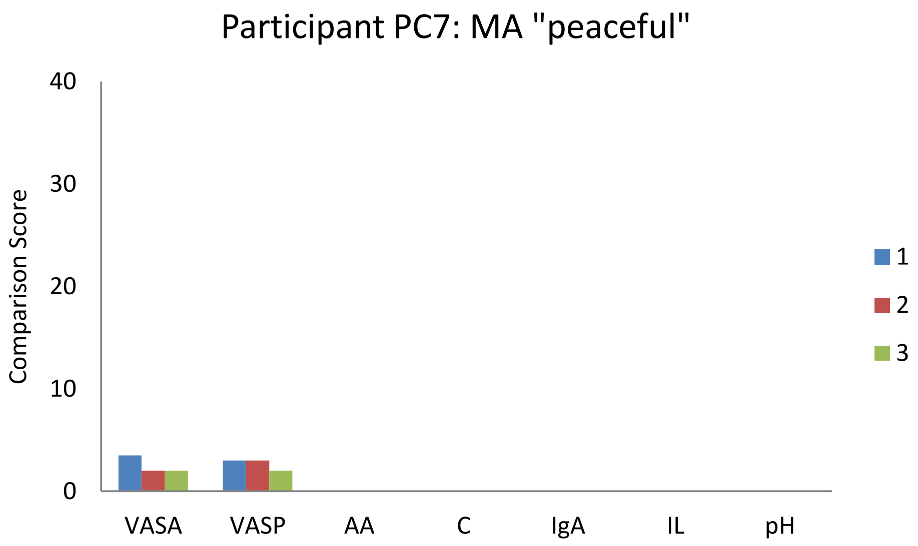

***Figure 31*.** Palliative care participant PC7: anxiety and pain outcome measures

PC7, a 73 year old female with a brain tumour, described listening to an audio recording of a violinist as "peaceful" (Figure 31). She liked easy-listening music, and rated all four affect scales at 10 out of 10. No objective data is available for this participant as no saliva was collected, and there were no differences in her breakthrough medications before and after the intervention. This patient had problems with the technique of allowing the saliva to dribble down the straw. She was producing saliva but it was not being collected successfully. With low baseline VASA (3.5 mm) and VASP (3.0 mm) levels, the slight falls seen in these after the music (to 2.0 mm) are inconsequential.

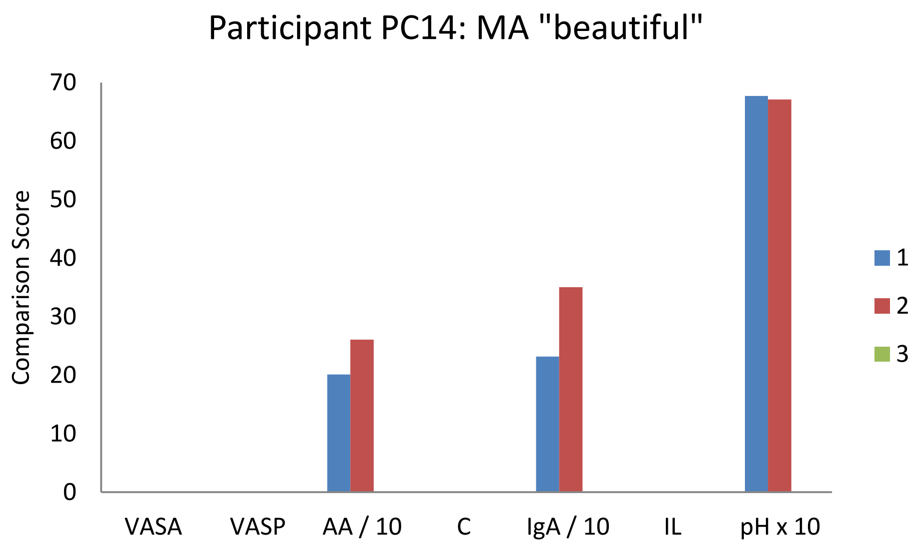

Figure 32. Palliative care participant PC14: anxiety, pain and immune outcome measures

The second participant exposed to MA was PC14, a 59 year old woman with breast cancer who had eclectic musical taste (Figure 32). Her one-word response at the end of the intervention was “beautiful”. She liked the violin music, rating it a 10. Her score for perceived emotion was 7, and she scored 6 for both felt emotion and absorption.

Only small volumes of saliva were collected before and immediately after the music, so a third sample was not attempted. The limited volumes were insufficient for some of the assays, so only sAA, sIgA and spH were measured. Levels of sAA rose from the baseline 201.00 U/mL to 260.60 U/ml immediately after the music, which indicates an increase in stress or anxiety. The fall in spH from 6.77 to 6.71 also indicates that no relaxation response was triggered. The immune marker sIgA did rise initially by 51.16%, from 231.76 µg/mL to 350.34 µg/mL.

The patient reported no pain and anxiety, with both the VASA and VASP given a score of zero at each of the three time points. No comparative medication doses were possible due to the patient being discharged within the 24 hours after the intervention.

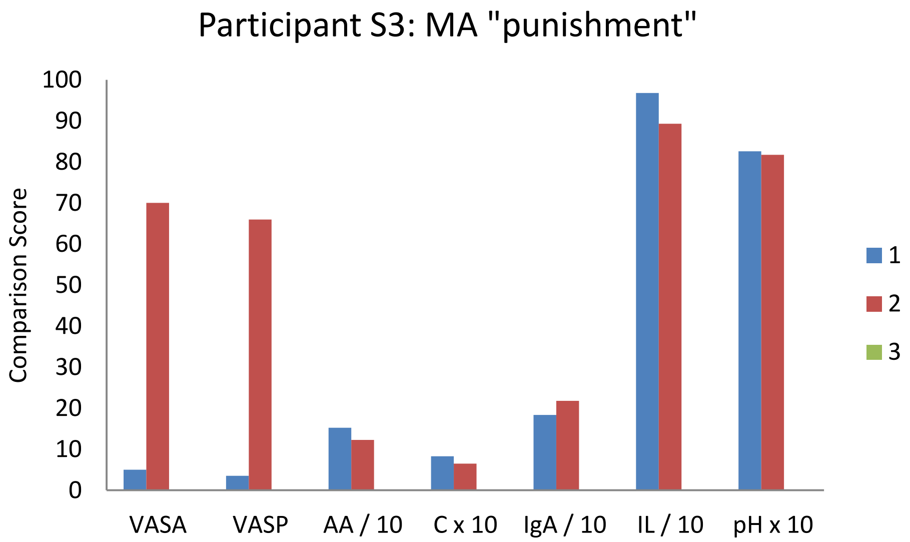

Figure 33**.** Surgical participant S3: anxiety, pain and immune outcome measures

S3 was a 72 year old surgical patient admitted for a lymphadenectomy (Figure 33). He was very clear on his musical preferences being country, and 60s and 70s popular songs, stating explicitly that he disliked classical music. His one-word summation of "punishment", as well as his low affect scale scores – 2 for both liking and perceived expression, and 1 for felt emotion as well as absorption – reflect his comments. Likewise, the sharp increases in both the VASA and VASP immediately after the audio recording playback further confirm this patient's negative response to the cello playing he listened to. The VASA ratings increased from 5.0 mm to 70.0 mm, and similarly the VASP ratings rose sharply from 3.5 mm to 66.0 mm.

Only the baseline and first post-intervention data collections were completed as the patient was transferred to the surgical suite before the third time point was reached. The stress markers sAA and sC did not confirm the strong self-reported increase in pain and anxiety, as seen in the decrease in sAA from 152.11 U/mL to 122.71 U/mL, and the sC baseline of 0.83 μg/dL followed by 0.65 μg/dL immediately after the music. However, the spH levels fell from 8.26 to 8.17, supporting the self-reported increase in anxiety.

The immune response was mixed, with sIgA rising (183.34 μg/mL to 217.67 μg/mL) and sIL-1β decreasing (967.75 pg/mL to 892.92 pg/mL) after the recorded music intervention.

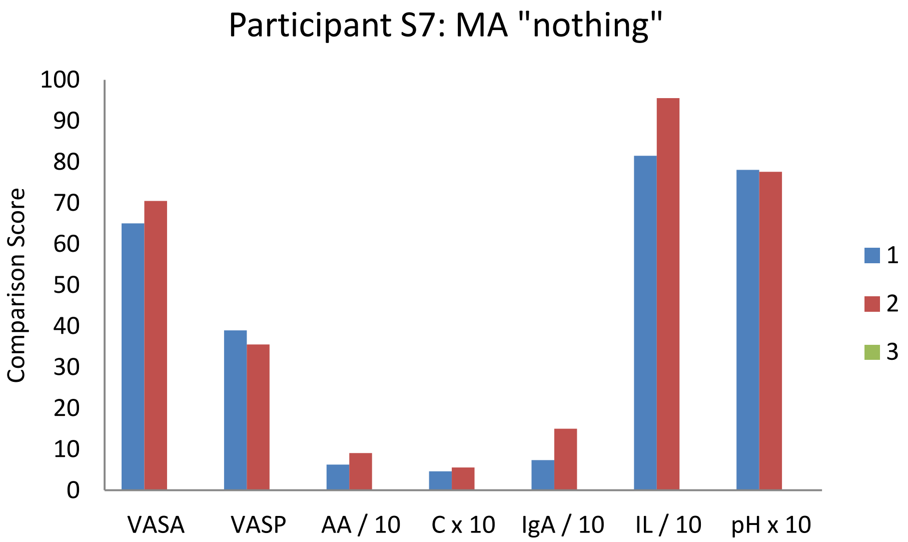

Figure 34. Surgical participant S7: anxiety, pain and immune outcome measures

S7, a 44 year old male booked in for an Achilles' tendon repair, reported an eclectic music taste (Figure 34). He rated the affect scales at 6 for liking, 5 for perceived emotion and absorption, and 4 for felt emotion. His one word response to hearing a recording of a viola was "nothing", to which he further added it was neither a positive nor negative experience. There were small changes in the VAS scales, with the VASA initially scored at 65.0 mm, and rising to a severe level of 70.0 mm after the MA, and the VASP baseline score of 39.0 mm falling slightly to 35.5 mm after the intervention. A third set of data was not collected due to insufficient time before transfer to the surgical suite.

All three markers of stress indicated increased anxiety after the intervention: sAA rose from baseline 62.37 U/mL to 90.50 U/mL; sC rose from 0.47 μg/dL to 0.56 μg/dL, and spH fell from 7.81 to 7.76. In contrast, changes in the immune markers indicated a positive immune response, with sIgA rising from 73.60 μg/mL to 150.07 μg/mL, and IL-1β also rising, from 815.16 pg/mL to 955.47 pg/mL.

Patient cases: live stories

There is no graph for PC2 as this 87 year old female with pulmonary fibrosis was unable to supply any saliva after a futile attempt. She summed up her experience of listening to a live story reading as "nice". No data was collected immediately after the intervention as the patient had fallen asleep. However, the

third VAS scales were completed, and rated at zero after initial ratings of 10.0 mm for the VASA and 7.0 mm for the VASP. As this represents a 100% amelioration of symptoms, the patient reported a positive clinically significant outcome (Jacobsen, 1999). She rated the affect scales at 6 for both liking and felt emotion, 10 for perceived emotion, and 5 for absorption.

Breakthrough medication dose of lorazepam after the intervention, at 2 x 1.0mg was double that of the 24 hours before. This is indicative of increased anxiety.

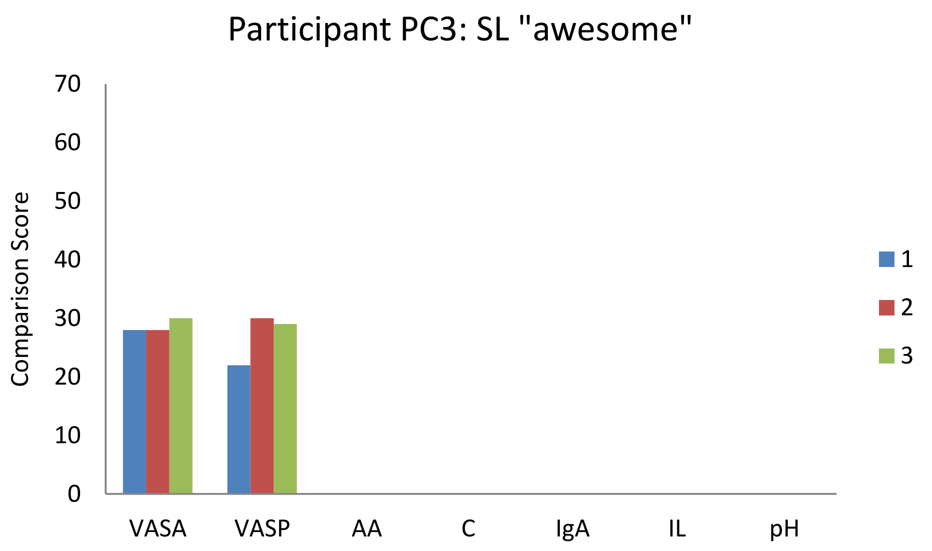

Figure 35. Palliative care participant PC3: anxiety and pain outcome measures

A 73 year old female with lung cancer, PC3 enjoyed being read to in her room, describing the experience as "awesome" (Figure 35). Only subjective data is available for this participant as she was unable to produce any saliva and there were no breakthrough medications to compare. She rated the affect scales at 8 for liking the stories, 4 for perceived emotion, 7 for felt emotion, and 6 for absorption. Her initial anxiety level remained unchanged, with self-reported VASA scores being 28.0 mm, 28.0 mm and 30 mm. Self-reported pain rose slightly from the initial mild VASP of 22.0 mm to a moderate level of 30.0 mm and finally 29.0 mm. However, these small changes are not considered to be clinically significant (Kelly, 2001).

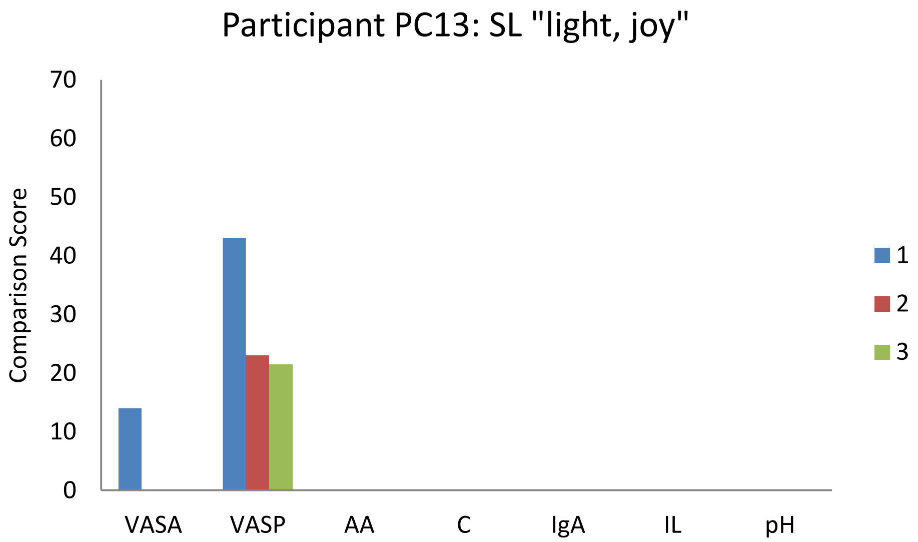

Figure 36. Palliative care participant PC13: anxiety and pain outcome measures

PC13, an 80 year old woman with lung cancer, described her experience of being read to as “light, joy”, and rated all four affect scales at the maximum 10 (Figure 36). Her positive responses to the intervention were also reflected in clinically significant VAS changes (Kelly, 2001; Williams et al., 2010), with the initial low VASA score of 14.0 mm falling to zero for the second and third ratings, and the moderate baseline pain level of 43.0 mm halving through 23.0 mm after the stories to a final low pain score of 21.0 mm.

No saliva was collected, but breakthrough medications did provide some objective confirmation of the self-reported falls in anxiety and pain levels. The single 0.5 mg dose of the sedative lorazepam taken prior to the intervention was not repeated in the ensuing 24 hours; and the three 2 mg doses of pain relieving hydromorphone taken in the 24 hours before the stories was reduced to two doses of 2 mg in the following 24 hours.

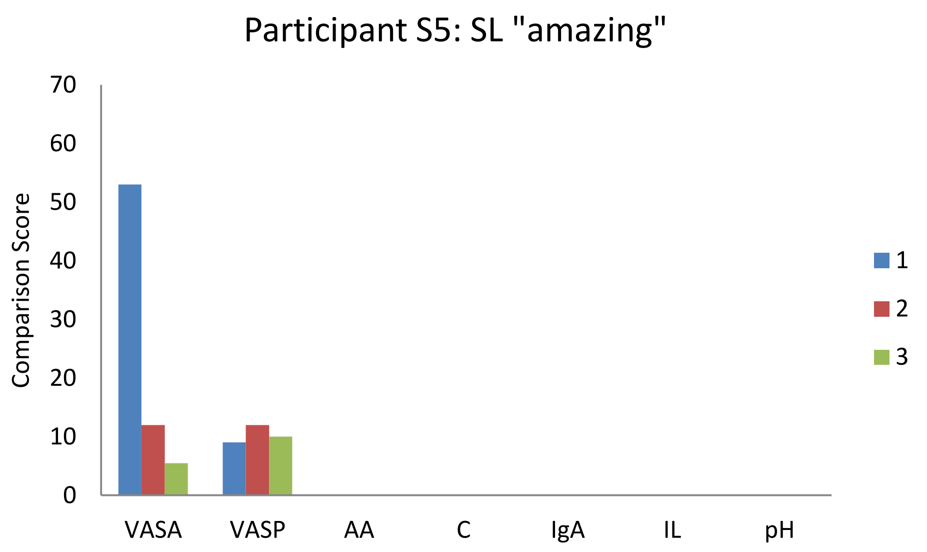

Figure 37. Surgical participant S5: anxiety and pain outcome measures

S5, a 77 year old female mastectomy patient, thought having stories being read to her was "amazing", rating liking at 8, perceived emotion and absorption both at 10, and felt emotion at 5 (Figure 37). Her initial VASA of 53.0 mm indicated she was anxious whilst awaiting surgery. However, self-reported anxiety fell to 12.0 mm following the stories and continued its downward trend to 5.5 mm by the final VASA. The low baseline VASP of 9.0 mm rose to 12.0 mm before settling at 10 mm for the third rating.

No saliva was collected as this fasting patient had a dry mouth and was unwilling to attempt to produce saliva, so no biomarker data is available for her.

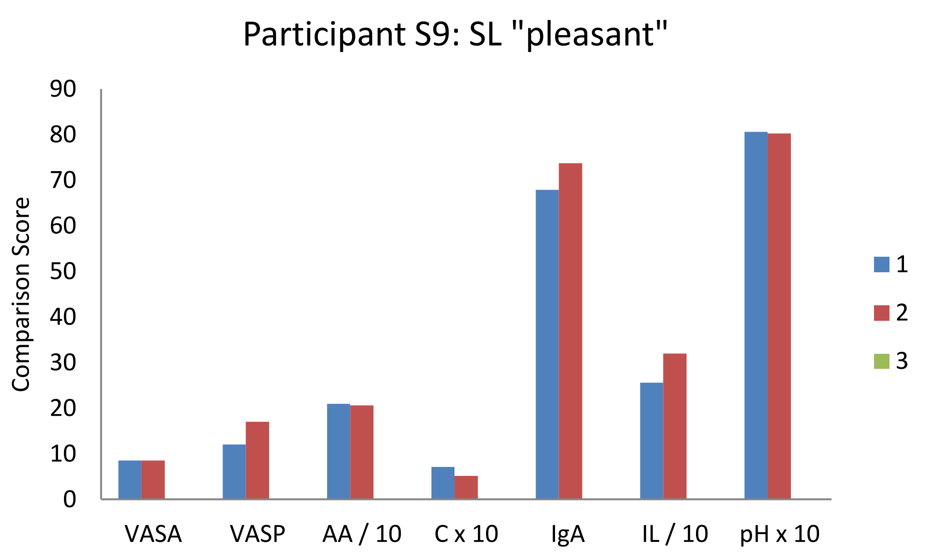

Figure 38. Surgical participant S9: anxiety, pain and immune outcome measures

The final patient in the SL condition was S9, a 79 year old man having bladder surgery (Figure 38). Only two of the three data rounds were completed before his transfer to the surgical suite. He described the story listening as “pleasant”, and rated the affect scales at 7 for liking, 9 for perceived emotion, and 6 for both felt emotion and absorption. His low baseline VASA of 8.5 mm remained unchanged, whilst there was a small rise in the VASP from 12.0 mm to 17.0 mm after the story reading.

Little change was seen between sAA levels of 209.46 U/mL and 206.17 U/mL., whilst sC levels fell in the second reading from 0.71 µg/dL to 0.51 µg/dL. A slight negative change was observed in the spH readings from 7.81 to 7.76. Both immune markers increased, with sIgA rising from 67.85 µg/mL to 73.70 µg/mL and sIL-1β from 255.82 pg/mL to 320.03 pg/mL, indicating a positive immune response.

Patient cases: audio stories

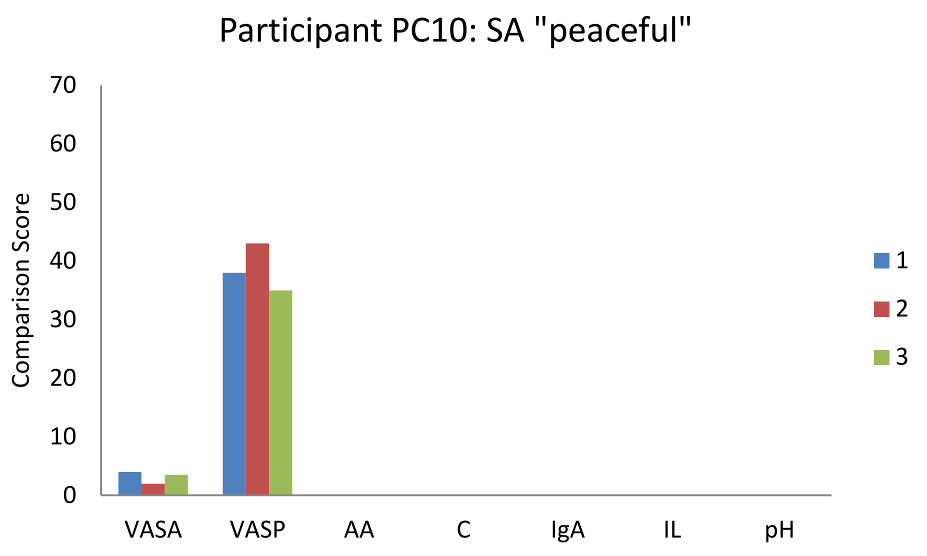

Figure 39. Palliative care participant PC10: anxiety and pain outcome measures

PC10, a 56 year old male with pancreatic cancer who listened to a recording of the story reading, described it as a “peaceful” experience (Figure 39). Only subjective data is available as no saliva was produced and breakthrough medications were the same for both 24 hour periods. Affect scales were rated in

the mid-range, with 6 for both liking and perceived emotion, and 5 each for felt emotion and absorption. Both VAS scales showed little change, with low VASA ratings of 4.0 mm, 2.0 mm and 3.5 mm and VASP scores of 38.0 mm, 43.0 mm and 35.0 mm.

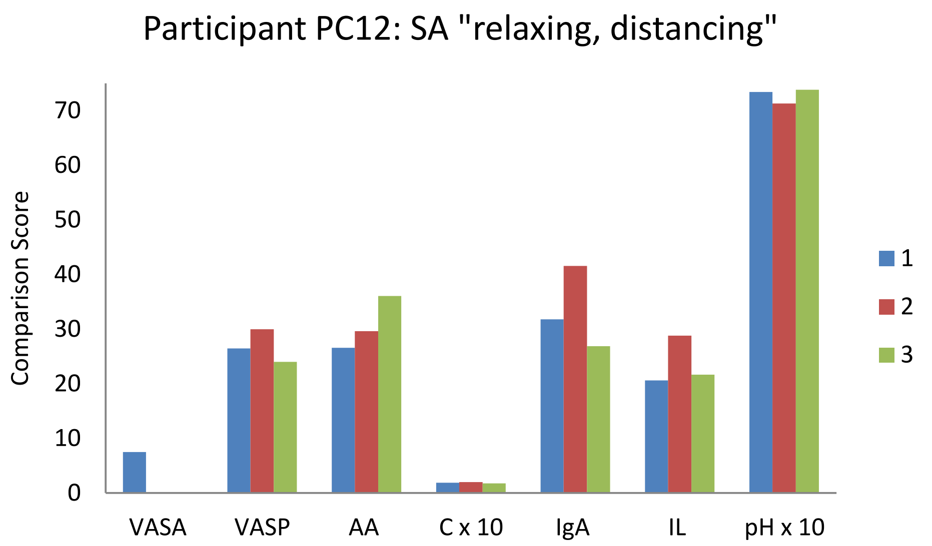

Figure 40. Palliative care participant PC12: anxiety, pain and immune outcome measures

A full set of data was collected from PC12, a 36 year old woman with colorectal cancer (Figure 40). She described her experience of listening to the recorded stories as "relaxing" and "distancing", and gave high ratings on the affect scales: 10 for liking, 9 each for perceived emotion and absorption, and 8 for felt emotion. Her initial VASA rating of 7.5 mm fell to zero for the two post-story ratings, whilst the VASP baseline of 26.5 mm remained at similar levels following the stories, at 30.0 mm and 24.0 mm.

Stress marker responses were mixed, with sAA rising from 26.61 U/mL to 29.61 U/mL and 36.08 U/mL after the stories, whilst the sC levels remained fairly constant at 0.19 μg/dL, 0.20 μg/dL and 0.17 μg/dL. Salivary pH fell initially from the baseline 7.34 to 7.13 before returning to 7.38. Both immune markers rose immediately after the stories before falling again to close to baseline levels. Salivary IgA readings were 31.77 μg/mL, 41.58 μg/mL and 26.87 μg/mL, and levels for sIL-1β were 20.64 pg/mL, 28.79 pg/mL and 21.69 pg/mL.

Comparison of breakthrough medication was inconclusive as the two 10 mg doses of hydromorphone administered in the pre-intervention period was replaced by two 40 mg doses of oxycodone during the following 24 hours.

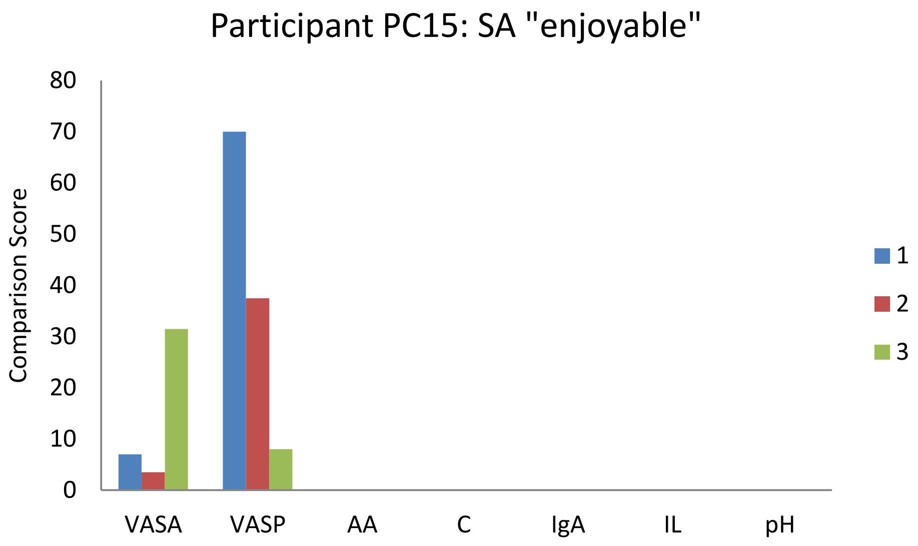

Figure 41. Palliative care participant PC15: anxiety and pain outcome measures

Despite a valiant attempt this 85 year old woman with bladder cancer was unable to produce a saliva sample. PC15 found the story readings "enjoyable", rating 8 for liking, 9 for perceived emotion, 6 for felt emotion, and 10 for absorption (Figure 41). Whilst the VASA rose noticeably in the third rating from the baseline 7.0 mm followed by 3.5 mm, to 37.0 mm, the VASP fell sharply from a severe pain rating of 70.0 mm to a moderate 37.5 mm and finally a mild 8.0 mm.

There were no breakthrough medications to compare, so no objective data is available for this participant.

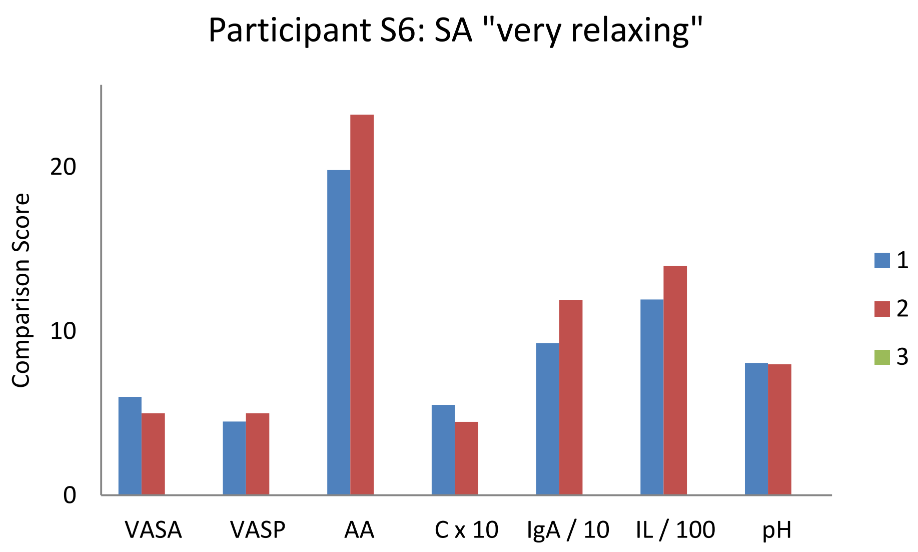

Figure 42. Surgical participant S6: anxiety, pain and immune outcome measures

The final clinical participant was S6, a 65 year old female admitted for an exploratory urinary tract procedure (Figure 42). Again, only the first two rounds of data were completed before she was transferred to the surgical suite. This patient found the experience of listening to the recorded stories "very relaxing", and rated the affect scales in the high range at 8 both for liking and absorption, 8.5 for perceived emotion, and a moderate 7 for felt emotion. The low baseline VASA of 6.0 mm remained fairly stable at 5.0 mm, as did the low VASP ratings of 4.5 mm followed by 5.0 mm.

Stress marker results were mixed, with sAA rising from 19.80 U/mL to 23.19 U/mL and sC falling from 0.55 μg/dL to 0.45 μg/dL. Salivary pH readings were 8.06 and 7.99. Both immune markers rose: sIgA from 92.70 μg/mL to 119.01 μg/mL, and sIL-1β from a high 1192.72 pg/mL to 1397.66 pg/mL. (These sIL-1β levels are considered to be outliers.)

Discussion on biomarker results

Due to the small sample sizes further diminished through missing data points, particularly with the clinical participants, this discussion is based on the visual data provided in tables and graphs. Some patterns emerged in the differential responses of the various biomarkers to the individual interventions. Firstly, there are some trends in the direction of change for each biomarker to the five

experimental conditions. However, biomarkers behave idiosyncratically, complicating interpretations of the responses.

Each biomarker is an indicator of a specific aspect of the stress/relaxation response or immune system, so it was not anticipated that the markers would necessarily behave in a systematic manner. Nevertheless, it was expected that the stress markers would generally agree with one another to indicate either an increase or decrease in stress levels, even if the timing of the onset of their changing levels was staggered. As will become apparent in the discussion which follows, this was not always the case. Furthermore, with little known about the likely response of one of the immune markers to music, namely IL-1β, it was unclear *a priori* whether the two immune markers would have parallel reactions.

Variability between variables

This study deliberately used a palette of five biomarkers to capture both the HPA axis (with sC) and SAM stress/relaxation responses (through sAA, spH and sIgA), as well as the natural versus acquired immune systems (via sIL-1β and sIgA). Based on previous findings (e.g., Thoma et al., 2013), possible differential response patterns occurring between the stress markers were anticipated. Similarly, the two arms of the immune system can behave differentially to stress and relaxation, with relaxation enhancing the acquired immune response (sIgA) whilst possibly suppressing the natural inflammatory immune response, reflected in sIL-1β levels (Gruzelier, 2002). However, with scant empirical information about how music impacts on sIL-1β levels, the interpretation of its response is still unclear.

Factors surrounding the saliva collection process may also have influenced outcomes for some of the participants. This was particularly the case with the hospitalised cohort, where general malaise, fasting, possible cognitive impairment, age, interruptions, and time constraints all may have impacted on experimental procedures. Additionally, as can be seen from the line graphs based on the students' raw results, the baseline levels in each group for all five biomarkers were not homogenous. In other words, as well as variations between variables, large intra-variable differences were evident, limiting options for statistical comparisons.

Each biomarker will now be discussed, specifically how it responded to the five experimental conditions in both the student and clinical populations. Also any differential responses between the markers are noted and possible explanations canvassed.

sAA

Levels of sAA, as seen in the bar graph of students' standardised scores in the results section (Figure 11), indicated a stronger initial relaxation response for the three music interventions, compared to stories, before levels rebounded beyond baseline levels in the final sample in all but the ML group. The largest initial fall was seen in the ML group, with a residual relaxation response indicated by lower than baseline levels in the final sample.

Only one of the three patients (S1) in the ML group showed the same sAA response pattern as the students, with an initial fall followed by a rise that remained below the baseline level (see Figure 25). This indicated a residual relaxation response to the live music. The remaining two ML patients with biomarker results, PC4 (Figure 22) and PC6 (Figure 24), both had sAA levels initially rise before falling again, in the case of PC6 to below baseline levels, which again is indicative of a delayed relaxation response.

With such a small sample no conclusions can be drawn from patients' changing sAA levels. In fact, one of each of the MAV (PC11) and MA (S3) groups, as well as the only SL patient who produced saliva samples (S9), also had falling sAA levels. What can be noted from the individual clinical cases though is the way sAA responded immediately, either increasing or decreasing, followed by a return towards, or even beyond, baseline levels. The students' graph (Figure 11) illustrated this rebounding in the MAV and MA conditions, whereas ML had a residual relaxation response and SA showed a lasting stress response with continuing rising levels.

A similar rebound of sAA levels occurred in a study of 25 young healthy females after a 10 minute massage (Noto, Kudo, Sato, Ebina, & Hirota, 2007). Levels fell from the baseline of 60.5 U/mL to 54.5 U/mL immediately after the massage, then rebounded to 73.5 U/mL 30 minutes later. The authors did not comment on this pattern of sAA response, reporting no change occurred in the levels of sAA or in the other stress marker sC. Indeed they concluded, based on

the lack of statistically significant changes, that sAA and sC were both unreliable indicators of the relaxation response.

Salivary glands are innervated by both the activating SNS and the PNS which enhances relaxation and the body's need to return to a balanced state (Morse et al., 1983; Nater et al., 2005). These two opposing forces within the ANS may explain the rebounding effects seen in sAA as the process of reaching homeostasis created oscillating levels until a balance was reached again.

It is worth noting at this point that the diurnal course of sAA rises naturally throughout the day after waking in the morning (Nater, Rohleder, Schlotz, Ehlert, & Kirschbaum, 2007). Any relaxation response detectible in sAA levels needs to be strong enough to overcome this background of rising levels over time.

Whilst sAA levels respond to stress and relaxation, sAA does not differentiate between these mainly psychological constructs and more physical stresses such as pain (Koh, Ng, & Naing, 2014). Shirasaki and colleagues (2007) found a significant correlation (r = 0.561, p < .01) between the VASP and sAA levels after epidural blocks in patients with chronic pain. In contrast, the patterns observed in this study did not indicate clear parallels between either of the VAS scales and sAA. There is further discussion on this point in the section of comparisons between objective and subjective outcome measures.

Dehydration can cause decreased secretion rates of sAA (Fortes et al., 2012). With all of the surgical patients being on a nil-by-mouth regime, it is likely that their sAA levels may have been affected by a lack of fluid intake, as well as fasting. Some of the palliative care patients had decreased saliva flow, so could have been similarly affected by illness limiting their intake of food and fluids. Additionally, medications may impact on saliva production and flow. Use of medications was understandably more prevalent in the clinical population than that reported by the students, further contributing to the low number of samples collected from patients.

sC

Students' sC levels fell after each of the interventions, and continued this trend in the third saliva samples (see Figure 13). In an almost complete reversal of what was anticipated in the original hypothesis, the weakest relaxation

response was seen in the MA condition, followed by ML, whilst the strongest response was evident in the SA condition, including a strong residual relaxation response. In all five conditions the third saliva samples had lower sC levels than the second, indicating a more lasting response of cortisol to the interventions, compared to sAA. This was anticipated as previous research has established that the response time of sC is slower and longer lasting than sAA, which responds quickly and returns to baseline within a shorter time (Maruyama et al., 2012; Nater et al., 2005).

Most of the patients' sC responses across the five interventions mirrored the same pattern. Three exceptions were PC6 and S1 in the ML condition and PC12 in the SA group, all with initial rising levels of sC that then fell below baseline in the third sample. The natural diurnal course for sC sees levels fall steadily through the day after an initial peak soon after waking in the morning (Nater et al., 2007). The observed falls seen after most of the interventions was therefore in part due to this natural reduction of sC levels over time. What needs to be considered then is the differential rate of change between experimental conditions, as reported in the preceding paragraph.

It is relevant to note here that if this study had measured only sC as its outcome variable the initial results and conclusions would be that audio story readings (SA) are a more effective anxiolytic than live stories (SL), as well as any music intervention. However, on closer inspection of the graph of students' standardised scores (Figure 11) and the tabled raw results (Table 8), it was evident that the delayed response of sC saw SL levels fall below those of SA by the third sample, and the sC levels of ML almost fell to the levels of MA. If this trend had continued, the residual sC responses may well have told a different story in a hypothetical fourth saliva sample taken after a further 25 minutes.

One possible explanation for the observed fall in sC levels across all the interventions is that salivary responses may be more related to the anticipation of the intervention rather than the actual intervention itself (Borgeat, Chagon, & Legault, 1984). Apprehension before the intervention and surrounding the first saliva collection, and even the short term stresses of getting to the venue at the appointed time in the case of the students, may have been countered once the participants engaged in the experiment, reflected in the overall fall of sC levels across all conditions.

sIgA

Interpretation of changes in sIgA levels can be confusing given that this protein is an indicator of immune competence, but also a marker of stress. As a consequence, both acute stress and relaxing interventions can result in rising levels (Euler, Schimpf, Hennig, & Brosig, 2005; Tsujita & Morimoto, 2002). Compared to sC, more stable levels throughout the day reduce diurnal influences on outcomes (Euler et al, 2005), although there is a natural decline of sIgA levels during the morning hours (Hucklebridge et al., 2000).

For the student cohort, sIgA concentrations initially increased most for the ML listeners, and less for the MAV group, and fell in the MA participants (see Figure 14). Both story groups had increased sIgA levels immediately after listening, but to a lesser degree than ML and MAV. These results do indicate a stronger initial immune response after ML compared to recorded music, in particular MA, and a less robust response to stories than music. However, as was seen with the rebounding sAA levels, by the third sample the sIgA had fallen to below baseline levels in all groups except SA, which returned to very close to baseline.

Each of the twelve patients with sIgA data, regardless of their intervention, had sIgA levels initially rise from baseline before falling again for the six who had a final sIgA result. Some rebounded to below baseline: PC4 (ML), PC11 and S2 (MAV), and PC12 (SA), whilst others remained elevated: PC6 and S1 (ML). No conclusions can be drawn from this very small sample, but it is interesting to observe the pattern of how this biomarker rose and fell fairly consistently in all the individual clinical participants. A possible explanation for the observed rebounding levels is the dual actions of the SNS and PNS which both innervate the salivary glands that release sIgA. It has been suggested that sIgA is more affected by the PNS, which triggers a relaxation response and thereby promotes homeostasis (McCraty et al., 1996).

Both stimulating and relaxing music have been shown to increase IgA concentrations (Chanda & Levitin., 2013). Similarly, mood induction, through both memory recall and music, was associated with increased sIgA levels for positive as well as negative moods (Hucklebridge et al., 2000). It is possible that the moods induced by the interventions, regardless of their valence, were a

common factor in all participants, moderating the differential effects reported between music and stories, and the live versus recorded modalities.

Most studies referred to for comparison of sIgA results used simple pre- and post-test designs with no third measure taken (e.g., Kreutz et al., 2004; McCraty et al., 1996), or repeatedly measured sIgA over a longer period of days or weeks (e.g., Euler et al., 2005), so were not enlightening as to whether there are precedents for the rebounding pattern seen in these current results. One study that did take a third sample 15 minutes after the end of the intervention compared interested, or engaged tertiary students attending a lecture to their indifferent, or bored peers (Tsujita & Morimoto, 2002). The engaged students' sIgA secretion rates were higher than baseline immediately after the lecture, and were falling, but still above baseline, 15 minutes later. In contrast, their bored peers had lower than baseline sIgA secretion rates after the lecture, and these rates were still the same 15 minutes later.

Unlike sAA, which has been shown to reduce in secretion rate after dehydration, the concentration of sIgA actually increased in the same participants of a study which investigated exercise-induced dehydration (Fortes et al., 2012). So the limited intake of food and water may not have impacted on this biomarker in the clinical cohort.

In order to further interpret the changes in sIgA it is helpful to compare them to the trends observed in the other biomarkers of stress and immune response. Any similar or differential trends are addressed in a later section comparing all the outcome variables, following discussion of the subjective results.

sIL-1β

As has been explained earlier, the role of IL-1β is a complex one, involving regulation of immunological and physiological responses of other biomarkers. Whilst IL-1β is associated with positive antiviral and tumoricidal activities, elevated levels are also seen in inflammatory autoimmune illnesses. Such paradoxes make it difficult to establish how the changes observed in sIL-1β levels in participants in this study should be interpreted. The dilemma is further complicated by the lack of studies using this marker with music interventions.

As an immune marker with no track record in music studies, the sIL-1β results from this investigation are of particular interest. The bar graph of students' standardised scores (Figure 17) illustrates a clear difference between the music and story interventions for the first post-intervention sample. Whilst both SL and SA precipitated falls from baseline, the three music groups all rose from baseline levels, mostly MAV, followed by ML and MA. The final samples revealed a residual rising trend only for ML, with levels for all the other groups falling below baseline readings. The rebounding levels were most notable in the MA group. The positive rising trend in ML could be interpreted as a robust immune response to live music. However, it is unclear how to explain the rebounds observed in the other groups.

Only nine of the clinical participants produced sIL-1β data. For both of the ML participants with sIL-1β results, PC4 and S1, the pattern of change was similar to the students, with initial rising levels. However, by the third sample levels were falling again, although remaining above baseline. One of the MAV patients (S2) had a pattern similar to the ML students, with initial rising levels which continued to rise strongly in the third sample. The second MAV patient (PC11) mirrored the MAV students' trend, with increased levels initially followed by a fall below baseline in the third sample. The final MAV patient (S8) had a strong initial rise in levels, but no third sample was available for analysis.

To summarise, all the patients across all five groups show initial rising sIL-1β levels, except one MA patient (S3) who specifically stated before the intervention that he disliked classical music, and described the experience as "punishment". Such a consistent positive immune response across all five interventions suggests that those who enjoyed the experience benefitted from the psychosocial factors inherent in providing the bedside music and stories. These benefits could have flow-on effects for a patient's general well-being in areas such as better resistance to infections (e.g., Glaser & Kiecolt-Glaser, 2005), and even improved sleep given that IL-1β plays a positive role in sleep regulation (Clinton, Davis, Zielinski, Jewett, & Kreuger, 2011).

spH

Both the SNS and PNS regulate spH (Cohen & Khalaila, 2014). Falling spH may therefore indicate increased stress, whilst a rise in spH is associated with a

relaxation response. Any reading above a neutral pH of 7.00 is considered alkaline, whilst a pH below 7.00 is acidic. The baseline readings of participants were variable, as anticipated from previous studies (see Morse et al., 1983), ranging from 6.68 to 7.98 in the student participants, and even more widely between 6.34 and 8.26 in the patients. Surgical patients' pH baselines, from 7.48 to 8.26, were higher than those of the palliative care patients, which sat between 6.34 and 7.34. Contrary to these results, it had been expected that fasting, as is required for all surgical patients, would reduce spH rather than increase it. Stress-induced xerostomia, or dry mouth, decreases bicarbonate secretion, thereby reducing pH (Cohen & Khalaila, 2014). Similar effects were expected in the fasting patients due to reduced saliva production, and the lack of stimulation from food triggering bicarbonate production.

Student spH results initially indicated reduced stress with rising pH only in the MA group, compared to falling pH in all the other groups immediately after the interventions. A rebound was then observed to near, for ML, or beyond the baseline in the third sample, for the other four groups, with the biggest initial fall and subsequent rebound noted in those who listened to ML (see Table 11, Figure 17 and Figure 18). This suggests a delayed relaxation response in this marker. On looking at the difference between the second and third spH readings, the biggest recovery was seen in ML (.277) followed by MAV (.110), SL (.096) and SA (.092). MA levels fell, after an initial increase, by .071 pH points.

Salivary pH data was available for twelve patients, of which six had no readings for the third saliva collection. All three ML clinical participants with spH data had higher than baseline spH in the third samples. Second samples fell from baseline in PC4 (7.27 followed by 7.11 and 7.60), and rose in both PC6 (6.34, 6.42, 6.87) and S1 (7.56, 7.73, 7.70). For the MAV patients, a rise in the third sample for PC11 (6.59, 6.54, 6.70) was balanced by a fall in this sample for S2 (8.20, 8.13, 8.02). The second samples were fairly stable in these two patients. A third MAV patient with spH data, S8 (7.77, 7.48), had a lower than baseline reading for the second sample, but no third sample was collected. The MA patients, PC14, (6.77, 6.71), S3 (8.26, 8.17) and S7 (7.81, 7.76), all had lower than baseline levels in their second sample, but had no third spH reading. Only one SL patient had some spH data, which showed little change between the first and second sample (S9: 8.06, 8.02). The SA condition also had one patient with a

full set of spH results, PC12 (7.34, 7.13, 7.38), which again showed a rebound back to baseline after an initial fall in spH. The spH of the second patient in this group fell between the first and second sample, but there was no third sample to test (S6: 8.06, 7.99).

The generally observed initial fall in spH could be an indication that this stress marker is more sensitive to the stimulating effects of music than some of the other markers already discussed. Another explanation for the initial indication of stress is that psychosocial factors such as anticipation of engagement with the experiment may have triggered some anxiety before the effects of the actual intervention were actually reflected in the final sample. An early study comparing relaxing and stressful experimental conditions found no differential variations between the conditions in salivary characteristics, including pH, but differences between the pre- and post-samples of both conditions. They concluded that the general demands of the situation and subsequent apprehension, rather than the specifics of the interventions, gave rise to the anomalies in the results (Borgeat et al., 1984).

Other studies that have used spH as an outcome for stress (Cohen & Khalaila, 2014; Sandin & Chorot, 1985) or depression (Khalaila et al., 2014) have measured spH over a longer time frame of weeks or months. This does not allow a direct comparison to the current study design and results which occur within a limited one hour time window.

Readings of spH may have been compromised due to the post hoc decision to include this marker in the study. As a result, the pH testing was carried out on thawed specimens rather than the ideal point-of-collection testing (e.g., Khalaila et al., 2014). Immediate testing is convenient and eliminates the need for transport and freezer storage of saliva samples. It also reduces the risk of increased pH through carbon dioxide loss which can occur when saliva is exposed to air during preparation for storage and subsequent assaying (Morse et al., 1983; Morse et al., 1986).

Summary of biomarker results

The most salient point to emerge from the salivary biomarker investigations in this study was the evidence of idiosyncratic patterns of responses for each marker. In part these differential responses reflect the discrete nature of the

HPA and SNS, as well as the acquired versus natural immune systems. And yet we know these systems are all integrated and moderate each other's responses.

The most unexpected differential outcomes were seen between the stress markers sAA (SAM system) and sC (HPA axis), as well as the spH results (SNS and PNS). Salivary AA responded as anticipated, indicating a stronger anxiolytic effect for music, in particular ML, than stories. In contrast, the sC results indicated stories overall precipitated greater stress reduction than music, and the live conditions did not demonstrate the expected superior anxiolytic effects. Most notably, all the five conditions had lower than baseline levels of sC in the subsequent samples, indicating a delayed peak response to the interventions. An apparent delayed relaxation response occurred in the spH readings, with ML recovering most from the initial drop in students' spH levels. Further explanations for the differential biomarker results can be found in the discussion section following the reporting of the subjective outcome measure results.

Length of hospital stay

Table 13. *Length of Hospital Stay for Surgical Patients*

	LENGTH OF HOSPITAL STAY (HOURS)								
ML		**MAV**		**MA**		**SL**		**SA**	
S1	45.00	S2	27.00	S3	52.50	S5	100.50	S6	22.00
S4	23.00	S8	48.25	S7	8.50	S9	24.25		
Total	68.00		75.25		61.00		124.75		22.00
Average	34.00		37.62		30.50		62.37		22.00

Each surgical patient's length of hospitalisation was recorded (in hours) after their release from the ward. Variable lengths of stay mostly reflected recuperation time as they were all admitted on the morning of their procedures.

However, the commencement times and amount of time spent undergoing the procedures were variable and not recorded.

The resulting data is presented here purely to illustrate the variations in this small data set (see Table 13). With a larger study this type of objective information could be useful in assessing differential residual effects of interventions.

Subjective measures

A variety of subjective outcome measures was selected to complement and compare to the objective biomarker results. These included visual analogue scales (VAS) for anxiety (VASA) and pain (VASP), self-report affect scales for liking, perceived and felt emotion, and absorption, as well as the elicited one-word response. In addition, some unsolicited verbal offerings from participants were recorded in writing at the time they were spoken, and one of the surgical patients provided a spontaneous written response. The data set for subjective measures was more comprehensive than that for the biomarkers due to fewer methodological constraints.

Visual analogue scales

As also seen with the biomarkers, the initial baseline readings for the VASA and VASP were not homogenous over the five intervention groups (see Table 14, Figure 43 and Figure 45). From a possible maximum score of 100 the mean baseline VASA for students ranged from 8.85 (ML) to 20.35 (SA), with a total mean across all groups of 13.86. Baseline means for the patients ranged even more widely, between 6.10 (SA) and 24.87 (MAV), with a total mean of 17.44. The VASP had a similar between group range of 6.25 (MA) to 13.33 (MAV) in the student sample, around the total baseline mean of 8.28, and again a wider variation of patients' group means from 11.08 (ML) to 34.75 (SA) reflected in a higher total baseline mean of 20.96. Whilst the VASA baselines of both cohorts started well below the suggested threshold for anxiety of 50 cm (Facco et al., 2011), baseline levels for pain in the patient cohort were over double those of the students.

Those with higher initial anxiety levels are likely to benefit most from music interventions (e.g., Schneider et al., 2001). The line graph of students' VASA raw scores (Figure 43) as well as the bar graph illustrating their standardised difference scores (Figure 44) both supported this earlier finding. SA, with the highest baseline VASA scores, showed the biggest difference overall for the third rating of the scale, and was second after MA for the second rating in terms of fall from baseline. In contrast ML, the group with the lowest baseline VASA, had the

Table 14. *Mean Scores (with SD) on Visual Analogue Scale Ratings*

STUDENT VAS RESULTS

	VASA 1	VASA 2	VASA 3	VASP 1	VASP 2	VASP 3
Group						
ML	8.85	6.65	6.15	7.40	4.95	5.15
(SD)	(7.48)	(4.43)	(3.26)	(6.94)	(3.82)	(3.83)
MAV	11.44	8.67	6.67	13.33	14.61	7.39
(SD)	(6.05)	(16.27)	(11.22)	(15.38)	(16.63)	(14.29)
MA	15.65	6.30	7.75	6.25	7.05	9.05
(SD)	(12.71)	(5.47)	(5.62)	(7.09)	(7.76)	(11.44)
SL	13.00	4.95	6.67	7.61	5.16	5.44
(SD)	(8.33)	(4.87)	(6.10)	(6.93)	(4.48)	(4.59)
SA	20.35	11.35	9.15	6.80	5.15	4.60
(SD)	(18.34)	(13.73)	(10.36)	(10.15)	(7.04)	(4.93)
Mean	13.85	7.58	7.28	8.28	7.38	6.33

PATIENT VAS RESULTS

	VASA 1	VASA 2	VASA 3	VASP 1	VASP 2	VASP 3
Group						
ML	15.16	8.25	3.10	11.08	11.33	4.10
(SD)	(17.41)	(4.85)	(2.97)	(8.39)	(6.05)	(2.68)
MAV	24.87	9.50	27.12	29.00	9.37	23.12
(SD)	(19.57)	(11.12)	(29.62)	(20.84)	(11.88)	(23.69)
MA	18.37	35.62		11.37	26.12	
SL	22.70	12.12	8.87	18.60	20.50	15.12
(SD)	(19.75)	(14.07)	(15.97)	(17.16)	(9.07)	(9.57)
SA	6.10	2.62	11.66	34.75	28.87	22.33
(SD)	(1.89)	(1.76)	(17.26)	(22.54)	(6.53)	(13.58)
Mean	17.44	13.62	12.69	20.96	19.24	16.17

N.B. No *SD* is shown for some patient groups due to small group size (see Table 15).

smallest change after the intervention in both the second and third ratings. Initial baseline pain and anxiety levels could therefore be a potent confound when interpreting the results. It should be noted, however, that all the baseline VASA group means were in the low range, reaching only around 20 out of a possible 100 (mm).

A similar pattern was seen in the student VASP graphs (see Figure 45 and Figure 46). Again, the group with highest baseline pain levels, MAV, showed the most dramatic fall in the third rating. However, with the patient cohort the MAV group, again with the highest initial reported pain levels, showed the inverse pattern of a sharp drop before rebounding beyond baseline in the third rating of the scale (see Figure 49 and Figure 50).

Table 15. *Visual Analogue Scales Participant Numbers by Intervention Group*

	Student VAS participant numbers					
	VASA 1	VASA 2	VASA 3	VASP 1	VASP 2	VASP 3
Group						
ML	10	10	10	10	10	10
MAV	10	10	10	10	10	10
MA	10	10	9	10	10	9
SL	10	10	9	10	10	9
SA	10	10	10	10	10	10

	Patient VAS participant numbers					
	VASA 1	VASA 2	VASA 3	VASP 1	VASP 2	VASP 3
Group						
ML	7	7	5	7	7	5
MAV	4	4	4	4	4	4
MA	2	2	1	2	2	1
SL	5	4	4	5	4	4
SA	4	4	3	4	4	3

It should be noted that, with low numbers overall and very low patient numbers in some groups, these visualised results are not in any way conclusive (see Table 15). In contrast, the student cohort had ten participants in each group, with only one final VASA and VASP missing from both the MA and SL groups, making this data set more complete and reliable.

VAS results: students

In terms of comparison between the interventions, VASA results reflected the sC results pattern, with stories overall falling further from baseline than the music interventions (see Figure 44). The exception for the VASA was the MA group which initially had a larger fall in reported anxiety than both SL and SA but was overtaken by SA in the final difference comparison. From these results, it can be inferred that overall the participants reported feeling less anxious after the interventions regardless of which group they were allocated to. The largest fall in VASA ratings occurred in the SA group, which had the highest baseline self-reported anxiety. All the groups except MA and SL continued to fall in the third ratings of the scale, indicating residual effects for ML, MAV and SA. This effect was strongest in the SA group.

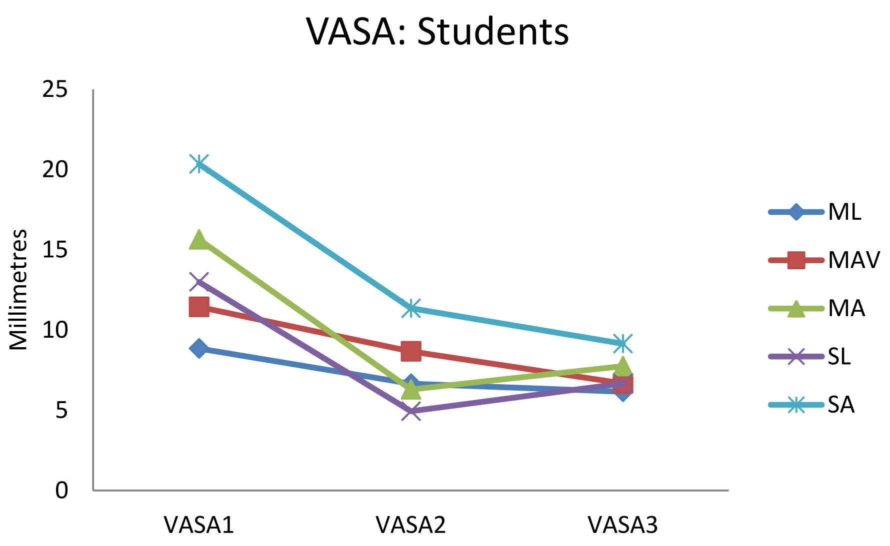

Figure 43. Raw scores for visual analogue scale – anxiety: students

Self-reported pain for all student groups fell into the mild range for the VASP. Kelly (1998; 2001) suggests a change of between 9 mm and 12 mm to

determine whether there is any clinically significant (CS) difference. None of the intervention group means demonstrated this amount of reduction or increase in pain. MA was the only group to report increases in pain both immediately and residually. The largest overall drop in this scale occurred in the MAV group (after an initial increase) which had baseline levels around twice that of the other groups (see Figure 45). Baseline pain levels may therefore be a moderator of intervention effects.

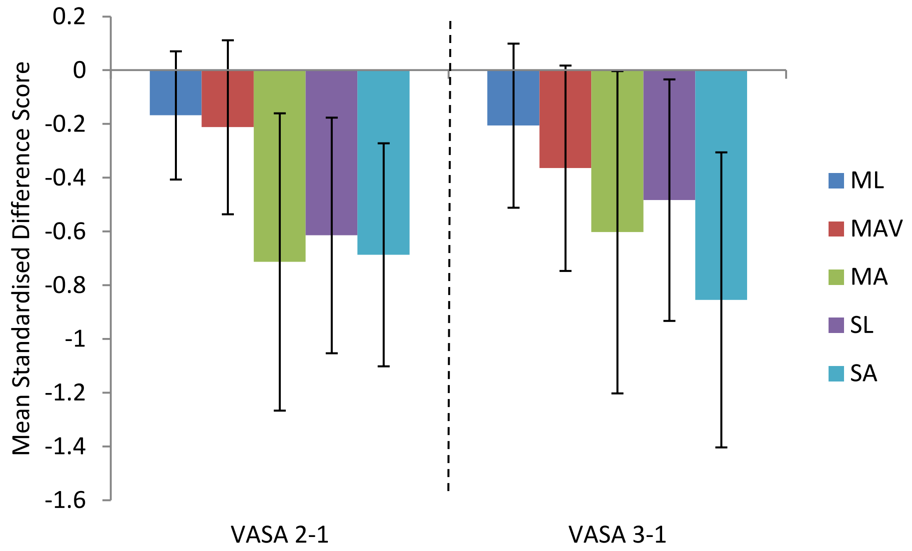

Figure 44. Mean group standardised difference scores, with 95% confidence intervals, for visual analogue scale - anxiety: students

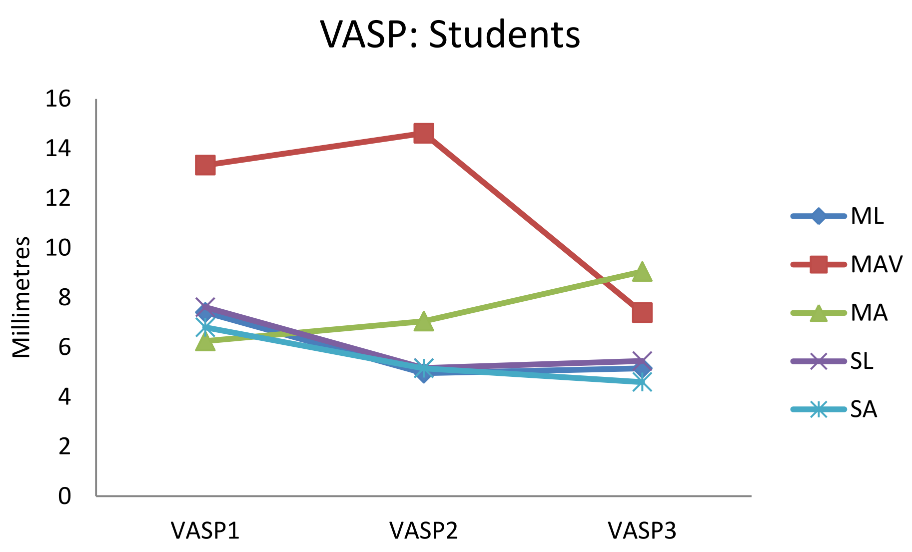

Figure 45. Raw scores for visual analogue scale - pain: students

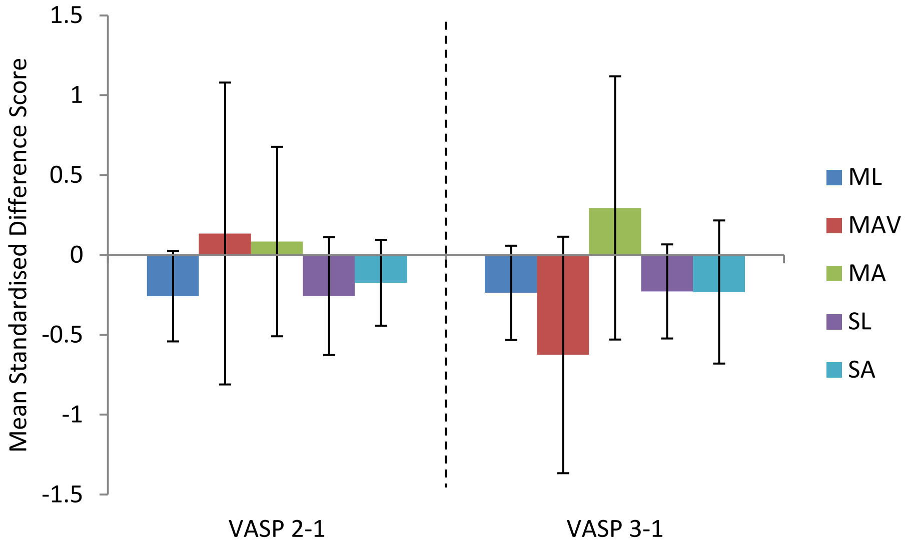

Figure 46. Mean group standardised difference scores, with 95% confidence intervals, for visual analogue scale - pain: students

VAS results: patients

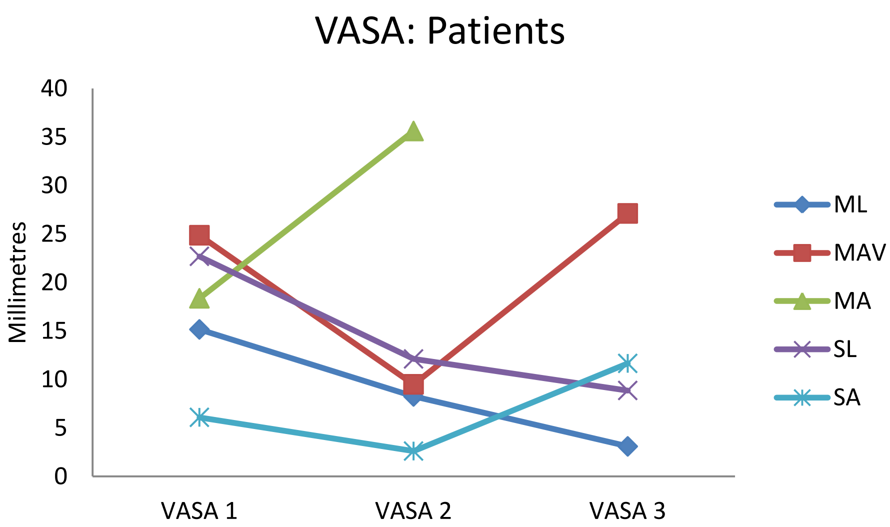

Figure 47. Raw scores for visual analogue scale - anxiety: patients

In view of the restricted numbers of VAS responses in each group, patient group means are represented here only as a record but, as indicated earlier, cannot be interpreted reliably. What can be seen in the bar charts showing the non-standardised difference scores from baseline (see Figure 48 and Figure 50) is

that all groups except MA (n = 1) initially appeared to benefit from the interventions, as reflected in both the VASA and VASP, and self-reported pain continued to fall in all groups. Final VASA scores rose in both the MAV and SL groups.

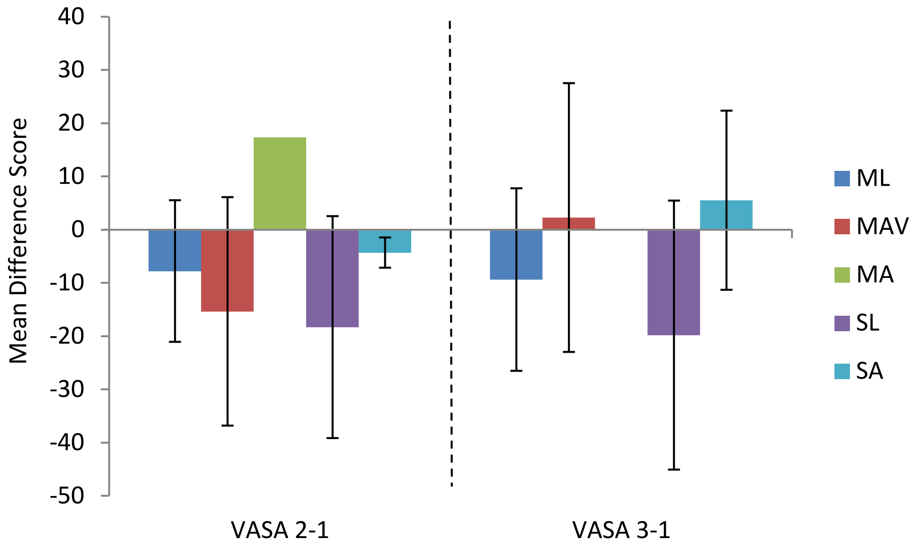

Figure 48. Mean group difference scores, with SD, for visual analogue scale - anxiety: patients

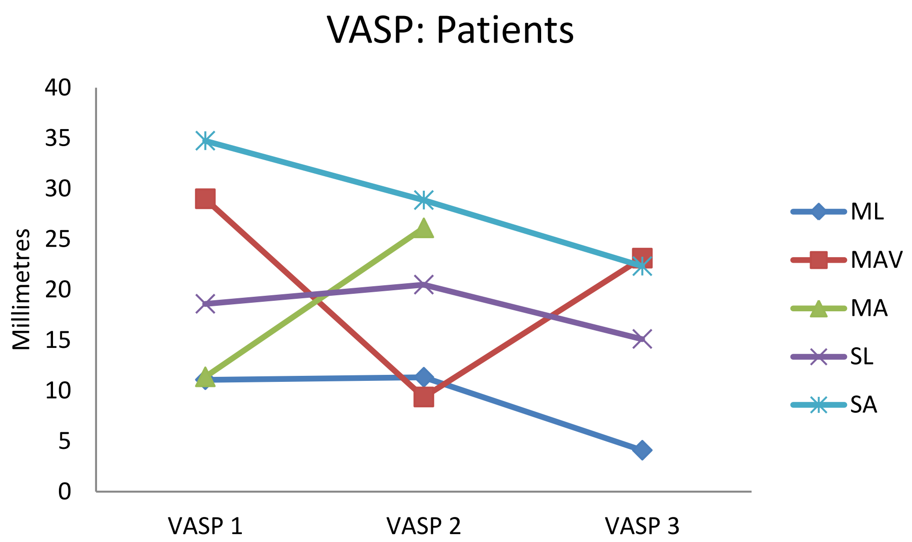

Figure 49. Raw scores for visual analogue scale - pain: patients

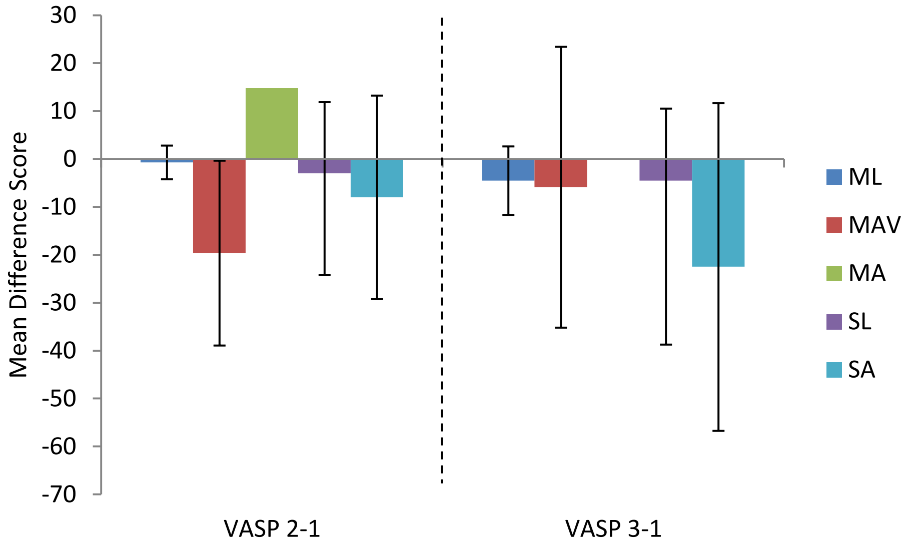

Figure 50. Mean group difference scores, with SD, for visual analogue scale - pain: patients

The VAS scales were of limited value where participants reported no initial pain or anxiety. Conversely, those with higher baseline VAS scores appeared to benefit most from the interventions. This is best illustrated by individual patient raw VAS scores (i.e., baseline ("1"), post ("2") and residual ("3") scores) represented as graphs. In order to compare self-reported anxiety and pain between the different intervention groups, individual cases for each group are presented together in group portraits.

VAS individual case results grouped: patients

Starting with the ML participants (see Figure 51) the most salient case, S1, illustrates the earlier point that those with higher levels of anxiety or pain are likely to benefit most from a therapeutic intervention. After a baseline VASA of 43 mm, close to the "anxious" threshold of 50 mm deemed by Facco et al. (2011), the live cello music precipitated an immediate reduction to 11.5 mm, and a further residual drop in the VASA to 3 mm, being a 40 mm change from baseline. Williams et al. (2010) considered a change of only 12 or 13 on a 100 point scale to be a minimum important difference (MID) in the VASA. This same patient also reported a reduction in pain, initially from a mild baseline 19.5 mm to 13 mm, and finally to 6.5 mm. The total 13 mm fall was over the 12 mm change considered as a minimum clinically significant difference (MCSD; Kelly, 2001).

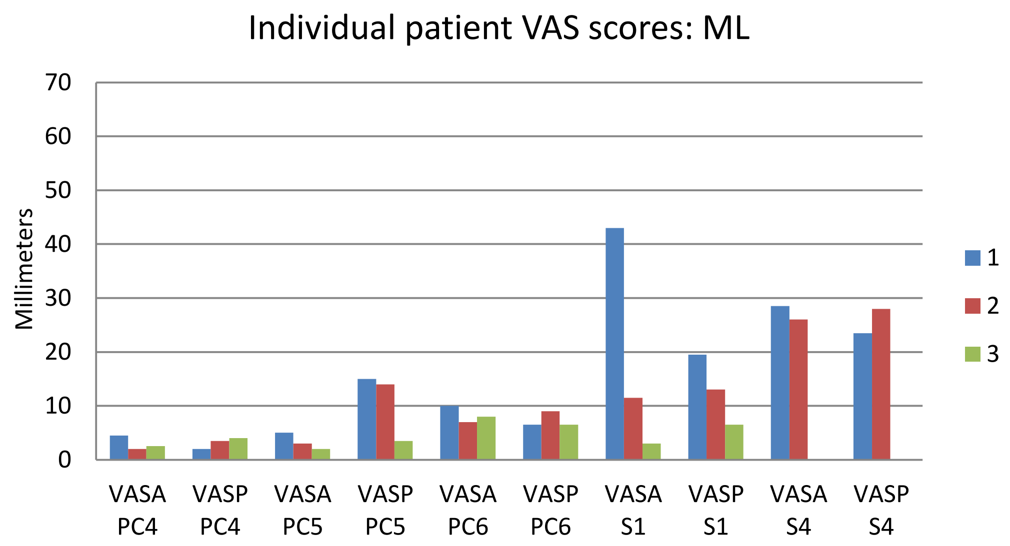

Figure 51. Patient raw VAS scores for ML

All five ML patients represented in the graph reported lower anxiety immediately after the music, and final VASA scores were still below baseline (except for S4 who did not complete a third VASA). VASP scores were less consistent, falling through both post scores in PC5 and S1, whilst rising initially in PC4, PC6, and S4, but returning to baseline again in PC6.

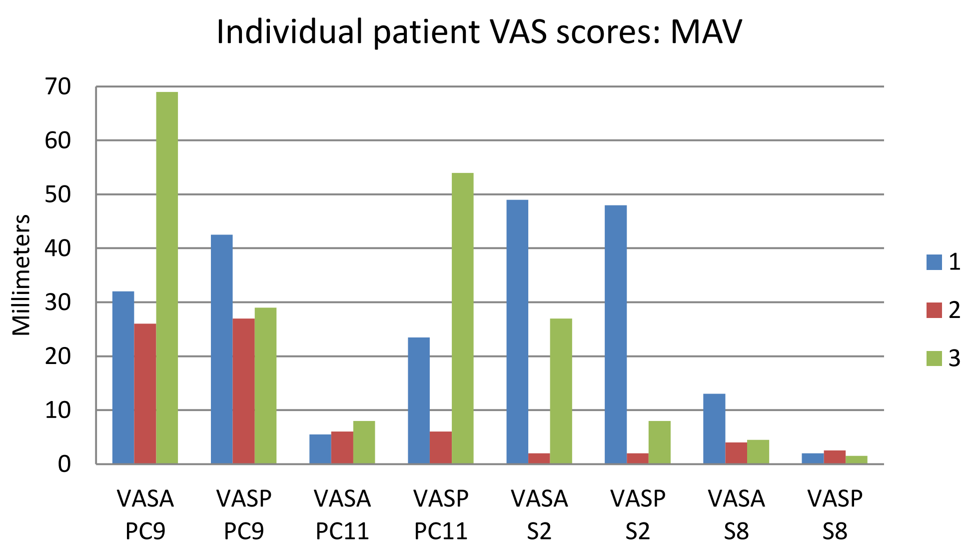

Figure 52. Patient raw VAS scores for MAV

The second group of patient raw VAS scores represents the MAV listeners (see Figure 52). VASA scores fell initially in three of the four patients, but the residual effect was only maintained in S8. For PC9 the third VASA score of 69 mm was a CS rise of over double the baseline 32 mm after an initial small fall to 26 mm. S2 rebounded to 27 mm in the third score after initially dropping to a very low 2 mm from the baseline 49 mm, which is a CS reduction in anxiety. Starting from a very low baseline 5.5 mm, PC11's VASA slightly increased in each subsequent score (6 mm and 8 mm).

VASP scores were mixed in the MAV group. For two of the patients, PC9 and S2, VASP scores went down. VASP scores rebounded after an initial fall for PC11 and remained fairly stable for S8. Looking at the changes in more detail, the initial fall of 15.5 mm for PC9, from baseline 42.5 mm to 27 mm, is considered CS for the moderate initial pain level. The analgesic benefits of the MAV intervention appeared to have a residual effect for this patient, with the third score rising from the second by only 2 mm, to 29 mm. S2 also had a CS reduction in the VASP scores, which dropped dramatically from a moderate 48 mm to a low 2 mm, rising again slightly to 8 mm. Again, these scores indicated both strong initial as well as residual benefits from the MAV intervention.

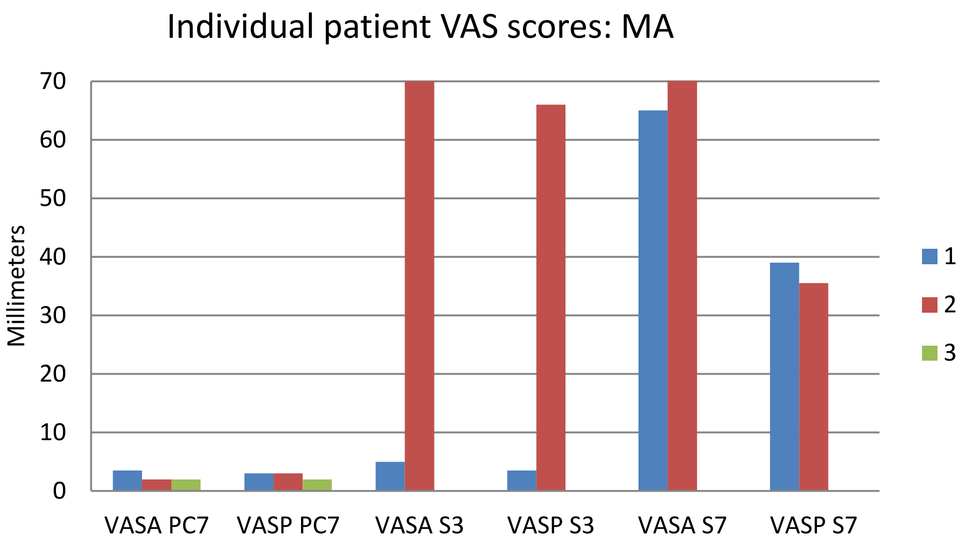

Figure 53. Patient raw VAS scores for MA

The graphs (see Figure 53) of the patients who listened to audio recordings of the music (MA) present a different picture to the preceding two intervention

groups, in part as two of the three patients did not get to score their third VAS scales. Whilst the anxiety and pain levels stayed fairly stable in PC7, falling only slightly from already low baseline levels, those of S3 rose dramatically from initial low baseline levels. As reported earlier, this patient had made his dislike of classical music very clear before participating in the study. His increased VASA from baseline 5 mm to an anxious 70 mm, and similarly his large VASP change from 3.5 mm to 60 mm, were consistent with his *a priori* comments. The third patient in this group, S7, rated the first and second scales similarly, with only a small rise in the VASA from 65 mm to 70 mm, and a small reduction in the VASP from 39 mm to 35.5 mm.

The strongest response to live stories (SL) was seen in PC2s VASA and VASP, with zero scores following baselines of 10 mm and 7 mm, and also PC13, with a baseline VASA 14 mm scored at zero at the subsequent two time points. This is the ultimate desirable outcome for any intervention (see Figure 54). From a moderate baseline VASP of 43 mm, a CS fall in pain was reported in the second and third scales, at 23 mm and 21.5 mm. The SL also had initial and residual CS anxiolytic effects on S5, with the "anxious" baseline VASA of 53 mm responding by falling to 12 mm, and then further to 5 mm.

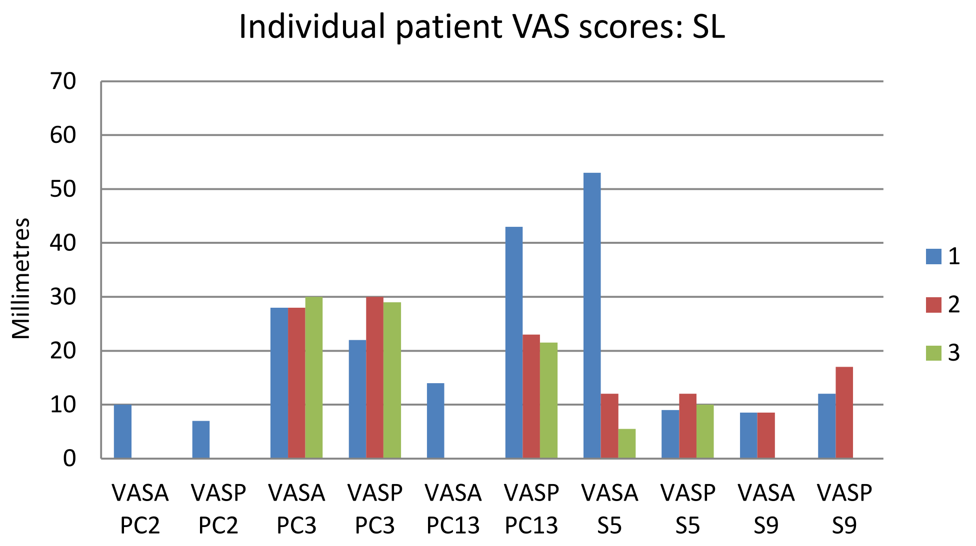

Figure 54. Patient raw VAS scores for SL

The other two patients in this group had either little change or slight increases in their VAS scores. PC3's three VASA readings of 28 mm, 28 mm and 30 mm

were stable, and her VASP similarly showed only small changes, from 22 mm to 30 mm, and settling on 29 mm. With the last set of VAS scales not scored by S9, baseline and initial VASA were both marked at 8.5 mm, and VASP scores were 12 mm and 17 mm.

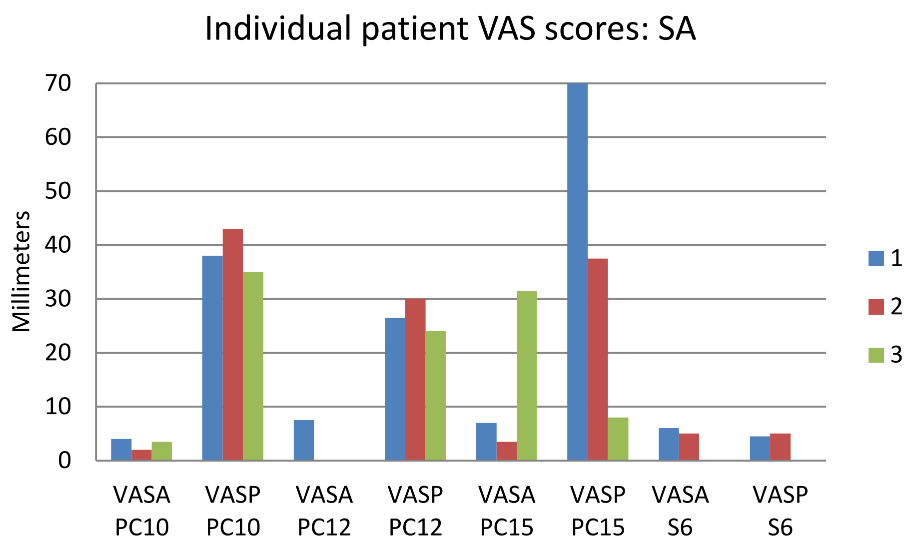

Figure 55. Patient raw VAS scores for SA

The final group of patients (see Figure 55) responded inconsistently to the recorded stories (SA). A CS analgesic response was seen in PC15, with her baseline 70 mm VASP rating, considered as severe pain (Kelly, 2001), nearly halving initially to 37.5 mm, and then still further to a final rating of a mild 8 mm. However, her reported final VASA increased to 31.5 mm, after an initial fall from baseline of 7 mm to 3.5 mm.

Both PC10 and PC12 showed small initial increases in their VASP before settling below their baseline scores (PC10: 38 mm, 43 mm and 35 mm; PC12: 26 mm, 30 mm and 24 mm). VASA for PC12 demonstrated an anxiolytic trend, scoring zeros for the second and third ratings after a low baseline of 7.5 mm. PC10 scored fairly stable VASAs of 4 mm, 2 mm and 3.5 mm. S6, with only the first two VASs scored, also showed little change, with VASA scored at 6 mm and 5 mm, and the VASP at 4.5 mm and 5 mm.

VAS individual case results and modes of presentation: patients

An additional way to evaluate and understand the patient cohort VAS results is to compare individual cases across the modes of presentation: contrasting the ML, MAV and MA responses of the three patients that heard the same musician, and similarly the SL and SA scores of pairs of patients who listened to the same readers. As all the individual VAS scores have already been reported, comments here are focussed on obvious trends in the direction of the VAS changes according to the mode of presentation. Musicians 3 and 4 are not represented in graphs as they did not have listeners in the recorded modes. Similarly, reader 5 was only heard live.

The most obvious difference in the patients' responses to the three modes of music presentation was the over 100% increase in the third VASA score for the patient in the MAV condition (see Figure 56). The same patient, PC9, did show a residual analgesic response to the violin music, with the third VASP score remaining below the baseline. The other two patients, in the ML and MA conditions, had little change in their VAS scores.

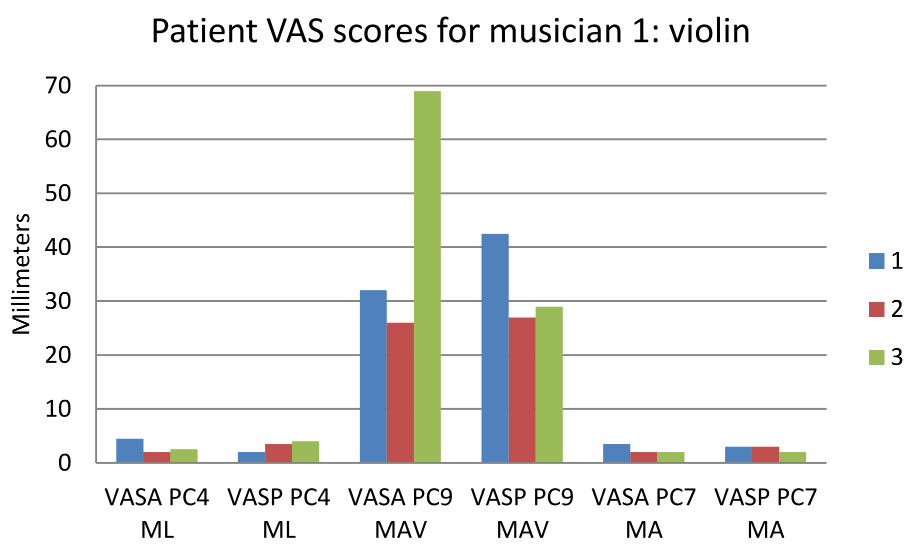

Figure 56. Patient raw VAS scores for musician 1

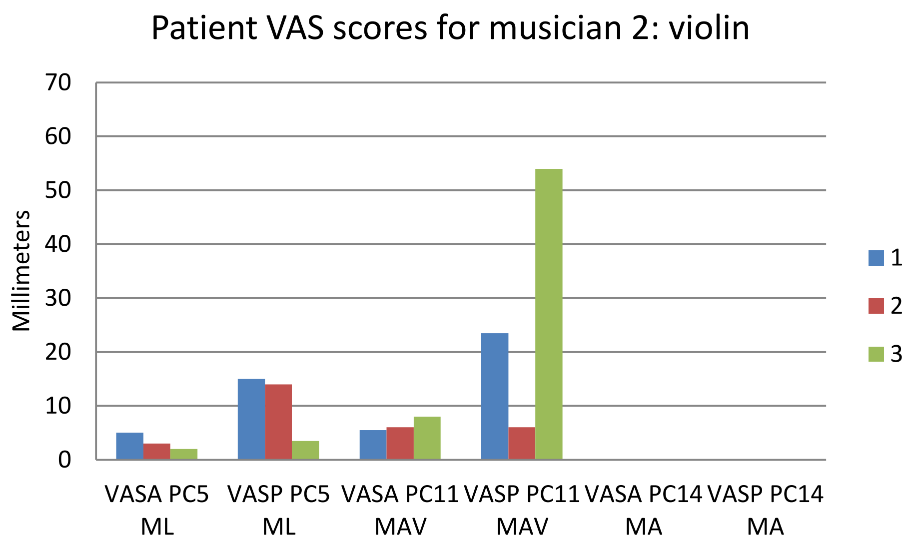

Figure 57. Patient raw VAS scores for musician 2

The MA listener for musician 2, PC14, scored zero on all VAS scales so cannot be used as a comparison here (see Figure 57). As noted for musician 1, the MAV listener for musician 2, PC11, similarly scored over 100% higher in a third VAS, in this case for pain. The same patient also reported only slight increasing anxiety in the second and third VASA. In contrast, the VAS scores for PC5, who had the live music, decreased in both the second and third measures.

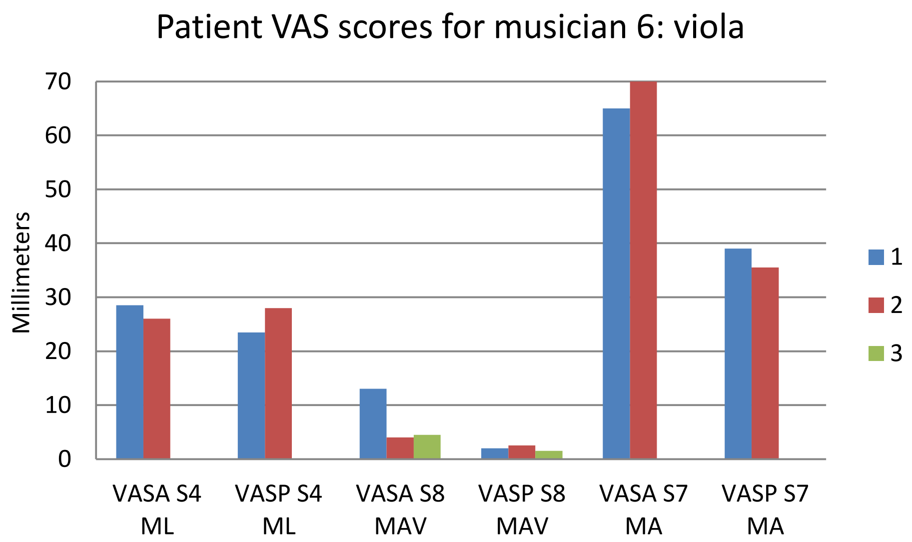

Figure 58. Patient raw VAS scores for musician 6

There is an incomplete data set for the three patients who listened to the viola player (musician 6), with both S4 (ML) and S7 (MA) not completing their third VAS scales. The scales that are shown in Figure 58 had no marked differences in VAS scores from baseline to immediately after the music, or for the third measure in the case of the MAV listener, S8.

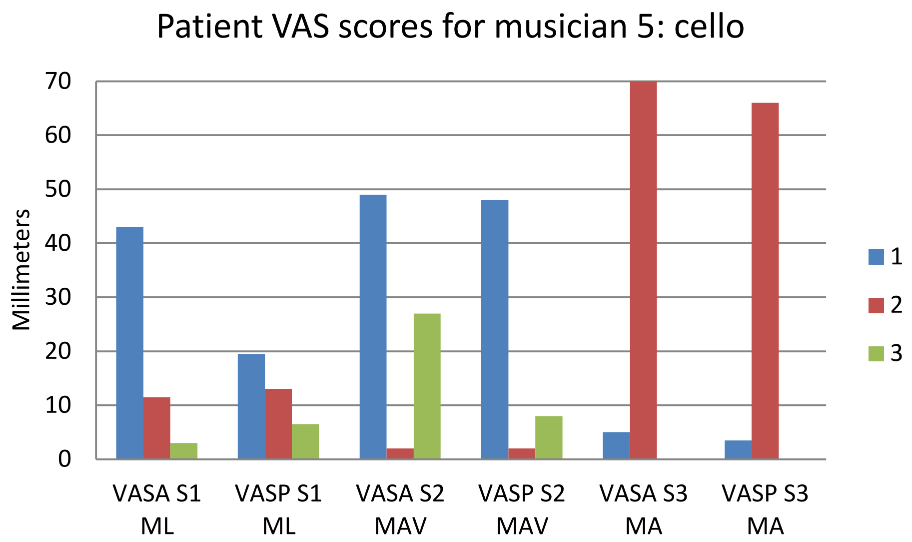

Figure 59**.** Patient raw VAS scores for musician 5

Self-reported pain and anxiety fell below baseline in all the VAS scales for both the ML and MAV patients who listened to the cellist (musician 5, see Figure 59). In sharp contrast, patient S3, who heard the MA, reported CS anxiety and pain immediately after the intervention, after starting with only minimal levels of symptoms. Again, this was the patient who was explicit in his dislike of classical music. No third VASs were completed by S3 due to lack of time before surgery.

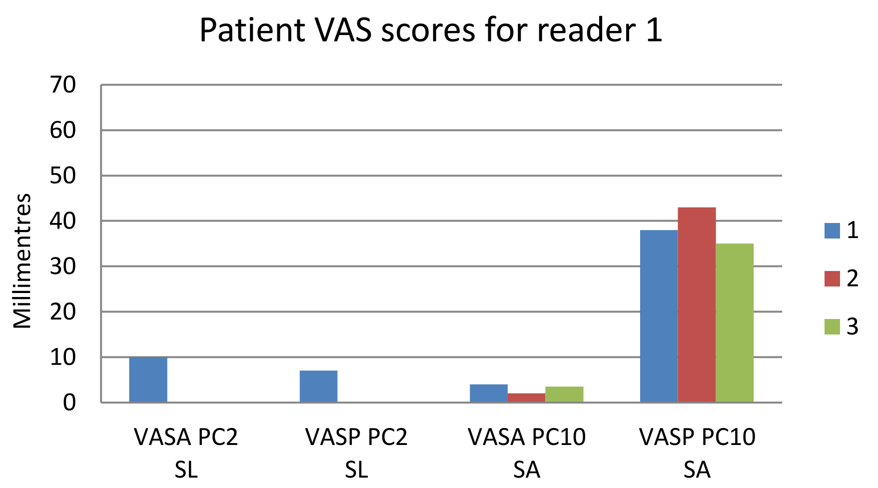

Figure 60. Patient raw VAS scores for reader 1

After listening to reader 1 the SL listener, PC2, scored zero for both the final scales, having missed the middle scoring (see Figure 60). In contrast, there was little difference in the three VASA scores of PC10 who heard the audio stories, although there was an observable residual effect for both the VASA and VASP.

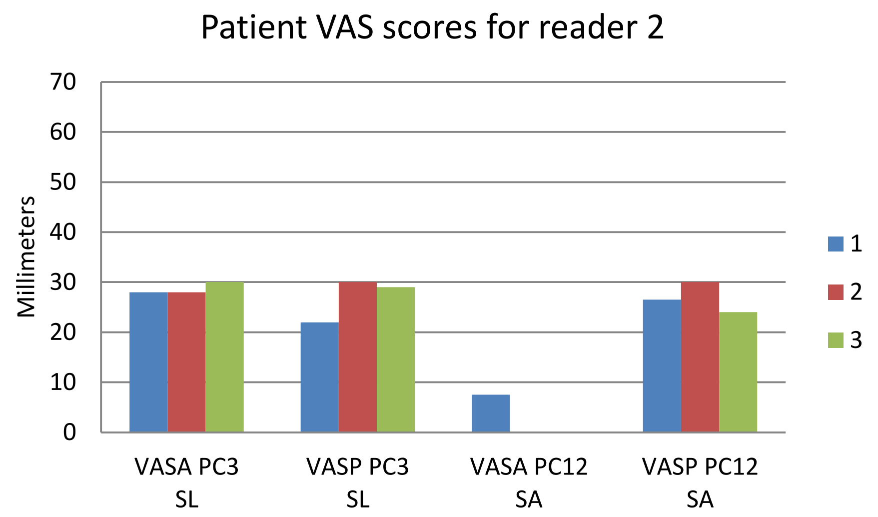

Figure 61. Patient raw VAS scores for reader 2

The listener pair for reader 2 (see Figure 61) had mixed results for their VAS scores. PC3 had slight increases in VAS scores after listening to the live stories, whilst PC12 reported zero anxiety after the recorded stories. Her VASP scores rose a little initially but settled below baseline.

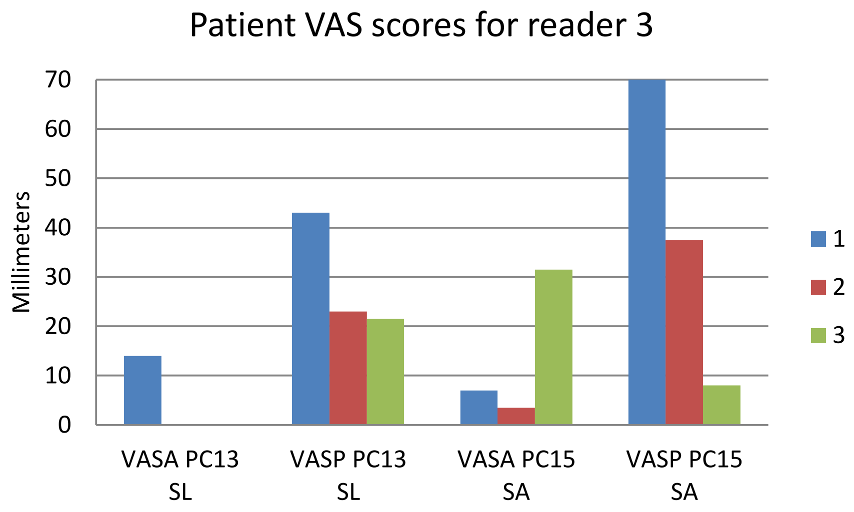

Figure 62. Patient raw VAS scores for reader 3

Participant PC13 scored zero for both VASA scales after the live stories read by reader 3 (see Figure 62), which is the ultimate desired and CS effect for an intervention. The same patient also indicated the intervention had an analgesic effect, scoring around half the baseline levels in the subsequent two VASP scales. A 50% reduction in pain from pre- to post-intervention is considered to be CS for pharmacological treatments (Hartford et al., 2008).

A clear and CS anxiolytic effect was observed in the VASA scores of S5, who listened to a live reading by reader 4 (see Figure 63). There was little variation in her VASP scores, with a slight increase observable over the three time points. The SA listener in this pair, S6, showed minimal variation from baseline in both VASs, for which the third rating was not completed.

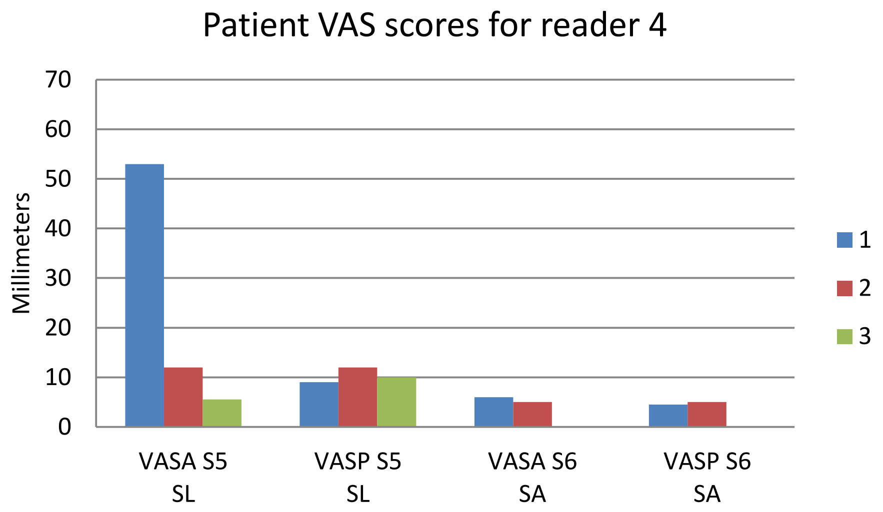

Figure 63. Patient raw VAS scores for reader 4

VAS: which patients benefited most from the interventions?

As is apparent from the reporting of the patients' VAS scores, not all benefited from the interventions in terms of reduced anxiety and/or pain. Two factors appear to be of importance in determining the efficacy of the interventions: the initial baseline reported anxiety or pain levels (Breivik et al., 2008) and the nature of the intervention received.

Looking at anxiety first, the patients' VASA scores, as seen in Figure 64, illustrate the effect of higher baseline anxiety on greater apparent benefits from the interventions. And these benefits were more apparent in the live interventions. All five ML patients reported lower than baseline anxiety in their subsequent VASA scores, with the largest anxiolytic effect seen in S1, who started with the highest VASA score. Responses of the MAV listeners were mixed, but again the patient with the highest initial VASA, S2, reported the strongest anxiolytic effect. This was not the case for MA listeners: even S7, with a baseline VASA of 65 mm, clearly in the anxious range, had a higher VASA score after the intervention. The SL listener S5 also scored the baseline VASA to indicate anxiety, which changed with a definitive CS relaxation response to the live intervention. In contrast, the second SL patient, S9, had stable low VASA scores before and after the stories. The SA group all started with low baseline VASA scores and demonstrated mixed responses to the audio stories.

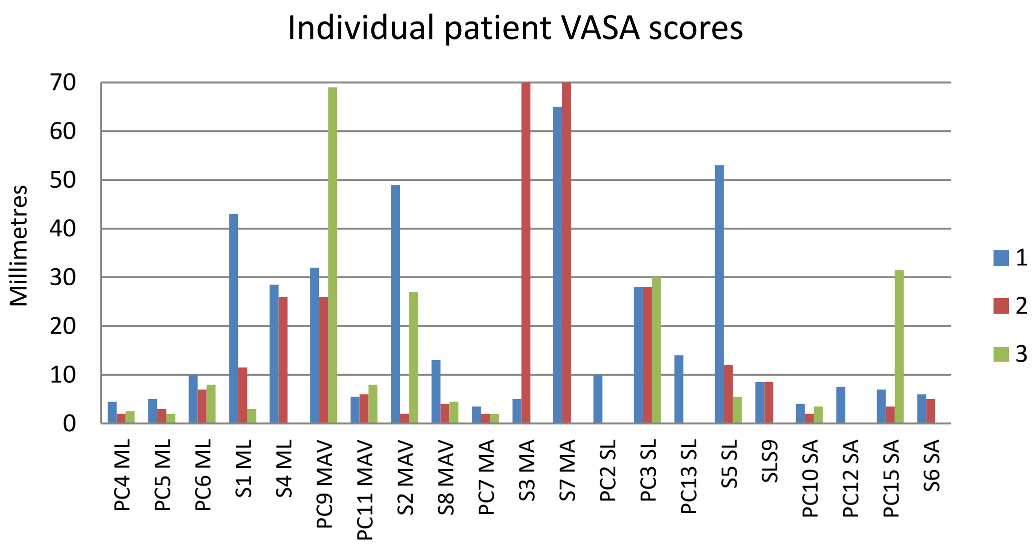

Figure 64. All patient individual raw VASA scores

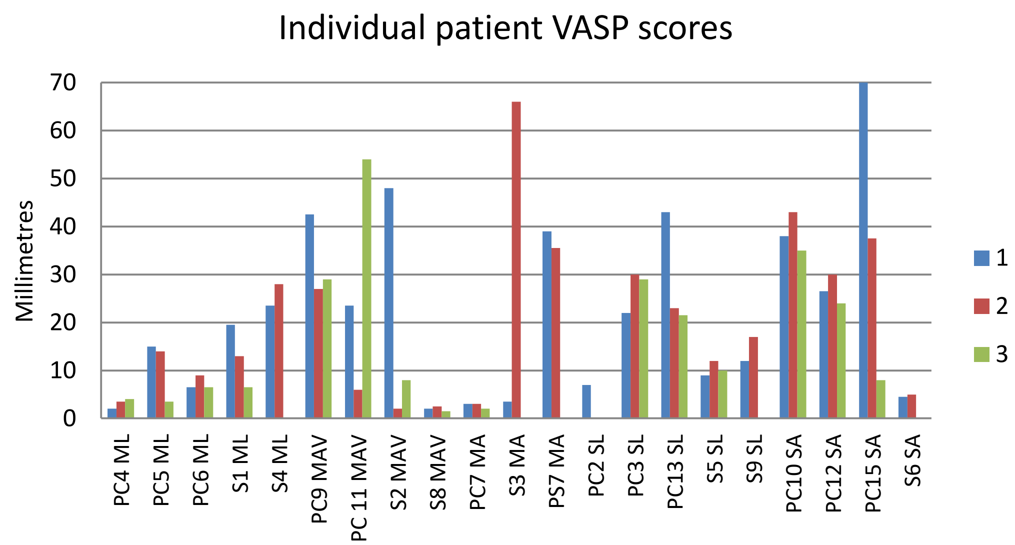

Figure 65. All patient individual raw VASP scores

Similar trends can be seen in the graph of the patients' VASP scores (Figure 65). Two of the three ML patients with the highest baseline VASP scores (PC5 and S1), even though these were in the mild range, reported benefits in terms of lowered pain levels in their subsequent scores. However, S4, with a baseline in a similar range, did not report a reduction in pain after the live music. The moderating effect of baseline pain levels is clearer in the MAV group. Both PC9 and S2 scored in the moderate range for their baseline VASP, and subsequently

reported low levels of pain. However, PC11, with a baseline VASP in the mild range, initially benefitted with a reduction in reported pain, but then rebounded to over double the initial VASP score. The only MA patient to report reduced pain, and only a small change, was PC7 who started with the highest baseline VASP, again in the moderate range. The graphs also clearly illustrate the moderating effect of high baseline pain levels in those who listened to stories, with only PC13 (SL) and PC15 (SA) scoring CS reductions on their VASP scales.

VAS: general discussion

It became apparent during data collection that some participants, especially clinical participants, were confused by the endpoints of the VAS scales, treating the actual faces rather than the ends of the lines as the extremes of the scales (see Figure 66). However, as the endpoint marked referred to no pain it was assumed that their intention was to score zero.

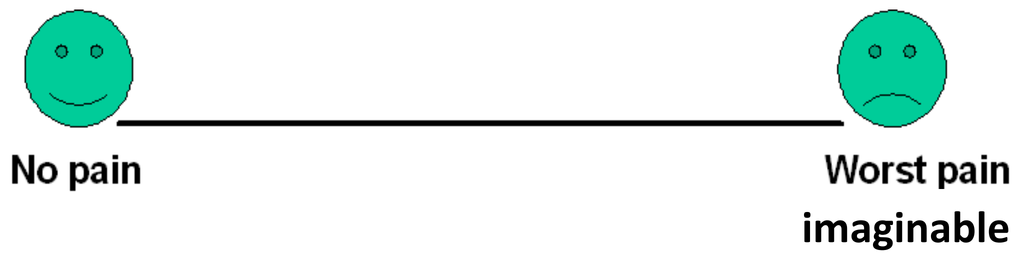

Figure 66. Visual analogue scale – pain

For the purposes of this research, the VASA and VASP were easy and fast to administer, and provided important self-report data to analyse, as well as to compare and contrast with other subjective and objective measures.

Self-report affect scales

It is important to again be reminded that each live presentation was repeated as recordings, meaning they were identical except for the manner in which they were presented to the listener. So the expectation could be that each presenter would be rated equally for their expressiveness or how much the listener liked their rendition of a piece of music or prose regardless of whether the listener

heard them live or as a recording. However, the graphs tell a different story (see Figure 67 and Figure 68, and group mean scores numerically in Table 16).

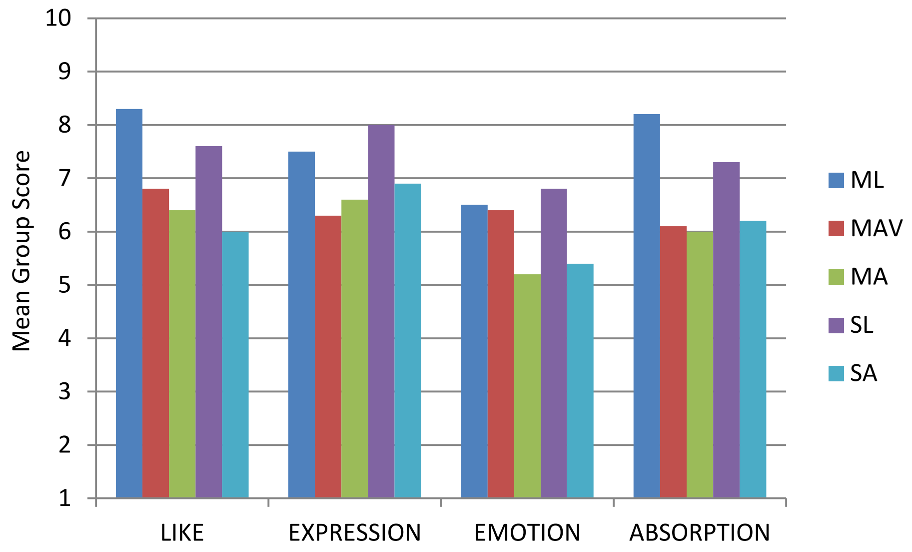

Figure 67. Mean group scores on affect scales: students

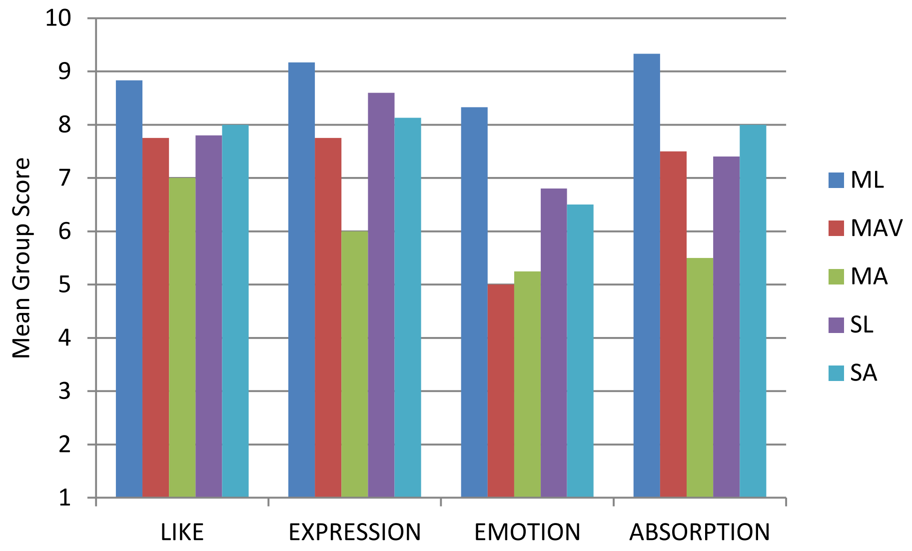

Figure 68. Mean group scores on affect scales: patients

Immediately after they heard the music or stories, participants were asked to mark the 10-point scales in response to how much they liked the music or stories, how expressive the presentation was, how much emotion they felt, and how absorbed they were. With both the student participants and the hospital patients, the live conditions were rated highest on all four scales, with the

exception of the liking and absorption scales with stories for patients. Students rated ML highest for the liking and absorption scale, and second for the emotion scales, whilst rating SL highest for the emotion scales and second for the liking and absorption scales. Patients rated ML highest on all the scales, with SL rating second highest on all but the absorption scale.

To summarise, visually the graphs show differences between the scores for ML and MA on all four scales in both cohorts, with ML scored consistently higher. Students liked the ML most and were most engaged (absorbed) with the ML, but found the SL most expressive and also felt most emotion with SL. Patients were more consistent, with the ML scored highest on all four scales, and SL scored second highest for both emotion scales. However, patients reported feeling more engaged with SA than SL, and also the liking scale scored slightly higher for SA than for SL. Possible explanations for these differential results are canvassed in the later section comparing all the outcome measures.

Table 16. *Affect Scales: Mean Group Scores out of 10, with SD in Parentheses*

		Student Affect Scale Results			
	n	LIKING	EXPRESSION	EMOTION	ABSORPTION
ML	10	8.3 (1.42)	7.5 (2.17)	6.5 (2.46)	8.2 (1.48)
MAV	10	6.8 (2.74)	6.3 (2.50)	6.4 (2.41)	6.1 (2.73)
MA	10	6.4 (2.41)	6.6 (2.27)	5.2 (2.10)	6.0 (2.26)
SL	10	7.6 (1.71)	8.0 (2.75)	6.8 (1.62)	7.3 (2.00)
SA	10	6.5 (0.97)	6.9 (1.79)	5.4 (1.26)	6.2 (1.03)
		Patient Affect Scale Results			
	n	LIKING	EXPRESSION	EMOTION	ABSORPTION
ML	6	8.8 (1.5)	9.2 (1.3)	8.3 (2.1)	9.3 (1.0)
MAV	4	7.7 (1.5)	7.7 (1.0)	5.0 (2.2)	7.5 (1.3)
MA	4	7.0 (3.8)	6.0 (3.4)	5.2 (3.8)	5.5 (3.7)
SL	5	7.8 (1.5)	8.6 (2.6)	6.8 (1.9)	7.4 (2.4)
SA	4	8.0 (1.6)	8.1 (1.4)	6.5 (1.3)	8.0 (2.2)

Affect scales comparisons: music versus stories

Briefly, as seen in Figure 69 and Figure 70, there was little difference in the affect scales when comparing music to stories. The comparison was made by combining all the music group means (ML, MAV and MA) and then contrasting them to the combined stories results (SL and SA). One obvious difference was that patients scored stories higher on all four scales, in particular the two emotion scales, and students scored stories higher for perceived emotion (expression).

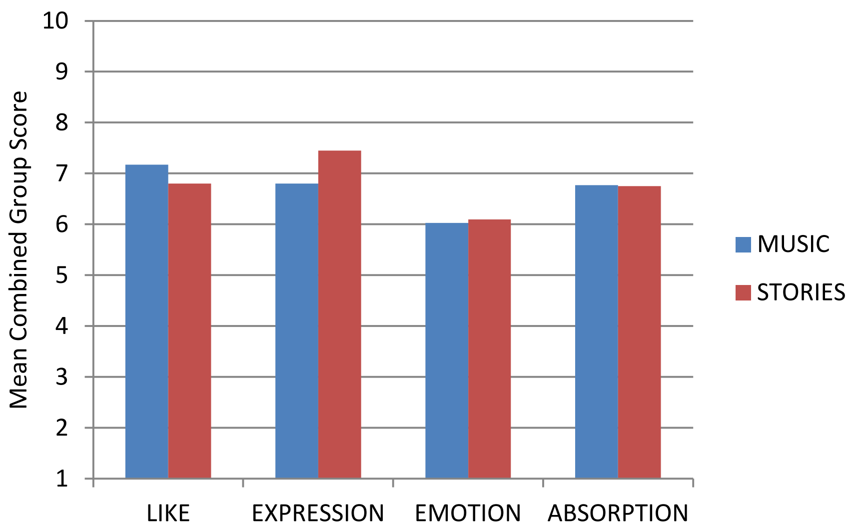

Figure 69. Affect scales students: music versus stories

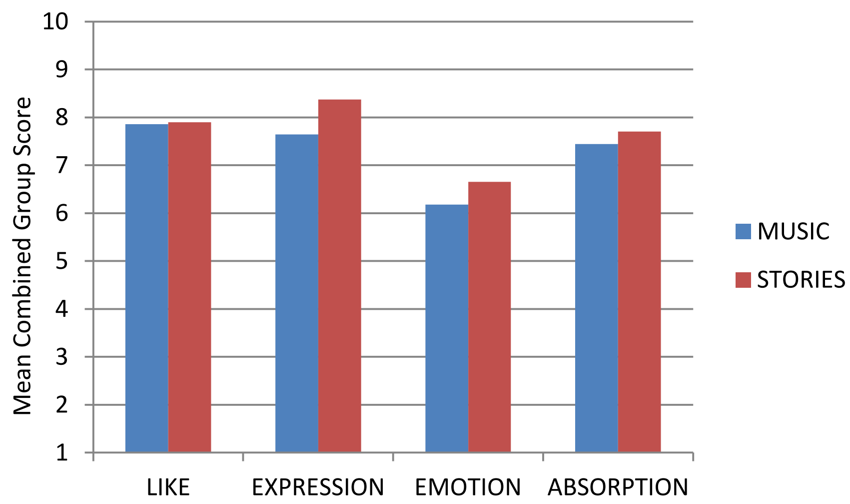

Figure 70. Affect scales patients: music versus stories

Affect scales comparisons: live versus audio

A clearer difference is seen in Figure 71 and Figure 72 when comparing responses to live (ML plus SL) and audio (MA plus SA) presentations. For both cohorts across all four scales the live conditions were scored higher than the audio equivalents. This consistent trend indicated a positive effect of some sort from presenting music or stories live rather than as audio recordings.

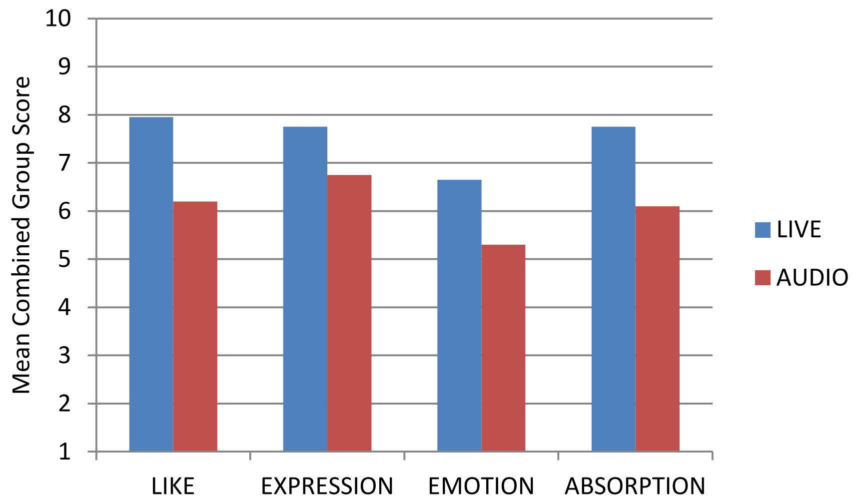

Figure 71. Affect scales students: live versus audio

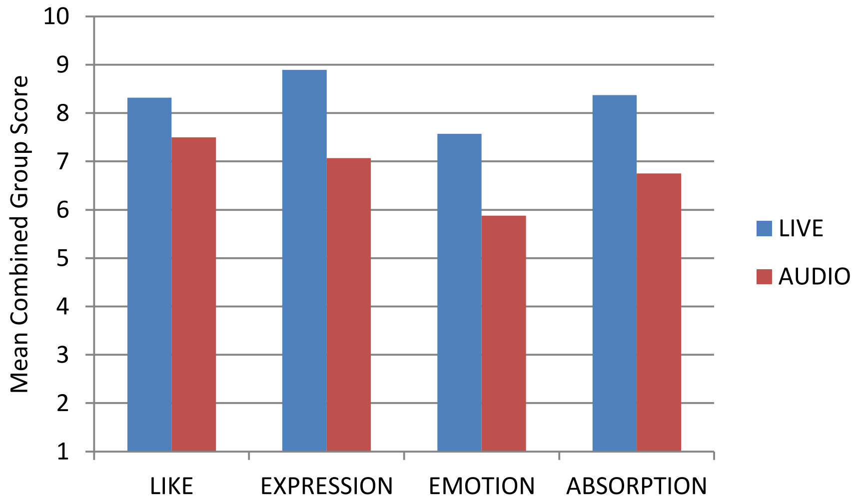

Figure 72. Affect scales patients: live versus audio

One-word responses

As soon as the listening component of each intervention was completed, the participant was asked to sum up in one word his or her experience of listening to the music or stories. These elicited responses proved enlightening. Looking horizontally along Table 17, a distinction emerges between the modes of presentation of the same musician. Where all the student responses to ML could be considered as positive adjectives, such as "soothing", "relaxing" and "uplifting", the words chosen in response to MAV and MA were more mixed, and included negative adjectives such as "grating", "painful", "wincing" and "annoying". In contrast, responses from patients to the music were more consistent (see Table 19), with positive words elicited by all modes of presentation, apart from the one patient who disliked classical music and described the MA as "punishment".

Table 17. *One-Word Summary of Student Listening Experience: Music*

Musician	Instrument	Live	Audiovisual	Audio
1	violin	soothing	relaxing	wincing
1	violin	engaging	repetitive	relaxing
1	violin	ballet/dance	grating	painful
2	viola	engaging	relaxing	relaxing
3	cello	relaxing	painful	relaxing
3	cello	relaxing	lovely	ordinary
4	cello	relaxing	long	pleasant
5	cello	relaxing	uncomfortable	sad
5	cello	relaxing	relaxing	annoying
6	cello	relaxing	different	beautiful

Both students and patients gave positive one-word responses to stories, regardless of whether they heard SL or SA (see Table 18 and Table 20). The contrast in responses was more related to whether the words were cognitive or emotional/physiological in nature. Students used more cognitive descriptors of their response to SL, such as "interesting", "insightful", or "creative", whilst the words following SA were mostly related to their physiological or emotional state: "relaxing", "calming" and "peaceful". Similarly, patients responded to SA with emotional or physiological descriptions of their experiences, such as

“relaxing”, “peaceful” and “enjoyable”, but more evaluative words such as “nice”, “awesome”, “light and joy”, “amazing”, and “pleasant” after SL.

Table 18. *One-Word Summary of Student Listening Experience: Stories*

Reader	Live	Audio
1	evocative	relaxing
2	interesting	calming
2	delightful	relaxing
3	creative	calming
4	insightful	relaxing
4	relaxed	interesting
5	relaxing	relaxing
6	enjoyable	relaxing
7	interesting	relaxing
8	calming	peaceful

Table 19. *One-Word Summary of Patient Listening Experience: Music*

Musician	Instrument	Site	Live	Audiovisual	Audio
1	violin	PCU	x	x	x
2	violin	PCU	uplifting	tranquil	peaceful
3	violin	PCU	sublime	serenity	beautiful
4	violin	PCU	exhilarating	x	x
5	violin	PCU	absolutely bliss	x	x
6	cello	SURG	calming	very relaxed	punishment
7	viola	SURG	very pleasant	relaxing	nothing

Table 20. *One-Word Summary of Patient Listening Experience: Stories*

Reader	Site	Live	Audio
1	PCU	nice	peaceful
2	PCU	awesome	relaxing
4	PCU	light and joy	enjoyable
3	SURG	amazing	very relaxing
5	SURG	pleasant	x

Overall, stories evoked positive and more cognitive responses (e.g., "interesting", "insightful", and "evocative") in particular after SL, whereas music elicited more emotional and physiological responses (e.g., "relaxing", "soothing", and "uplifting"), as well as negative responses after the MAV and MA (e.g., "grating", "wincing", and "repetitive"). A similar distinction between music and stories emerged in additional remarks made by some of the participants.

Spontaneous qualitative responses

A number of students (*n* = 17) and patients (*n* = 11) offered unsolicited comments about their experiences as participants in the study. These were immediately recorded in writing by the researcher. One surgical patient (S1) even wrote down her own thoughts whilst the researcher was out of the room. Certain themes emerged from the unexpected but insightful contributions. The first cluster of themes presented is around how the music or stories affected the listener, such as triggering memories, flow experiences, and emotional responses. The second group of themes covers the processes which stimulated these responses, including entrainment, aesthetics, cognitive factors, and the live listening experience. The final set of themes addresses some of the negative experiences that the listeners reported, such as physical discomfort, the length of the interventions, and the quality of the musicianship.

How did the music or stories affect the listener?

Participants provided candid insight into how they experienced the sessions of listening to music or stories. They spoke of memories, gratitude, immersion in the moment, and physiological, emotional, and even existential responses.

Familiarity, memories, comfort

Familiarity with the music or instrument prompted comments from several students and patients. A 46 year old female student (U20) said, "I enjoyed the ones I recognised more", after a ML experience with a cellist, whilst a 76 year old patient (PC6) appeared delighted when he exclaimed, "I know that one!" during the ML program. He later added that the musical offering brought back "memories of my uncle who used to play the violin." Another male patient

(PC14) also recalled, “My father played violin, but he never taught me.” The MA triggered both positive memories and regret for the 59 year old.

Stories also sparked memories. A 64 year old female student (U31) commented after SL, “It all had strong anchors for me.” A 56 year old patient (PC10) simply stated the SA “brought back memories” for him, whilst a 36 year old patient (PC12) spoke of the “comfort of listening to others tell a story”. She went on to explain she felt like “a little girl listening to stories” during the SA.

Cocoon, transport, transformation, flow

Some listeners described flow-like experiences, such as being unaware of their immediate surroundings, or being transported to other physical or emotional spaces. One 76 year old patient (PC5) described her ML experience: “I was just not in this room here. I don’t know where I was.” She later added, “I was just lost….just lost in that.” A 26 year old female student (U5) told the researcher, after watching the MAV, “I completely forgot you were sitting there.” A case of emotional transportation was eloquently related by a 45 year old female student (U10) after ML: “I felt like I was on an emotional journey, that I was carried along emotionally by the different pieces.”

The same listener specifically described her focus drifting away from the performance into her own thoughts, creating an internal cocooned space and a type of meditative state where thoughts were allowed to flow: “….drifting away from the performer into my own world.” A similar statement came from another ML listener: “…..find myself with my thoughts just drifting” (46 year old female student, U20).

For some participants the MAV felt like a live performance. MAV student participants watched the videos on a laptop, sitting in the same position in the same room as the ML listener when the recording was made. This prompted the comment from a 26 year old student (U5) that she “felt I was there, maybe because the picture was in the same room.” Others commented, “I felt like I was disrespectful when I looked away – as it felt like the performer was actually present” (26 year old male student, U16), and, “I feel like I should clap” (27 year old female student, U22).

There were also descriptions of transformative experiences. The following two quotes are from female PC patients who listened to stories. The first, an 80

year old (PC13), said after the SL, “Everything else stopped. It’s like having a dreadful toothache and then having the dentist pull it out and you feel at peace.” The second, a much younger 36 year old who was struggling with coming to terms with her terminal condition (PC12), described a feeling of “distancing” from her own state of fatigue and illness. “The sick me is over there, and the listening me is here” she said, after listening to SA.

Physiological responses

Several participants were aware of how the music impacted on them physiologically. One student noticed that the slower pieces increased his saliva production (26 years old U16, MAV), whilst a surgical patient reported she experienced musical chills (43 year old S1, ML). Some of the PC patients had additional sessions with the researcher, who played violin for them and shared further conversations. One such patient, the 80 year old lady who had previously participated as a SL listener (PC13), beautifully described her musical chills after hearing the live violin music, as it “gives enough goosebumps to fill a pillowcase!”

Emotional release

Three reactions from patients illustrate the emotional effects of live music and stories. The first is an observation by the researcher that the surgical patient who described musical chills also became teary during two of the cello pieces, Saints-Saens’ *Swan,* and Bach’s *Arioso* (S1). A female patient (52 year old PC4) characterised her response to the ML simply as, “It was uplifting.” After listening to SL, 80 year old PC13 recounted, “I felt 100% emotion — so much peace — so much enjoyment.”

Soporific, comforting, therapeutic

A number of the spontaneous offerings described relaxation responses. “You can send me to sleep anytime,” and “you are sending me to sleep young lady!” were comments addressed to the violinist playing for an 84 year old female patient (PC8). After the MAV finished, another female patient (68 year old PC9) responded with, “That was so nice, I could almost go to sleep.” Similarly, listening to SA prompted a female patient to share, “I could have gone to sleep,” (65 year old S6).

The therapeutic benefits of music were recognised in remarks by two patients. A 49 year old patient (S2) spoke of "falling asleep", feeling "warm and comfortable," and that the MAV was "therapeutic". The 59 year old patient PC14 recommended "a good dose, to have 10 or 15 minutes of this every day!" When asked after the MA, "Are you feeling any anxiety?" he replied, "Absolutely not, with the music so fantastic!"

Gratitude, inspiration

Many participants spoke directly about their sense of gratitude for the musicians and readers, and the experiences in general, as well as feeling inspired by the musical performances. The 52 year old patient PC4 expressed her gratitude for the ML in a number of comments: "That was wonderful! I really appreciate that." "What a privilege, what a gift." "I can't wait to tell my daughter. It's made my day." Another female patient also spoke of privilege whilst listening to ML: "Lovely – I am very privileged" (76 year old PC5). After listening to SL, a 77 year old female patient (S5) shared, "I loved it, the best thing that could have happened!" Another female patient (68 year old PC9) interjected during the MAV presentation with, "Well done young lady! . . . I feel like clapping!"

Remarks made by some of those who listened to, and also saw the music being played, indicated they felt inspired by the performances. "That makes me want to pick up a violin and see if I can do it!" said a 23 year old student (U23) after his MAV intervention. And 84 years old PC8 commented, "My fingers wanted to move… wanted to play along," after she heard ML.

Existential

Whether waiting for surgery or contemplating their life-limiting illnesses, patients faced existential issues. Music in particular stimulated reflections around life and death matters, and even a life changing epiphany.

From general conversations prior to the ML intervention, 43 year old surgical patient S1 appeared anxious, her speech rapid, with the focus of her conversation on things that had gone wrong in previous treatments. After she heard the cellist play she appeared calmer, more positive and more reflective, although still loquacious. She described the experience as "life changing. It feels literally like your life is in front of you … I feel like everything is going to be ok!"

She went on to explain, “It made me feel like I need to stop and take stock of – there are things in my life that I need to take stock of and change.” Then, whilst the researcher was out of the room, she wrote down more of her thoughts, which appeared to be an anthology of relevant quotes that she recalled. “Yes you came from other worlds, and in music you can experience…. because when I could not speak, you gave me words…. It is the use of creativity which heals the creative wound …. no one can make you feel inferior without you [sic] consent.” When asked, “Was it like an epiphany?” she replied, “Yes, definitely!”

The 36 year old patient PC12, who had additional sessions with the researcher, explained that music — whether live or recorded — helped her connect with her emotions and her deep sense of loss. After hearing the violin playing, she described how the music “makes me feel whole again” and facilitates “reconciling myself with myself”.

The wisdom of age was heard in the statement of 80 year old PC12 during a live music session with the researcher: “There is something in my years of living and your years of playing that touch each other,” she reflected.

What processes were involved?

Some of the remarks offered by participants provide insight into possible processes that contributed to their experiences of the music and stories.

Entrainment

Entrainment to the music or musician can be rhythmical or emotional. However, a dissonance can arise between perceived emotions, as observed in the movements and behaviour of the musician, and the emotions felt by the listener directly in response to the music. One 45 year old student (U10) described her ML experience as “intently observing….and reacting to *her* emotional responses, like a smile, which didn’t always match my emotional response.”

Aesthetics

Patients responded to the aesthetics of the music they heard: “It was just beautiful,” (female 76 years old PC5, ML); “that’s beautiful,” (male 76 years old PC6, ML); “it was beautiful,” (female 73 years old PC7, MA); and “thank you, that

was beautiful," (female 81 years old S4, ML). Stories did not trigger such comments.

Cognitive

However, stories did stimulate reflections on the cognitive processes of listening. "When I listen to music I don't really have to listen to the lyrics, but I really had to concentrate and listen to the stories," offered 20 year old student U32 after she heard SL. Another student (23 year old U39) believed the SA were "interesting [in the] type of language used to express the topics [and] similes and comparisons they use." His comments are evidence of analytical listening. And a 20 year old student (U35) described the SL as "insightful, because I've watched the *Wind in the Willows* but never actually heard the story." Listening to the story gave more meaning to her prior experiences, and her earlier viewing of the film coloured her current responses.

Listening to SL appeared to stimulate and organise cognitive processes for 80 year old PC13. Immediately before the stories she was finding it hard to find words during a conversation. This had not been evident in earlier chats with her. After listening to the stories being read she was back to her eloquent lucid self.

Listeners with some musical knowledge may also reflect analytical processing in their comments, such as PC13 who described Bach's *Prelude* as "the journey of indecision" after the researcher played it for her.

Live experience

The same patient (PC13) was clear in her opinion regarding the superiority of live music. "There is nothing like the actual music being created in front of you. It is so personal." And of recorded music she offered: "Mass production – can't have worth anymore." Her spontaneous response after her SL reading was similar in its sentiments. She effused, "It was glorious!" [There is] no comparison: the closeness, sharing and warmth [of the live experience]."

Another patient (PC6) described the tangible emotion of the ML performer "as if she was living it" (76 year old male).

Surrender

Earlier comments made by participants regarding drifting off, falling asleep, feeling peaceful, and being unaware of their immediate surroundings, are all indicative of letting go and surrendering to the musical or story reading experience. Others spoke of, or showed signs of, emotional surrender, succumbing to the emotions evoked whilst listening, as for example the 43 year old surgical patient, S1, who became teary during the ML session.

Distraction of visual component

Whilst for some participants the visual component in ML, MAV and SL enhanced their appreciation of the presentation, others spoke of the distraction of seeing the presenter whilst listening to them. Quoted earlier, 45 year old student U10 spoke of reacting to the live musician's emotional expressions which were not necessarily the same as what she herself was feeling. Another student who listened and watched ML, 46 year old U20, described how for her "the performer's appearance was dissociated from the music — he didn't appear to be enjoying it as much as I was". Similarly, a 48 year old student (U7) commented that she preferred listening to audio music as she found the visual aspect of ML arousing and distracting from the musical experience. A 26 year old male student (U16) explained after MAV, "I'm the type of person who visualises things when I listen to music, [for example] TV shows, fantasies or stories I am imagining in my own mind."

Visualisation

For those preferring to visualise for themselves, the ML or MAV was a distraction; but visualisation could enhance the MA experience for others. One 73 year old patient (PC7), who thought she was listening to a viola in addition to the violin, said "I could imagine them, maybe on a small stage." She spoke about how visualisation of the performer brought the MA recording to life.

Did listeners report any negative experiences?

Music is not automatically a positive experience for everyone and in every context. The reasons for listening, whether it is by choice or imposed, the physical environment and how it impacts on bodily comfort, and so forth, can all

impact on the listener. For the students in particular, the physical environment and circumstances for listening were artificially created and not optimum for comfort.

Physical discomfort

Several students said they would have preferred to recline, like the 33 year old (U8) who explained she would have liked to lie down and rest during the MA rather than sit, which made her fidgety. Similar sentiments were expressed by another female student (46 year old U20) after ML: "I would have liked to just lie down". And 22 year old U15 said he "liked the [MAV] music, but my back was uncomfortable." The music itself led to physical symptoms for this same listener, causing "sharp pain in my head with high notes".

Too long

The original length of the music intervention was around 25 minutes. Feedback from students after MAV, such as "I was wishing it to end" (53 year old female, U12), and another who said she really enjoyed the beginning but then it went on a long time (18 year old U13), provided grounds for reducing all the interventions for patients, as well as the stories for the students, to around 15 minutes. For optimum levels of engagement to take place, the ideal length of an intervention needs to be enough to facilitate measureable physiological change, but not so long that the listener disengages and the positive effects start to erode.

Ambivalence

Comments from some participants were a mix of positive and negative or even neutral evaluations. A 60 year old student (U27) who listened to MA started out saying she thought it was "annoying the way it stopped and started." She added it was "not my sort of music." On the other hand, her final point was: "but it was alright – nice to just sit." So despite the music not being ideal, she chose to be in the moment and take something positive from the musical experience. A surgical patient, who also listened to MA, put it this way: "I don't feel it was mood-altering. It didn't give me a buzz — it wasn't horrible and it wasn't brilliant" (44 year old male, S7).

Musicianship and quality of sound

Feedback from students, as seen also in the one-word responses, showed that they were aware of the less than ideal tonal quality of the recorded music. This may be due to the lower standard of technical ability of the student musicians — compared to the professionals who played for the patients — exacerbated by the basic recording and playback equipment used in this study. An example is a comment from 47 year old U26, who said she found the MAV was "grating on my nerves a little bit — the prolonged sound of the violin." Again there is a reference here to the length of the program. A solo violin can also be limited in its tonal colour and range over a lengthy period of time.

"Not my cup of tea"

The 60 year old student U27, quoted earlier, indicated this was not her sort of music, but she chose to just sit and be with it anyway. A 72 year old patient (S3) had stated his very strong preference for country music before the intervention, and quipped after listening to MA, "I feel sorry for Scott Joplin!" He then added that the classical music was "not my cup of tea!"

Summary of qualitative responses

The insight gained from individual reactions to the interventions was an unexpected bonus, and contributes to a deeper understanding of the common processes at play as well as personal variations. There are also some contrasts apparent between responses triggered by music and stories, as well as between live and recorded modes.

Familiarity with the music or instruments was an aid to memories, including recalling loved ones. Stories were comforting, eliciting memories of childhood. Music, in particular ML, induced flow experiences. Stories also were transformative, with several listeners sharing their feelings of disengaging from their physical or existential pain. Positive physiological reactions were described by two ML listeners. ML also elicited intense emotional reactions. Some SL listeners reported strong emotions too. Relaxation responses, such as nearly falling asleep, were mentioned following both music (ML and MAV) and stories (SA). Gratitude was also expressed by both music and story listeners, but

only where they could see the presenters (i.e., ML, MAV and SL). Powerful existential experiences were described only after listening to ML.

From comments offered it is apparent that the process of entrainment took listeners on emotional journeys. For some ML and MAV listeners this led to dissociations between perceived emotions, from the musicians' behaviour, and felt emotions, through the music. Others spoke of the visual component being a distraction in ML and MAV as they preferred to visualise their own creative images to bring the music to life. Music, but not stories, precipitated comments about beauty and aesthetics. Stories on the other hand were more likely to trigger cognitive processes, such as needing to concentrate, analytical listening, insightful thoughts, and even helping to reorganise thoughts.

Several students claimed they were uncomfortable sitting at a table during the long music program and would have preferred to lie down. One MAV listener (U26) also spoke of aural discomfort from the prolonged sound of the violin. Listeners of both ML and SL described the closeness, sharing, warmth and immediacy of the live experience. Live modes of presentation were also more likely to allow the listener to surrender to the moment, although even when not really liking the music itself a MA listener (U27) chose to be in the moment anyway.

The qualitative data presented add extra facets and hues to the kaleidoscope of quantitative outcomes that form the backbone of this study, and are a reminder of the personal and individual nature of participants' experiences. They also provide further opportunities to contrast, compare and reflect within both numerical results and the more narrative data, and across these two aspects of the data set.

Counterpoints and discussion

Data from a variety of outcome measures were described and also presented in graphs and tables in the results section. These measures include objective as well as subjective quantitative instruments supplemented by qualitative data. The benefits of multiple approaches to collecting data include a more comprehensive and multifaceted set of results, providing greater rigour to the study. The downside is the emergence of inconsistent or conflicting results that require careful consideration to identify why certain dissociations occurred, and to clarify what they are actually telling us in terms of the original hypotheses.

Aims at the outset of this study were to compare live to recorded music, and to measure the outcomes of anxiety, pain and immune function using salivary biomarkers as well as self-reported anxiety and pain. Live and audio story readings (SL and SA) were added to control for the psychosocial factors inherent in providing the live, audiovisual and audio music interventions (ML, MAV and MA). Participants from the two cohorts of students and patients also completed four scales to evaluate aspects of emotions and engagement. Additional data was collected by asking each participant for one word to reflect their music or story experience.

The expectation was that ML would result in greater reduction in anxiety and pain, and more increases in markers indicating a robust immune response, than MAV and MA. It was also expected that overall music would precipitate more of these positive health outcomes than stories. Whilst aspects of the results did support the hypotheses, there were anomalies in some of the biomarker measurements and subjective data that conflicted with these anticipated outcomes. The following discussion both recapitulates and elaborates on the results. Its focus is comparing and contrasting the various measures to gain a deeper understanding of the psychoneuroendocrine (PNE) processes as well as the cognitive-emotional and biopsychosocial mechanisms inherent in listening to music or stories, be they live or recorded.

Comparisons between biomarkers

During the early planning stages of this study it became apparent that salivary biomarkers have idiosyncratic patterns of release as well as complex interactions that make interpretation of results anything but straightforward. Salivary biomarkers were carefully selected to provide specific measures of anxiety or stress as well as pain and immune function. Each of the five markers was chosen based on its link to particular aspects of the stress and immune systems, as shown in the comparative table of biomarkers (Table 1). A review of recent empirical understanding of the actions of these markers indicated they could exhibit differential responses to a music intervention (e.g., Gangrade 2012; Thoma et al., 2013). This was indeed the case in the current study. However, some biomarker outcomes also validate each other and clearly support the original hypotheses. Potential PNE mechanisms are discussed in this section as possible explanations for the results.

Stress markers

The two main stress markers measured indicate the activities of discrete stress-related systems: sC measures HPA activity whilst sAA is a marker of SAM processes of the ANS. These two systems have different time-courses of activation and release, as well as individual interactions and feed-back loops, which may cloud the interpretation of observed results (Engert et al., 2011).

The most notable difference between sC and sAA is their divergent diurnal rhythms, with sC falling throughout the day, after an initial peak in levels around 30 minutes after awakening, whilst sAA initially drops in levels, then increases through the day, peaking around late afternoon (Nater et al., 2007; Rohleder & Nater, 2009). Ideally saliva samples should be taken when markers are most stable; but when multiple markers are being measured from the same sample, collection times may not be optimum for all the markers.

Briefly, the patterns of sAA response were consistent with ML being more effective in reducing anxiety than MAV and MA, and music overall showing greater anxiolytic effect than stories. In contrast, sC levels indicated all interventions provided stress-relieving benefits, but stories had more beneficial impact than music. However, whilst a comparison of the students' live conditions of ML and SL to the audio MA and SA initially indicated only the

audio conditions reduced sC levels, the residual effect of the live interventions was equal to the audio by the third sample.

Unexpected sC outcomes in earlier studies could be due to methodological issues such as collection time, physiological interactions, or even underlying pathologies or other stressful events confounding the results (Gröschl, 2008). A rise in levels beyond the baseline observed at the students' third measurement of sAA in all conditions except ML may in part be explained by the natural diurnal rise expected in the late morning when samples were taken. The sC levels continued to fall in all conditions, consistent with the diurnal rhythm for that marker.

Another explanation may be that sAA responded to the arousing nature of the interventions (Katz & Peckins, 2017). A recent study comparing sC and sAA responses to *in vivo* music listening concluded that perceived arousal was indeed a factor, with increased sAA as arousal rose (Linnemann et al., 2016). SNS activity will increase with attention, irrespective of valence (Gordis et al., 2006). In order to comprehend them, stories require closer attention for the listener than music, which may partly explain the observed differential between stories and music, with sAA rising in levels at both measures after stories but falling initially after music before rebounding above baseline.

An additional interpretation for the observed rebound in sAA is that the levels of this marker oscillate beyond baseline as the two divisions of the ANS, the arousing SNS and the inhibiting PNS, effect their opposing forces towards homeostasis. As sAA is more immediate in its action than sC, this process of fluctuating levels can be observed in the relatively short time frame of the study protocol.

Very few studies measure the effects of relaxation rather than induced stress with sAA. One study did look at relaxation, measuring biomarkers of 25 female nursing students who were given a 10-minute back massage (Noto, Sato, Kudo, Kurata, & Hirota, 2005). Mean baseline levels of sAA (U/ml) were 60.5 (*SD* = 39.8), followed by lower immediate post-massage levels of 54.5 (*SD* = 38.7), but a rebound in levels 30 minutes later to 73.5 (*SD* = 57.6). Comparative levels were reported as not statistically significant, and the observed trend in the change of levels over time was not discussed. The authors only suggested that salivary biomarkers may clearly indicate changes induced by stress, but are

not as conclusive when assessing relaxation interventions. However, they also noted that biomarkers indicating immune system changes, such as the chromagranin-A measured in their study, may be more useful in research trying to establish benefits of psychosocial or psychophysiological interventions such as massage (Noto et al., 2005).

The slower acting sC does not demonstrate the oscillation observed in sAA. All five conditions had decreased levels of sC by the third samples, reflecting the more residual actions of the HPA axis compared to the SAM system indicated in the rebounding sAA results (Maruyama et al., 2012; Nater et al., 2005). The delayed beneficial effects of ML may have been more evident if a fourth saliva sample had been taken at a later time point. This is supported by Engert and her colleagues (2011) who established a lag of 13.5 minutes between sAA and sC peak responses to psychological stress. Of course, the response to relaxation interventions would be quantifiably different.

Earlier studies have reported the lack of correlation between sC and sAA (e.g., van Stegeren et al., 2008). In part this is due to sAA being sensitive to both emotional arousal as well as physical stressors, whilst sC is responsive to more challenging stress tasks (van Stegeren et al., 2008) as well as negative affect (Katz & Peckins, 2017). Another contributor to the diverging patterns seen is the time lag in sC response compared to sAA (Maruyama et al., 2012; van Stegeren et al., 2008). The SAM system relies on hormonal responses, whereas the HPA axis consists of a string of neuronal reactions (Maruyama et al., 2012). Importantly, both the SAM and HPA systems are somehow integrated and influence each other, through both up and down regulation.

The third stress marker spH is, like sAA, an indicator of ANS activity. Stress stimulates the SNS, rendering the saliva more acidic as less bicarbonate is secreted, whilst relaxation activates the PNS, inducing a higher and therefore more alkaline spH (Cohen & Khalaila, 2014; Morse et al., 1983). However, the patterns of spH changes in this study were more reflective of the sC results, with a delay in the peak response. Students overall appeared to benefit more from stories than the music interventions. Initially there also was an increase in spH only for the audio conditions, but the final measure has the spH of the live listeners rebound beyond the audio groups.

There is a caveat to the spH results given that the pH was not tested on fresh saliva samples as recommended. The decision to test spH was made after data collection had commenced and early samples were already frozen. Multiple handling of samples, including dividing into smaller vials for storage and later again for assaying, would have exposed the saliva to air with the likely loss of carbon dioxide affecting the pH readings inconsistently.

Immune markers

Much of the knowledge surrounding the differential responses of biomarkers is based on research involving laboratory created acute psychosocial (e.g., Rohleder, Wolf, Herpfer, et al., 2006) or physical stress (e.g., Silvestrini et al., 2011). There is far less understanding of the relaxation response and how the same markers may behave when, through the activation of the PNS, the body aims to achieve homeostasis. It is known that chronic stress negatively impacts on both the natural and acquired immune systems (Sergestrom & Miller, 2004). But does this automatically mean that immune markers will increase after an intervention targeting anxiety?

Markers of both the acquired and natural immune systems were selected for this study (IgA and IL-1β). The two immune markers are sensitive to stress as well as relaxing stimuli. Chronic stress generally depresses sIgA secretion, whilst acute stress as well as relaxing interventions can increase levels in the short term (McCraty et al., 1996; Tsujita & Morimoto, 2002). It is thought that sIgA is affected more by the SNS rather than the PNS, and is particularly responsive to emotional states, rising in levels with positive valence (Kreutz et al., 2004). Acute stress can trigger a natural immune response. In turn, the HPA axis is stimulated by proinflammatory cytokines such as IL-1 (Hucklebridge & Clow, 2002). Therefore both the HPA and SAM pathways contribute to inflammatory responses during stress (Miller et al., 2009).

Based on the assumption that both immune markers rise after a relaxing experience such as music or stories, the results do support a stronger immune response occurring after ML than for the other interventions. Levels of sIgA for students were highest initially after ML and rebounded least below baseline in the final sample. Similarly, sIL-1β levels were initially second highest for ML, after MAV. Then in the final sample ML was the only group to continue to rise

above baseline, with all other groups falling below their baseline levels of sIL-1β. In comparing music to stories the initial sIgA levels for music were higher than for stories, but then rebounded strongly below baseline. The music groups for sIL-1β also rebounded but for both post measures the music stimulated higher sIL-1β levels than the stories. A comparison of live to audio conditions indicated stronger immune responses for both markers after the live interventions. In particular, the initial sIgA response for live music plus stories was strong compared to no difference after the audio. The initial levels of sIL-1β were higher for the live conditions; then only the audio groups rebounded below baseline.

The overall pattern of an inverse relationship between sC and sIL-1β, in particular with the first readings taken after the music or stories interventions, has also been noted in previous research (Kunz-Ebrecht et al., 2003). There are complex interactions and feedback loops between proinflammatory cytokines such as IL-1β, and glucocorticoids such as cortisol. Whilst the cytokines are potent activators of the HPA axis, glucocorticoids inhibit cytokine production, thereby shutting down potentially harmful inflammatory processes resulting from prolonged immune activation (Kunz-Ebrecht et al., 2003).

A similar inverse relationship has also been discussed in the literature specific to music interventions for sIgA and IL-1 compared to sC, with increases in the immune markers being associated with falling cortisol levels after music (Gangrade, 2012). This same pattern is evident in the student standardised graphs, which show sC below baseline in all the groups for both post measures (see Figure 13), whilst the sIgA levels are above baseline in all but the last SA samples (see Figure 14). At the same time sIL-1β rises above baseline in the three music groups in the first post measure, and retains its higher levels in ML in the final sample, but all the other groups rebound to below baseline levels (see Figure 17).

There is also evidence of oscillation occurring beyond baseline readings with immune markers. Levels of sIgA in all student groups except SA fell below baseline in the final sample, and the third measures of sIL-1β were below baseline in all groups except ML, which continued to rise. As with the stress markers, it is possible that the immune markers are rebounding below baseline levels as they overcorrect before reaching homeostasis. This complex dance has

many partners, including the HPA axis and SNS, who together weave their way to a more settled, but always restless and never final, curtsey.

And the dance changes with age. The immune system is generally resilient, bouncing back after activation. However, flexibility and self-regulation decrease with increasing age, making the older person more vulnerable to degenerative diseases, autoimmune illnesses, and infections (Griffin, 2006; Sergestrom & Miller, 2004). The clinical cohort, at 67 years, had around double the mean age of the students' 33 years. Further compounding this issue is the likelihood that most of the hospital patients would have compromised immune systems due to their illnesses and possibly also their medications and cancer treatments. It is therefore important to have alternative data to evaluate the hypotheses, in this case provided by subjective measures of anxiety and pain, but not of immune function.

Comparisons between subjective variables

A battery of self-report data was collected. This included quantitative VASA and VASP measures for anxiety and pain, and four affect scales providing feedback on how much participants liked and were engaged with the music or stories as well as their perceived and felt emotion. In addition, qualitative one-word reflections were elicited and spontaneous comments were recorded in writing.

Reporting of this data has already established differential responses to live compared to recorded conditions, as well as music versus stories. What is interesting to explore is how the outcomes for anxiety and pain may have been influenced by emotional responses to, or engagement with, the presentations.

Self-reported anxiety and pain

A quick recap of the VAS scores reminds us that student VASA scores fell for all intervention groups in reverse of the expected order, with ML reporting the smallest anxiety reducing effect and SA the largest fall in VASA scores. For patients, the strongest benefit was seen in the SL listeners, and the least in the MA group. With the VASP, students reported most initial benefit after ML and SL and least following MAV; but residually MAV was most beneficial and MA increased pain above baseline. Patients noted most analgesic benefit initially after MAV and subsequently from SA, and least after MA.

There are parallels between the patient VASA and VASP graphs, in particular the initial post-intervention scores (see Figure 48 and Figure 50). MA rose in both cases, whilst all other groups fell. MAV showed the largest initial fall for the music interventions in both scales. No obvious similarities were apparent between the student VASA and VASP. Scores were below baseline across the board for the VASA. However, the initial as well as residual VASP ratings for MA were above baseline levels. So MA increased students' self-reported pain, and increased both pain and anxiety in the patient cohort.

It is at times a challenge to delineate between the two constructs of anxiety and pain. Rather than being discrete experiences it is understandable that anxiety can magnify pain perception, and pain in turn makes a person anxious. Self-reports of these symptoms can therefore become blurred. The patient VAS results point to the experiential and linguistic limitations in assessing anxiety and pain separately as outcomes, as well as the interplay between these symptoms.

Emotions and pain

Emotions also play an important role in pain perception, with a cyclical relationship existing between emotion and pain (Finlay & Anil, 2016). A correlation has been established between self-reported pain and lower levels of state and trait positive affect (Pressman & Cohen, 2005). Enhanced positive emotional responses to the interventions should therefore be reflected in lower pain scores.

The student SL group scored both perceived and felt emotion highest, followed by the ML listeners. Patients listening to ML scored both the emotion scales highest, followed by SL. Both cohorts scored the stories higher on the emotion scales than the music. It is feasible that listeners found stories more directly accessible than music in terms of emotional content. The VASP results partly followed this trend, with the students reporting most initial pain reduction in both the ML and SL groups. The timing of this first post intervention VASP coincided with the scoring of the affect scales. However, the patients' VASP demonstrated the strongest pain reducing effect with MAV, followed by SA. Delving a bit deeper into individual cases may provide further insight into interactions between emotions and pain perception.

Statistical significance and clinical significance

The emotional reactions which music may arouse are as numerous as the individuals reacting, and the subjectivity of emotional experiences which is reflected in all this variability is the core of our problem. . . . Science is usually befuddled by subjectivity. Its object is communality, not individuality.

(Fisichelli & Paperte, 1952, p.15)

Group differences only show part of the picture. Establishing statistical significance involves making assumptions based on group averages. As a consequence, individual variations in behavioural responses are clouded by the need to statistically support or refute a hypothesis (Speelman & McGann, 2016).

Group means do not provide information on how many individuals benefited from a treatment or study condition (Jacobson, Roberts, Berns, & McGlinchey, 1999). Where an intervention is specifically being assessed for its potential clinical relevance and efficacy, it is more appropriate to consider clinical significance (CS) of the outcomes. Assessing CS can be a complex mathematical process, or may boil down to the simple question of how likely it is that the patient or client will leave therapy without the problem they presented with (Jacobson et al., 1999). Realistically though, in many settings, including PC, a full return to normal functioning is not achievable. What can be aimed for is some degree of amelioration of distressing symptoms.

The case by case presentation of patients in the results section includes assessments of CS related in particular to their VASA and VASP ratings. These are based on parameters of CS suggested for anxiety by Williams et al. (2010) and Facco et al. (2001), and for pain by Kelly (2001).

One of six ML patients reported CS reduction in both anxiety and pain, another in pain only. A third patient who reported CS less pain also required no breakthrough medications in the post intervention 24 hours, whilst she had taken anxiolytics and analgesics before the ML. Two of the remaining ML patients had low baseline levels, so no CS reduction was expected. Amongst the four MAV listeners, one reported CS less anxiety and pain after the music and a second patient had her CS fall in the VASP corroborated by a 66% reduction in post-intervention breakthrough opiates. A third MAV listener had low baseline scores so again no CS reduction was possible. No CS reductions in VAS scores or

medications were observed in the MA group. The only patient starting with moderate to high baseline scores did not show any CS change.

Three of the five SL patients reported CS reductions in symptoms: one in the VASA, another in the VASA and VASP. A third patient reported CS lower scores on both the VAS scales, and her breakthrough anxiolytic medications were reduced 100%, and 33% for the analgesic. One of the remaining SL listeners had no reduction from baseline VAS scores in the moderate range, whilst the fifth SL patient had low baseline VAS scores. Of the four SA listeners, one reported CS less anxiety and a second had a CS lower VASP score. The third had no real change in the VASP despite his baseline score being in the moderate range. All other baseline levels were too low to expect a CS reduction.

To summarise, three of the six ML patients (50%) had CS reduction in one or more of their symptoms, as did two out of four of the MAV group (50%). However, none of the four MA listeners reported CS reduced anxiety or pain. Three of the SL group of five had CS outcomes (60%), as was the case for two of the four SA listeners (50%). Overall, 10 of the 23 patients (43.5%) had CS reduction in measures of anxiety or pain as a result of the interventions. Comparing music to stories, 5 of the 14 music listeners (35.71%) compared to 5 of the 9 story listeners (55.55%) experienced CS reductions in one or more of their measures, whilst 6 of the 11 live listeners (54.54%) had CS outcomes compared to 2 of the 8 audio listeners (25%).

Whilst there is nothing conclusive to draw from the above presentation of CS data, it can be said that patients exposed to live experiences were more likely to have CS benefits than those who heard audio recordings. And the live stories in particular were effective in promoting CS outcomes for patients.

Further discussion on live versus recorded presentations and music versus stories can be found later in this chapter. But first some thoughts will be canvassed on the influence of musical preference and engagement with the presentations.

Effects of the affect scales

Many factors contribute to whether a piece of music works for the listener, in terms of engagement and emotional response. These include how it is recorded and played back, who performs it, the social context of the listening experience,

the quality of the sound and acoustics, and the readiness of the listener to be engaged with the music (Byrne, 2012). Music that the listener does not find enjoyable is unlikely to be an effective intervention for pain (Finlay & Anil, 2016).

The impact of how much the listener liked, or did not like, what they were asked to listen to is clearly demonstrated in the responses of patient S3, who graciously participated despite his stated dislike of classical music. His low baseline VASA of 5.0 mm and VASP at 3.5 mm shot up to the high 70.0 mm and 66.0 mm after the MA. In contrast, patient S1, who stated that the ML was calming, reported dramatically reduced VASA (from 43.0 mm to 3.0 mm) and VASP scores (from 19.5 mm down to 6.5 mm) after the intervention.

How much a listener liked the music or stories could also impact on their engagement with the intervention. S3 scored his four affect scales at 2 for liking as well as perceived emotion, and only 1 for felt emotion and absorption. At the other end of the spectrum, S1 scored all four scales at 10 out of 10.

Older participants are more likely to rate classical music as preferable compared to younger participants (Finlay & Anil, 2016). Indeed, the patients in this study liked the music overall (7.86 out of 10) a little more than their student counterparts (7.17 out of 10), who were half their mean age. This is consistent with the preferred genres of each cohort: 39.1% of the patients included classical music in their favourite genres, compared to 22.0% of the students. However, patients tended to rate all the affect scales a little higher than the students, which may reflect the older generation being more inclined to want to please. The order in which they rated their liking of the music was the same in both cohorts: highest for ML, then MAV, and least MA. For all the other scales ML was rated above the recorded modes by both students and patients. This does indicate a consistent relationship between how much listeners like the music and the emotional and engaging qualities of the presentations.

Self-reported emotional responses can be clouded by difficulties in differentiating between perceived and felt emotions (Vuoskoski, Gatti, Spence, & Clarke, 2016). Participants in this study were asked to rate how emotional the presentation was (perceived emotion) as well as how much emotion they felt. Their responses did show there was an understanding of these two distinct constructs of emotion. In comparing the scales for live versus audio (music plus

stories), students rated perceived emotion at 6.65 for live and 5.30 for audio, and felt emotion higher at 7.75 and 6.10 (see Figure 71). Patients rated these same scales at 7.57 and 5.88 for perceived emotion, compared to the higher 8.37 and 6.75 for felt emotion (see Figure 72). As well as the differential between the two emotion scales, there are clearly both stronger emotional perception and emotional response to the live presentations. In addition, there is a consistently higher rating for stories on the two emotion scales in both cohorts. As suggested earlier, this may be due to the emotional content of the stories being more accessible to the listeners than the abstract emotions conveyed through the music.

Absorption may also moderate the intensity of emotional responses to music (Sandstrom & Russo, 2011). Both students and patients were more absorbed with live compared to audio presentations, consistent with their liking and emotional responses. The differential between music and stories was less clear, with little difference between the absorption scores for students (6.77 for music and 6.50 for stories), and only a small advantage for stories (7.70) over music (7.44) in the patients' ratings (see Figure 69 and Figure 70).

How much the listener recognises the music, or stories, may also affect their responses. A correlation has been found between familiarity of the music presented and the relaxation responses of healthy adults (Tan et al., 2012). This may also be reflected in how much the participants reported liking the music or prose they heard. The link between knowledge of the material and relaxation is just one example of how the subjective responses of participants and their physiological outcomes are related.

Subjective versus objective measures

Numerous studies have reported inconsistencies between subjective measures and objective biomarker measures (e.g., Noto et al., 2005; Miller et al., 2007). Self-reported symptoms may not accurately reflect the physiological conditions triggered by the environment or an intervention (King & Hegadoren, 2002). For this reason, Pearson and her colleagues (2005) stressed the importance of drawing on both subjective and objective measures to control for confounds

inherent in their study, which demonstrated a link between elevated pre-operative anxiety and blunted cortisol responses during surgery.

However, it cannot be assumed that the physiological parameters measured are superior in accuracy to the subjective measures as there are complexities in the interactions between underlying chronic conditions and snapshot sample biomarker results. For example, chronic stress and depression are both associated with flattened cortisol responses due to less sensitivity to the negative feedback effects of this marker (e.g., Kalman & Grahn, 2004).

Measures of anxiety and pain

The SAM system, as measured through sAA in response to stress and relaxation, does not differentiate between psychological and physical stressors (Koh, Ng & Nain, 2014). It is therefore unclear whether changing sAA levels reflect pain or anxiety, or both. On the other hand, the VASA and VASP clearly ask about the specific symptoms of anxiety and pain. But are these really distinct and discrete symptoms? One person might be describing physical pain, whereas another may refer to more existential, emotional or mental pain. And physical pain can cause anxiety, whilst tension amplifies the experience of pain, although it is not clear how these stressors interact with the HPA and SAM systems (Maruyama et al., 2012).

A significant relationship has been demonstrated between the STAI and sAA, as an indicator of psychosocial stress, but not the STAI and sC (Noto et al., 2005). However, inconsistencies are evident in some studies between self-reported anxiety and hormonal measures after music (Gangrade, 2012). There appear to be complex bi-directional interplays between psychological and physiological effects of music listening (Gangrade, 2012).

A comparison of the VASA and sC results for students showed all groups for both outcome measures fall below baseline after the interventions, and in a similar hierarchy of response levels. Responses measured with both the VASA and sC were stronger to stories than music, and audio more than live interventions. It is unclear why the observed profile of responses occurred in these outcomes. The same was not seen in the other stress marker sAA, which supported the hypothesis of music being a superior anxiolytic to stories, and live stronger than audio interventions.

Part of the VASA and sC results may be due to initial variations in baseline levels rather than the specific effects of the different interventions themselves. It is already clear that participants with higher levels of anxiety coming into a study benefit more from any intervention targeting this symptom (e.g., Schneider et al., 2001). Baseline VASA scores were far from homogenous across the student groups, being highest for SA, then MA, SL, MAV, and lowest in the ML group (see Figure 43). The order for baseline sC was similar (see Figure 12), again highest in SA, followed by SL, ML, MAV and MA.

In contrast, baseline sAA levels indicate the ML group as most anxious coming into the study, followed by MAV, SA, MA and SL (see Figure 10). A similar order was seen in the baseline spH (see Figure 18), with MAV recording the lowest readings (indicating highest anxiety), followed by MA, SA, ML, and SL as the least anxious group before the interventions. Why these differences between the baseline outcome measures occurred within the same participants is not clear. It is possible that the sAA responded to arousal, commensurate with entering a new environment (the setting for the study), and anticipating a new experience, rather than a negative stress per se. The VASA and sC are more specific in measuring a negative psychosocial stress experience or even a chronic stress state. The possible influence of chronic stress on outcomes is demonstrated in another study where patients with higher pre-operative state anxiety (STAI) had a more blunted neuroendocrine response to surgery (measured by cortisol in urine) compared to the less anxious patients (Pearson et al., 2005).

Another factor clouding interpretation of results is that perceived stress moderates sAA activity (e.g., Koh et al., 2014). Pain can also confound stress readings as it causes arousal, which is detected by sAA (Katz & Peckins, 2017). Salivary AA does not differentiate between psychological and physical stressors, which both factor in pain (Koh et al., 2014). Pain, as an acute stressor, is also known to increase cortisol concentrations (King & Hegadoren, 2002). However, comparing the visual data of patients' readings does not indicate any trend of association between higher VASP scores and higher sC. There were several patients whose higher VASP scores were matched with higher sAA levels (PC11, PC9, and PC12). Equally, others' higher VASP ratings were not reflected in their sAA levels (S2, S3, and S7). With the very limited number of patients with both

VAS and biomarker results it is impossible to draw any conclusions from these observations.

HPA axis activity is influenced by subjective responses to a stimulus, seen in a positive correlation between subjective distress and outcome measures (Miller, Chen & Zhou, 2007). One such measure is sIgA, which negatively correlated with self-perceived stress in studies with nurses and students (Koh & Koh, 2007). As well as perceptions of stress, the listeners' emotions and engagement with the stimulus can moderate outcomes.

How do participants' perceptions of their experiences influence outcomes?

Music that the listener does not find enjoyable may have the opposite of the desired effect (Finlay & Anil, 2016). Establishing whether the participant actually likes the music is therefore an important factor in assessing the outcomes of the various interventions. Levels of emotional connection and engagement are also relevant. The link between VAS scales and the four affect scales has already been discussed. The next step is to examine whether participants' evaluations of the presentation are reflected in the biomarker results.

McCraty and colleagues (1996) noted sIgA increased when the listener liked the music, but no positive change occurred if they did not. The sIgA levels of students were initially highest in the ML, then MAV, and fell in the MA group. Students also liked the music in the same order, that is, the ML most and the MA least (8.3, 6.8, and 6.4).

Effects of some stimuli can be moderated by the participants' responses to them. For example, sIgA has also been shown to be affected by engagement and absorption. Response to a university lecture was moderated by how interested or engaged the students were, with higher levels of interest correlating positively with sIgA levels, compared to the students who were indifferent or bored with the lecture (Tsujita & Morimoto, 2002). The absorption scales for students also followed the order of ML as highest (8.2), then MAV and MA nearly the same as each other (6.1 and 6.0).

Emotional responses may also moderate biomarker measures. A study, comparing active participation in choral singing with passive listening, found active singing was associated with increased positive affect and sIgA, and a

reduction in negative mood, whilst passive listening to recorded choral music increased negative affect and decreased cortisol levels but had no significant influence on sIgA levels (Kreutz et al., 2004). Salivary IgA reacts more to the SNS than the PNS, and is particularly responsive to changes in affect, with levels typically increasing with positive or relaxing experiences and falling with stress and intense physical effort (Kreutz et al., 2004).

Listeners' moods coming into the music experience can colour their perceptions of emotions in the music (Balteş & Miu, 2014). Listeners who are feeling sad perceive more sadness in ambiguously valenced music, and do not show the typical preference for happy music (Hunter, Schellenberg, & Griffith, 2011). As Kreutz and his colleagues (2004) found, negative affect was associated with decreased cortisol levels, so music can provide a cathartic effect for stress associated with sadness. The mood state of student and patient participants in the current study was not assessed; and the music selection included pieces with a mixture of both positive and negative valence.

Just as mood states colour the participants' experiences, pain and anxiety levels before the interventions are also critical. Low baseline levels, as seen in many of the participants, in particular students in this study, do not allow a true assessment of the efficacy of the interventions. The study of surgical patients by Leardi and colleagues (2007) also found no significant change to post-operative pain as all groups reported low initial pain levels.

The evaluation of whether an intervention to reduce pain has been effective can be arbitrary, based on statistical differences, CS differences, or some other measure of difference or improvement. CS difference, as discussed earlier, is in itself not concrete but based on reports of improvement by the patient, which at the same time is susceptible to measurement error (Cepeda, Africano, Polo, Alcaca, & Carr, 2003). Even a person's expectations, such as whether they think music should help them relax or reduce pain, may influence their scaling of self-report instruments (see Buhle, Stevens, Friedman, & Wager, 2012; Lamont, 2011; Linnemann, Strahler, & Nater, 2016). Ultimately though, what is important is that the individual feels that symptoms are reduced, regardless of whether this is validated by objective measures or not.

Immune competence

The possibility therefore exists that psychological interventions might usefully contribute to the armory of therapeutic approaches to disease management . . . [including] the course of infection and pathology itself.

(Hucklebridge & Clow, 2002, p. 14)

A limitation of self-report measures is that they cannot directly assess immune competence: indirect associations can be only be suggested regarding immune function based on measures of stress. There is ample evidence for the links between acute and chronic stress and illness via a process of immune down regulation (e.g., Andersen, Kiecolt-Glaser, & Glaser, 1994; Glaser & Kiecolt-Glaser, 2005). Infections often contribute to morbidity and ultimately to mortality in cancer patients (Anderson et al., 1994). Any intervention that can impact on anxiety should by inference improve outcomes. Studies have indeed demonstrated that psychological interventions targeting stress do improve cancer patients' survival (Anderson et al., 1994).

Glial cells, which make up around 80% of the brain, perform both the task of providing structural support for neurons and nerves, and the vital role of the brain's immune system (Krout, 2007). The interfaces between neurones and glial cells may partly explain how music can influence the body's immune system, in particular the natural immune system and its associated cytokines. Through both direct neural connections, such as via the vagus nerve to the gut and the trigeminal nerve to the mouth (Miller et al., 2009; O'Connor et al., 2009), and more indirect endocrine processes (Yehuda, 2011), immune responses can be communicated to other nervous system and somatic regions. The immune system is dispersed throughout the body, and communicates through both afferent and efferent pathways with the CNS (Hucklebridge & Clow, 2002). Microglial cells also play a role in creating as well as pruning synaptic connections (Harvey, 2017), providing a link between the immune system and learning, including emotional learning.

The complex matrix of interconnections between the CNS, enteric and peripheral nervous systems, as well as immune systems, allows emotions precipitated by music interventions to influence stress levels, pain and immune function. The pleasurable experience of listening to music releases hormones such as endogenous opioids and oxytocins which buffer stress responses

(Chanda & Levitin, 2013; Kreutz et al., 2012). The limbic system, which contains the neural circuitry for processing emotions, also integrates the ANS flight or fight state (Harrington, 2013). In addition, through the processes of entrainment basic components of the music such as beat and rhythm can impact on the ANS directly, affecting HR and breathing (Fancourt et al., 2014). Vital signs can be perceived by the individual as emotions, as well as affecting the HPA axis and SAM system which in turn influence other parts of the nervous and immune systems.

To summarise, although there are no direct comparisons to be made between subjective and objective measures of immune competence in this study, it could be inferred that the decreases demonstrated in subjective anxiety would be reflected in improved immune function. So a comparison between the VASA and the immune markers sIgA and sIL-1β may corroborate this. However, as reported and discussed earlier, the unexpected profile of the student VASA graph mirrors the sC results rather than the immune marker measurements or even those of the other stress marker sAA.

Students versus patients

Although the student VASA results do not conform to the original hypothesis, the patient cohort supports some aspects of the expected outcomes, as discussed earlier. This is just one of the differences uncovered between the two participant groups. A brief discussion will now consider some possible explanations for these differential outcomes.

Age

The most salient variable between the two cohorts is age, with the students' average age of 33 years being less than half the patients' 67 years. Age can influence musical tastes and how music is consumed. For example, older participants are less likely to use music as background to their activities than their younger counterparts according to a study examining music consumption habits of 18 to 64 year olds (Chamorro-Premuzic, Swami, & Cermakova, 2010), and younger listeners are more likely to consume many hours of music every day through electronic devices (Lonsdale & North, 2011). Age is also a factor in health status, more so given the discrete cohorts in this study of generally

healthy students compared to patients with moderate to profound health issues. Other age-related factors that may affect outcomes are immune competence, which becomes less resilient with age and illness (Griffin, 2006; Sergerstrom & Miller, 2004), and higher rates of medications consumed by the older and less well patient group.

More of the older patient cohort reported their preference for classical music (39.1%) compared to the students (22.0%). This in turn could have influenced their assessment of how much they liked the music (7.86 and 7.17 out of 10). In terms of how the two generations may typically engage with music, this does not seem to have influenced the affect scales. Across both cohorts all four scales were rated higher for live than for audio presentations.

Environmental factors

The settings where data collection occurred differed for the two cohorts. Students entered an unfamiliar space: a windowless room on the university campus. In contrast, the patients were in their own space, albeit a temporary environment for them: a comfortable single hospital room with a pleasant view, of which they had some sense of ownership and control.

A recent study compared a live vocal recital attended by a regular concert audience with the AV, audio-only and visual-only recordings of the same recital played back in a university lecture theatre (Coutinho & Scherer, 2016). Members of the live audience had higher levels of emotional convergence, or consistency between listeners of felt emotions, than those listening to and/or watching the recordings in the more artificial environment of the lecture theatre. The authors suggested that the context was an important factor in the differential results, as well as the likelihood that most of the concert audience were there by choice and had certain expectations of the concert experience which increased appreciation, motivation, empathy and engagement. In contrast, they pointed out that the audience in the lecture theatre were less connected with the actual performer and attributed more of the emotional effect to the music itself.

The students' experiences of the music or stories were perhaps more artificial than for the patients, who all welcomed the presenters into their space, happy to embrace any distraction or time filler on offer. Having someone come

in to play or read specifically for the students may have been awkward for some, and a situation over which they had little or no control. This could have contributed to the unexpected VASA results, where the students reported less stress relief from the live interventions than the recorded music and stories.

Students were seated in an office chair at a table or desk, whilst patients had the choice of sitting up or lying down in their bed, or sitting in a comfortable chair in their room. Some students did comment that they were not comfortable and would have preferred to lie down during the intervention. Any discomfort they felt also made them restless and the time drag on, as described by several students.

Quality of musicianship

Student participants listened to student musicians, whereas the patients had professional musicians play for them. Several of the comments made by students reflected tone quality that was not pleasant for them to listen to. Technical and musical skills, as well as the standard of instruments played on and the brighter acoustics of the room, may have all contributed to the live performances not being of equal standard. Patients had clearly more benefits in terms of self-reported anxiety and pain from ML than MA, which increased above baseline in both the VASA and VASP. Students also reported above baseline pain after MA whilst ML listeners reported reduced pain. However, ML was far less effective in reducing students' anxiety than MA.

Saliva production

Differences between students' and patients' saliva production was a factor in the sporadic data set for patients' biomarkers compared to the more complete set of students' assay results. Surgical patients are on nil-by-mouth regimes, so lack of fluids in particular could have impacted on their ability to produce saliva. Palliative care patients, whilst not on any protocols to avoid sustenance, were typically very ill and could lose interest in food. Their medications could also affect saliva production. Specific biomarkers are affected differentially by saliva flow rates. In one study, exercise-induced dehydration was found to decrease secretion rates of sAA, but not of sIgA, although concentration of sIgA was increased (Fortes et al., 2012).

Summary

Overall, student and patient results aligned on the subjective affect scales but not for the VASA and VASP. Due to the incomplete data set for patients' biomarkers, no direct comparisons could be made with the students' results. The issue which is at the heart of this study though is not to compare students to patients, but to uncover the differential effects of live and recorded modalities of music presentation.

Live versus recorded music

. . . once it was fixed to the film, some of cinema's vitality would be lost. . . . the art and power of cinema for [Charlie] Chaplin was, through music, not something fixed and static, but fluid and able to breathe in the moment.

(Robertson, 2016)

Finding a workable definition of music remains an unresolved theoretical challenge for researchers (Kreutz, Quiroga, & Bongard, 2012). However, the parameters around live and recorded music are clearer, with a live music experience occurring when both the musician and listener inhabit the same physical space, as was the case in the era of silent movies where musicians created the sound track in real time in the cinema whilst the film was rolling. Recorded music listening is the experience of hearing music, which was performed and recorded at an earlier time, being played back in either AV or audio format.

Recorded music is becoming increasingly available, accessible and prevalent as a mode of listening (Sloboda, Lamont & Greasley, 2009). The ubiquitous nature of recorded music results in the music itself not necessarily being the primary focus for the listener, but rather being relegated to a secondary function whilst engaging in daily living activities (Sloboda et al., 2009).

Despite the financial and time commitments required, live music events remain popular across all age groups and genres (Fujiwara, Kudrna, & Dolan, 2014), even increasing in their share of the popular music market in recent years (Montoro-Pons & Cuadrado-García, 2011). Recently, too, we see a return to the era of silent movies with orchestras staging special events where epic films are screened with a live symphony orchestra simultaneously playing the

soundtrack (see for example the West Australian Symphony Orchestra website www.waso.com.au). So it appears that live music offers the consumer more than just the combination of aural and visual stimuli (Montoro-Pons & Cuadrado-García, 2011), which are also available in the AV format. Audio music eliminates the visual component of a music performance, but AV still retains this element. Even though music can be watched on an electronic device, including as AV coverage of live concerts to attempt to encapsulate the "live" element, the appeal is still there for attending the actual live events (Frith, 2007).

Part of the attraction for live music may be the acoustics of the live venue (Halmrast, 2015; Schärer Kalkandjiev & Weinzierl, 2015; Thompson, 2006). Also, the spontaneity of the live performance contrasts to the sameness and predictability of recordings (Robertson, 2016). Even the context in which the music is heard is a factor, in particular the social context, but also the physical space (Coutinho & Scherer., 2016).

Possible explanations for the differential results reported between live and recorded music are now discussed as they pertain to two theoretical frames of reference outlined in chapter two.

Cognitive-emotional explanations

> *. . . the multifaceted interactions between audio and visual cues suggests that the experience of musical emotions is far more complex than is often assumed . . .*
>
> (Coutinho & Scherer, 2016, p. 17)

Thoughts and emotions

Subjective response shapes HPA activity, according to Miller and colleagues (2007). Taken a step further, the affect and valence of self-generated thoughts have been shown to moderate the stress-induced release of stress markers such as sC and sAA. In a recent study, participants who reported more negatively toned emotional thoughts and more social temporal thoughts with a past focus had higher sC and sAA levels after induced stress than their counterparts whose thoughts after the stressful intervention were more positively toned and focussed on the future (Engert, Smallwood, & Singer, 2014). Both music and stories have the capacity to influence the emotional content of thoughts and memories, as seen in the elicited and spontaneous responses offered by some of the participants.

Catharsis

Music may induce both positive and negative emotions, providing the listener with the opportunity to explore — even confront — and process both joyful and painful memories and existential issues (Ruud, 2013).

Positive and negative emotions each have different evolutionary and adaptive values. Positive emotions tend to be broadening, whilst negative emotions narrow the individual's focus (Harrington, 2013). Positive emotions buffer stress and contribute to improved immune and cardiovascular systems, thereby influencing overall health outcomes (Pressman & Cohen, 2005). Positive affect encompasses feelings of pleasurable engagement with the environment (Marsland, Pressman, & Cohen, 2007). Negatively valenced emotions elicited by music, such as sadness, may also provide positive health outcomes by allowing the listener to tap into feelings they are unable or unwilling to express verbally. And sadness in itself may be pleasant for the music listener as it is experienced as a vicarious emotion and therefore not perceived as threatening (Kawakami, Furukawa, & Okanoya, 2014).

The music program of this study included pieces which could elicit the three most common music emotions of happiness, sadness and nostalgia (Juslin, Liljeström, Laukka, Västfjäll, & Lars-Olov, 2011). Nostalgia in particular was noted in spontaneous comments offered by listeners. Tears, along with musical chills, were triggered in one patient (S1). The live cello music precipitated what Harrison and Loui (2014, p. 1) call a "transcendent psychophysiological moment in music". They noted the previous work of Panksepp (1995), who found sad music more likely to induce such responses than happy music. Lamont (2011) also found that some of her listeners reported SEMs that were totally unexpected, taking the listener by surprise, as was the case with S1.

Visual component: distraction or enhancing the experience?

Vuoskoski and colleagues (2016) reported that, contrary to their hypothesis, listeners in their study showed more evidence of emotional arousal with MA than MAV. Some of their explanations for the unexpected results were that the visual component of the MAV was not as expressive as the audio, and that some of the listeners may have preferred to create their own visual imagery whilst listening to the music. Current results also show this trend, with both students'

perceived emotion and patients' felt emotion scoring higher for MA than MAV, although both cohorts scored highest for ML.

The visual component in particular is salient in processing music emotions (Coutinho & Scherer, 2016). A study comparing restrained, standard and exaggerated expressive styles in performances of a Stravinsky solo clarinet piece found that these variations in expressive intention had most impact when rated by listeners from AV rather than audio-only recordings (Vines, Krumhansl, Wanderley, Dalca, & Levitin, 2010). Gestures, used to impart emotional content in language, are a universal feature of all cultures (Fay, Lister, Ellison, & Goldin-Meadow, 2014). Indeed, gestures used alone were found to be a more effective communication tool than vocalisations used alone in a recent study (Fay et al., 2014). Musicians' movements as they play their instruments convey emotional content to those watching them which is in addition to, and may even be incongruent to, the emotions conveyed by the music alone. Several participants commented on this aspect. One student said the performer's appearance was dissociated from the music and that the musician did not appear to be enjoying it as much he did. Another explained that she preferred listening to audio music as she found the visual component of MAV arousing and distracting from the overall musical experience.

Visual factors alone cannot explain the differential effects between ML and MA as there were also observed differences in the results between ML and MAV. Furthermore, as has been previously used as an example, neonates were more settled with live music than recorded music, despite the fact that many of these tiny infants would have their eyes closed most of the time (Arnon et al., 2006). Clearly there are other influences at play here contributing to the superior effects of the live music.

Biopsychosocial explanations

> *. . . what is it that constitutes the uniqueness of the live presence of the performers — a sense of reality, spontaneity, unpredictability, credibility, increased empathy or still other factors?*
>
> (Coutinho & Scherer, 2006, p. 18)

Arousal

The Yerkes-Dodson curve from early in the twentieth century illustrates how insufficient arousal results in boredom, whilst too much arousal can be

distressing (Harrington, 2013). The just-right Cinderella zone sits in the middle section of the curve, where ideal levels of arousal elicit optimal degrees of engagement with an activity.

The ubiquity of recorded music may render it less arousing for some listeners as they have learned to disengage from it whenever other sounds or thoughts become more salient. ML, on the other hand, is more prominent in the participants' environment and harder to ignore. MAV, with its visual component drawing the attention of the listener, is also likely to be more engaging than MA over the period of the intervention.

The absorption scale, scored out of 10, confirms this hypothesis. Patients clearly reported they felt more engaged with ML (9.33), followed by MAV (7.50) and MA (5.50). Students also felt more absorbed by ML (8.20), but there was no difference between MAV (6.10) and MA (6.00). Perhaps the students, being of a younger generation, were more used to disengaging from AV stimuli than the older patient cohort. However, they remained engaged with the ML.

Social benefits

Shared music experiences connect people to each other (Levitin, 2006). As well as a sense of connection with the performer and his or her values, a mutual sense of gratitude develops between a musician and the listener. The former is evident in the unsolicited comment made by a few ML participants, for example, "That was wonderful! I really appreciate that." Some of the MAV participants felt the musician was there with them. One student said, "I felt like I was disrespectful when I looked away – as it felt like the performer was actually present." A palliative care patient enthusiastically remarked, "Well done young lady!" when the MAV finished.

Musicians also benefit from the presence of an audience. In a recent study, listeners (Shoda & Adachi., 2015) preferred recordings of musicians playing for a live audience, rather than in a recording studio. Somehow the presence of an audience made the musicians play better, or more expressively.

Recordings are inert

> *Recordings are popular and provide pleasurable experiences not because of what they lack but because of what they offer — sounds which do not demand full attention, that fill and transform spaces, and free the eyes to attend to more important things, like one's laundry or one's dance partner.*
>
> (Wallach, 2003, p. 41)

Regardless of how well a recording is produced, it remains the same over time (Robertson, 2016). Whilst this predictability may be comforting in some circumstances, the fact that a recording does not change with each hearing has consequences for the perception of live music. Listeners' expectations of how a live performance should sound is coloured by their listening experiences of recorded music (Milner, 2009). Commercial recordings, through multiple electronic manipulations, are a perfect though artificial benchmark that live performances cannot attain. What is gained in errorless performances is lost in the vitality of the live music experience. There is pressure on recording artists to perform their repertoire just as it is in their recordings when they play to a live audience (Robertson, 2016), thus inhibiting the spontaneity that sets a live performance apart from a recording.

There is more to understanding this paradox than just the issue of the variability of live performances. If we consider the parallel of the visual arts, then viewing an original painting, which is — unlike a music performance — fixed in time, is a very different and more satisfying experience than seeing a poster reproduction of the same artwork (Robertson, 2016). Perhaps the analogy lies in the brush strokes and other subtleties that can be detected in the original painting but are lost in a poster, just as the overtones and non-musical sounds made by the musicians and instruments are lost in the pure hi-fidelity recordings of today. A current popular source of music listening, the MP3, further compresses the sound spectrum, resulting in a lifeless soundscape reaching the listener's ears (Wallach, 2003). Another possible explanation is that the original artwork or live music performance has more intrinsic value to the consumer than a reproduction and therefore is worthy of more attention and engagement.

Despite all the above detractors, recorded music has many advantages, including portability, immediacy, wide availability, low or no cost, self-control of

the listening experience, range of musical genres that can be accessed, and the flexibility for listening to be a private or shared experience. On the flip side, the listed advantages also make music a disposable commodity which can be taken for granted as it is passively, and at times mindlessly or even forcefully, ingested. This may even occur with live art experiences. There are common examples where live music or art is not automatically engaged with by the observer or listener, such as public artworks including statues and murals, or buskers on a city street encountered whilst people hurry by to work or shop. Live music and artworks demand time and attention of the consumer to fully engage with and benefit from their presence. And, where visual art generally remains unchanged from one viewing to the next, live music is ephemeral and can only be appreciated in real time (Harvey, 2017).

The live music experience

Sound . . . not only emanates from vibrating bodies, but also has the power (regardless of its source) to vibrate other bodies with which it comes in contact.

(Wallach, 2003, p. 42)

Where both the music makers and the listeners are present in the same physical space, live music provides context for the listener, which is not available when listening to a disembodied recording (Wallach, 2003). Context helps provide focus and mindfulness in the listener. Furthermore, sound waves are detected not only in the ears but can resonate in the entire body. This audio-tactile experience, as Wallach (2003) describes it, impacts directly both physically and physiologically on the listener. As just discussed, the nature of the sound waves available from a recording are not of the same natural wide range as those perceived by the listener emanating from an acoustic instrument. It is therefore understandable that differential physiological responses will occur in listeners of live compared to recorded music. These physiological responses in turn can influence subjective responses to the music (e.g., Kreutz et al., 2004).

Live music quality can be inferior in terms of technique and musicianship to a professional recording. The artificially perfect and flawless recordings engineered by record producers may set up false expectations in a live audience of what an ideal listening experience should be (Frith, 2007). As Milner (2010) put it, “live music is heard through the prism of the recorded.” The standard of

the student musicians compared to the professional players may have moderated the positive effects of ML more in the student cohort than for the patients.

Social factors in live music listening

. . . across genres the concert . . . continues to be the experience which for most music lovers defines their social values.

(Frith, 2007, p. 9)

Live music is mostly experienced in a group context. A recent study of students' strong experiences of music (SEM) found that a majority of reported SEMs (78.3%) occurred whilst listening to live music, at festivals, concerts, ceremonies such as funerals and weddings, and so forth (Lamont, 2011). The social bonding aspect of such musical contexts would contribute to these intense responses by heightening emotional engagement (Sloboda, Lamont, & Greasley, 2009).

Live music is introduced to some events, such as weddings, funerals, cocktail parties and so on, specifically to create a particular atmosphere (Finnäs, 2001). There are extra-musical factors that contribute to the ambience emanating from live musicians performing, such as their mode of dress and behaviour (Finnäs, 2001). The same musician typically dresses formally and behaves seriously when playing in a string trio or symphony orchestra, whilst being more physically demonstrative, with clothing to match, when part of a rock band. Where the expectations of the listener are incongruent with how the musician appears or acts, the visual component of a live or AV presentation can detract from the overall experience (Finnäs, 2001). Several participants in the current study reported a mismatch between the visual and aural components of the performances they watched.

Expectations can influence outcomes where the performer is not of a high professional standard. Finnäs (2001) noted in his review comparing live, AV, and audio presentations of music, that the amateurishness of two cellists in the study of Handler and Butler (1985) could in part explain why participants rated audio recordings somewhat higher for emotional level than the AV recordings.

For live performances the audience may be more forgiving of less than perfect performance or sound quality. Thompson (2006) reported that the

perceived quality of a live concert participants were asked to rate was less of a predictor of enjoyment than their affective responses to the orchestra's performance. Although recordings have set a high benchmark, the ideal performance is one that does not distract through obvious mistakes or technical lapses, or with a performer who draws the audience's focus too much on them rather than the music, whilst still retaining a sense of individual personalities of both the composer and musician (Frith 2007).

A listener may have expectations that a live performance will be more enjoyable, engaging and relaxing than listening to a recording. However, clinicians in one study said they would hypothetically prefer recorded music in their neonate unit rather than live music (Kemper, Martin, Block, Shoaf, & Woods, 2004). But the medical staff and parents who actually experienced both modalities with their neonates concluded they preferred live music therapy over recorded music and no therapies (Arnon et al., 2006). The differential sound qualities of live versus recorded music may partly explain the preference for live music.

Aesthetics

Thompson (2006), in his study of real audience members, noted that listeners' satisfaction with the concert hall itself contributed to their overall enjoyment. Humans' appreciation for the aesthetics of musical sound may go back more than 40,000 years, with some evidence that caves were deliberately used for their natural resonance (Harvey, 2017). The beauty of a musical performance is influenced largely by the quality of the musicians' technical and musical skills, their appearance, physical expressiveness and overall stage presence, as well as the listeners' own musical expertise and socio-cultural factors (Coutinho & Scherer, 2016).

Plato (427-347 BCE) wrote of the connection between the love of good and beautiful things and happiness (Harrington, 2013). In this study, a beautiful musical experience was not guaranteed, especially when using student musicians to provide the music. Musician number 1, a violinist in her early twenties, gave three live performances for students, all of which were later heard as MAV and MA. Whilst the three ML listeners provided positive adjectives for their one-word summaries (soothing, engaging, ballet/dance), the

MAV and ML listeners were less consistently enamoured with the performances (relaxing, repetitive, and grating after MAV; and wincing, relaxing, and painful following MA).

The timbre of this violinist and instrument were particularly an issue, with the at times harsh rather than sweet sound being exacerbated in the recorded versions. Timbre contributes to the degree of pleasantness, and plays an important role in determining emotional responses in the listener (Hailstone et al., 2009). In a professional studio recording the timbre can be remediated; but in this study there was no attempt made to alter any aspect of the timbre or intonation of the player. Current studio practice uses technology to automatically correct pitch, as well as to remove some of the harsher overtones. The end result, according to Milner (2009), is a very inhuman droning effect. Particularly problematic is the application of artificial equal temperament — where all semitones are equally spaced — to tune notes rather than the temperament which is appropriate for the genre. For example, in baroque, klezmer, or jazz, depending on the key and chord progressions, certain semitones will be narrow whilst others are played wider. This sense of bending notes adds to the tensions and resolutions in the musical structure. Tampering with it alters the listener's perception of some of the important emotional cues inherent in a musical performance.

Not only listeners are influenced by the acoustic quality of the performance space. The room itself transforms the musical sound and alters the way the musician plays his or her instrument, which impacts on expressive factors such as dynamics and timbre (Schärer, Kalkandjiev & Weinzierl, 2015).

Live versus recorded stories

Music listeners have expectations about musical interpretation, technique, sound quality, and so on. Participants listening to stories were likely to be more open to how they were delivered, which may partly explain the mixed results when comparing SL to SA.

Recapping the students' stress markers, sAA remained lowest after SL, whilst there was no difference in the final falling levels of sC between the two groups. However, the SL levels fell faster between the second and third samples,

indicating a stronger delayed anxiolytic effect. The residual increase in spH, an indication of reduced anxiety, was higher in SL than SA. Differential results of immune markers were similarly mixed for students. SA sIgA remained slightly above baseline whilst SL fell, but sIL-1β settled slightly lower after SA than SL.

Students reported more decrease in anxiety after SA than SL. This is consistent with the differential VASA scores for MA and ML. Similar psychosocial factors to those discussed earlier may have contributed to these unexpected results. Patients' final VASA scores were above baseline for SA but remained reduced after SL. Differential results for students' VASP were not apparent, but patients reported more residual pain relieving benefit from SA than SL. However, the clearest consistent pattern is apparent in the affect scales, with SL scoring higher than SA on all four scales across both cohorts, except for liking and absorption in the patient group.

In summary, the stress markers indicated more residual benefit from SL than SA, but this was neither corroborated by the VAS sores nor by the mixed immune marker outcomes. Overall there are no conclusive differences, or distinct patterns of benefits, between SL and SA across the outcome measures.

Music versus stories

I prefer to view music as an expanded form of expression
[which] makes full use of the properties of sound to move
the human body in ways that speech cannot.

(Wallach, 2003, p. 36)

Music communicates differently to speech, despite both music and language sharing syntax, prosody and hierarchical structures that need to be processed by the listener (Harvey, 2017; Lerdahl, 2001). Where language conveys thoughts and emotions directly through words and phrases, the notes and phrases of music are more abstract and open to interpretation. These factors likely influenced the participants' perceived emotions, with stories being scored higher than music by students and patients on this affect scale. Patients also scored the felt emotion scale higher after stories than after music.

Stories have a direct effect on thoughts. If fully engaged whilst listening to stories being read, the listener's own thoughts do not remain salient. Negative

ruminating thoughts can therefore be set aside. The moderating effect of more positive thoughts that are less focussed on the past can be seen in lower sC and sAA (Engert et al., 2014). Compared to visual stimuli, sound is more difficult to ignore or detach from (Wallach, 2003). It could be that the added level of semantics present in speech compared to music may lead the listener to engage cognitive processes more automatically when hearing someone speak in a language that they comprehend. Readers may recall situations where foreign languages spoken around them can be ignored as they hold no direct meaning, whilst conversations in a language they do understand are more salient.

Engagement

The accessible semantic content of the stories in this study provided participants with an inherent level of challenge as they concentrated on the narrative, a clear goal of listening and following the stories, and the immediate feedback of comprehending and hopefully enjoying them. These three factors are necessary to achieve a level of flow, or peak experience and immersion (Harrington, 2013). Music may have been less accessible for some of the listeners, thus not automatically providing all three requirements for full engagement.

Emotions

Sound, from any source, has the ability to envelop the listener (Wallach, 2003). Most sounds convey emotional information, whether speech, music, or sounds from the natural or man-made environments (Weninger et al., 2013). Music, with its tendency to resonate and create multiple layers of sound waves, would appear to have more capacity than human speech to surround the listener, and therefore engage and impart emotional content.

Both music and stories can also evoke memories from the past (Forsblom et al., 2010), thus eliciting emotional responses. Scores on the affect scales support this: there was little difference between music and stories across the scales and cohorts, with stories being scored slightly higher than music, except for liking by students; and no difference on felt emotion and absorption for students or liking by patients. The affect scales were only scored once by each participant, immediately after the interventions, so give no indication of any longer lasting benefits.

Residual effects

Looking at the biomarker results of music compared to stories may give some insight into which intervention provides a longer residual effect, as measured in the third saliva collection. Levels of sAA remained lower for music than stories. However, residual levels of sC and spH indicated stories had a stronger lasting relaxing effect than music. Immune marker results are also not clear cut. Residual levels of sIgA fell sharply for music listeners but remained closer to baseline after stories. In contrast, the residual levels of sIL-1β indicate a stronger lasting immune benefit from music. However, as Miller and Cohen (2001) pointed out, it is not clear how long such changes persist and if they last sufficiently long to influence the listener's risk of disease.

In considering the longer term differential therapeutic effects of music and stories, a comparison of listening to music and audio books found stroke patients benefited more from music in terms of relaxation, positive mood and increased motor activity (Forsblom et al., 2010). The authors suggested that music impacted on emotions more than the audio books did, thereby contributing to the heightened benefits described. The study collected subjective data over a period of two months. The snapshot data collected in this current study did not allow for such appraisal of more long term benefits of the interventions.

An important caveat in discussing the differential outcomes of music and stories in this study is that for the student cohort the stories (13.60 minutes) were shorter than their music programs (24.21 minutes). Those listening to the shorter presentations may have had less time to get bored or irritated if they were not fully engaged or enjoying the experience. Even so, the absorption scale for ML (8.2) was higher than for SL (7.3), although there was no difference in this scale overall between music and stories.

Music and locus of control

To a certain extent, we surrender to music when we listen to it – we allow ourselves to trust the composers and musicians with a part of our hearts and our spirits; we let the music take us somewhere outside of ourselves.

(Levitin, 2006, p. 242)

Those suffering from any form of chronic illness or impairment are likely to experience reduced sense of control over their activities and environment (Pothoulaki et al., 2012). Music has been shown to contribute to a person's sense of control and autonomy (Pothoulaki et al., 2012). Furthermore, an individual's perceived sense of control over their circumstances or environment may buffer the impact of stress on their immune function (Khalaila et al., 2014).

One of the limitations of music selected by the researcher is that it represents an external locus of control (Chanda & Levitin, 2013). However, in reality there is little control over a music program when a listener attends a live performance, or even when listening to broadcast music such as on the radio, other than choosing a certain genre. Decisions about what music will be played are generally in the hands of the performers or producers of a program. A listener may exercise control only by remaining present or leaving the performance space, or switching off the music playing device, or by moving their attention away from the music.

One of the joys of listening to music is being drawn into the music and being absorbed. Absorption, or effortless engagement (Herbert, 2011a), actually requires the relinquishment of control and a surrender to the musical experience.

Surrender

Why had this familiar part [of the Brahms] become filled with a power so great that I was forced to surrender? . . . [It] seemed to reach out and grab me by the soul. . . .
I began to weep.

(Robertson, 2016)

Emotions conveyed by music can be related to on a cognitive, intellectual level. However, simply understanding musical emotions is not the same as allowing oneself to be immersed in them (Sandstrom & Russo, 2011). Musical absorption necessitates a willingness to let go of the external environment and surrender fully to the musical experience and its emotional consequences (Levitin, 2006).

Music in particular facilitates absorption due to the multiple modalities and processes it involves, including auditory and other senses, where the music emanates from, entrainment, emotions, and so on (Herbert, 2011a). Live music especially, through engaging on a multisensory level, is ideally placed to fully absorb the listener (e.g., Cason & Grissom, 1997). In this study, live presentations resulted in higher absorption ratings than the audio music and stories in both student and patient cohorts, although there was little distinction between the music and stories.

Participants spontaneously commented on their surrendering to the music, and also the story readings, either physically, physiologically, or emotionally. ML participants spoke of being lost in the experience, being carried along on an emotional journey, and experiencing musical chills as well as tears. SL listeners reported emotional responses of peace, enjoyment and feeling uplifted. There were comments from participants across all the groups, except SL, of wanting to drift off to sleep.

Many of the one-word responses elicited also referred to listeners' surrender to the moment. Nine of the ten ML students used adjectives such as relaxing, engaging and soothing. Only three of each of the MAV and MA groups said it was relaxing. Three students described SL as relaxing or calming, whilst all but one of the SA listeners used similar adjectives. The presence of the reader appeared to keep the SL listeners in the here and now, drawn to the human interaction — perhaps feeling obliged to remain attentive in the company of the reader — rather than surrendering to the listening experience.

Overview of comparisons

What the results show

Differential biomarker outcomes, as well as a mix of corroborating and non-corroborating subjective data, vindicated the use of multiple measures to test whether live music has more therapeutic benefits than recorded music modalities. PNE processes involved in music perception are never straight forward as they require numerous environmental and sensory input systems, and engage a complex network of cognitive, emotional, neural, and hormonal interactions. Variations between biomarker responses reflect differential stress

and immune system patterns of the HPA, SAM and natural versus acquired immune systems. Whilst the varied results are open to interpretation, they do identify some consistent trends that contribute to our understanding of the differential mechanisms at play when listening to live or recorded music and stories.

Inconsistencies in biomarker results in part reflect the separate stress or immune systems that the markers responded to. There was clear support from the sAA outcomes for the study's hypothesis of ML being a more effective anxiolytic than MA, and music overall being more effective than stories. However the sC levels, whilst indicating benefits from all the interventions in targeting anxiety, were in the opposite order to the hypothesis. A mixed trend emerged from the spH readings: stories showed a stronger anxiolytic effect than music, but live interventions appeared to be more relaxing than audio music and stories.

Immune markers indicated that ML contributed more to immune function than the other interventions, and that live music and stories had more positive effect on the immune system than audio. Initially music contributed to higher levels in both sIgA and sIL-1β, but a rebound in the final sample of sIgA led to less of a fall below baseline after stories than after music.

Rebounds are considered to reflect oscillations towards homeostasis in faster acting markers (sAA and sIgA), and the residual effects of slower responding markers (sC, spH and sIL-1β).

Students' VASA results were similar to the sC profile. Patients' VASA scores are less clear, but SL stands out as the most beneficial intervention and MA as the least. MA also had the least initial analgesic effect for patients according to the VASP. This was also the case in the students' final VASP scores. Patients reported most initial impact on pain after MAV, whilst students showed most residual benefit from MAV. Apart from the negative effects seen for MA (except in the students' VASA), overall the VAS results were inconclusive. However, an evaluation of the clinical significance of patients' VAS scores concluded that those exposed to live music or stories were more likely to report CS benefits than the patients who listened to audio interventions.

Scores on the affect scales were more consistent, and supported the hypothesis. They reflected a relationship between liking the presentations and

positive scores for perceived and felt emotion as well as engagement. The one-word responses also saw trends of more positive responses from students to ML than MAV and MA. This was less clear in the patients' responses to music, or with the responses from both cohorts after they listened to stories.

The unexpected contribution to the data of unsolicited comments offered by some students and patients illustrated the real experiences of these participants and helped frame some of the explanations for the results covered in the discussion and recapped now.

Possible explanations

The most obvious differences between the two cohorts were age and health status. Patients were around twice the age of the students, which influenced musical taste and patterns of consuming music (Chamorro-Premuzic et al., 2010). Age and health status were both likely moderators of immune function (Griffin, 2006). Unfortunately, no direct immune system comparisons were possible due to insufficient PNE data from the patients.

It is likely that live acoustic music is a more natural experience for many older people compared to those of the students' generation who are perhaps less comfortable with the intimacy of such an experience. Having a story read is a more universal experience, and evokes positive childhood memories.

The acoustic quality of the space where stories are read is less important than where music is played. Acoustics were part of the contrast between the two settings of a hospital room and the university laboratory. The hard bare surfaces of the room at the university compounded the negative timbral aspects of some of the musicians, which were further attenuated in the recorded versions. The hospital rooms were less bright acoustically, and also provided a more comfortable and pleasant physical, visual and social context for the interventions.

Timbral differences between the instruments were another possible confounding variable (Hailstone et al., 2009). However, the one-word responses did not highlight any differences between words chosen after violin, viola or cello programs. It is likely that variable skills of the musicians were a more prominent factor than their instruments.

Live and recorded music are usually engaged with in different contexts. Exposure to some form of recorded music whilst going about everyday activities is almost unavoidable (Sloboda et al., 2001). Live music, in contrast, is usually consumed through choice and therefore has more intrinsic value for the listener (Coutinho & Scherer, 2016). As a result the listener may be more attentive, and also have expectations that the experience will be enjoyable and even relaxing (Lamont, 2011). Such preconceptions can even elicit a placebo effect, with reduced anxiety and pain, and release of endogenous opioids (Buhle et al., 2012). Once either live or recorded music is heard, classical conditioning associating certain classical music with relaxation may even come into play (Chafin et al., 2004). Linneman and her co-authors (2016) reported that solitary music listening reduced stress when deliberately used for relaxation. On the other hand, expectations based on "perfect" recordings can set up unreasonable forecasts of the quality of a live performance (Milner, 2009). Such expectations are less likely to be an issue with story reading.

An unexpected outcome of this study was the positive effects seen in some story listeners. Having stories read to participants evoked positive childhood memories and stimulated feelings of comfort (Forsblom et al., 2010). The advantage of story reading is it does not require a trained person or any equipment to provide the intervention. A volunteer or family member can sit at a hospital bedside and read to a patient. And if no one is available to do so patients have the option to listen to audio books on their mobile phone or similar device.

Overall there was little to differentiate the SL and SA interventions. A likely moderator was the presence of the researcher during all data collection. Her interactions with the participants as part of the procedures and during the waiting time between data collection points introduced social contact to the SA group which may not occur in a naturalistic setting where a person listens to an audio book on their own. The same was the case for the recorded music groups. Despite this, ML was still superior to recorded music in a majority of the objective and subjective measures.

Another moderator of the positive effects of ML and MAV is the visual distraction inherent in these modalities, leading to possible incongruence between the sound and visual components. MA allows listeners to create their

own visual imagery (Vuoskoski et al., 2016). On the positive side, watching a musician who is emotionally engaged in their playing can draw the listener in, through emotional entrainment and processes involving mirror neurons (Damasio & Damasio, 2006). Cross-modal interactions between the audio and visual also amplify emotions (Vines et al., 2010) as well as the physiological evidence of emotions felt by listeners or viewers of one mode only, highlighting the importance of being able to view the musician (Chapados & Levitin, 2008). Indeed, musical chills and other strong experiences with music are more likely to occur at live music events (Lamont, 2011).

What separates ML from MAV is the physical presence of the musician. The dynamics between the musician and listener are bidirectional, with subtle changes in a performance occurring in response to the behaviour of the listener (Shoda & Adachi, 2015). In turn, the listener's emotions respond to the physical expressiveness as well as appearance of the musician (Behne & Wöllner, 2011). And there is a mutual sense of gratitude inherent in the social transaction of the shared experience. Acoustic music played in a small space increases this sencse of intimacy, although it may cause some listeners to feel awkward. Close proximity of the musician also allows for the listener to sense the audiotactile presence of the sound waves surrounding them (Wallach, 2003), even if they are not consciously aware of this phenomenon.

The affect scales demonstrated the superior ability of ML to engage the listener. They also corroborated an earlier finding that increased absorption is associated with heightened perceived and felt emotion (Herbert, 2011a).

As well as heightening emotional responses through multiple modalities, ML increased arousal more than MA or MAV. Musical chills are associated with brain regions involved in reward and motivation, but also those linked to arousal (Blood & Zatorre, 2001). Whilst biomarkers respond to stress they may also be responding to eustress, or positive arousal, which explains how stimulating music can increase sC as well as sIgA (Chanda & Levitin, 2013). Previous studies using vital signs have also picked up this positive arousal response, resulting in self-reported decreased anxiety not being reflected in the physiological outcomes (De Marco et al., 2012).

Methodological issues

Design and data collection

This research project was intended as an exploratory study to be used as a springboard for further research in this underexplored area of comparing live to recorded music. The resulting small sample size limited conclusive results but provided a strong basis and direction for future investigations. Trends observed may hold with larger group numbers to provide statistical evidence to corroborate the findings presented here.

The inherent design, which required some ML and SL interventions to occur before they could be heard as videos or audio recordings, precluded full randomisation of participants, although this was achieved wherever possible. Participants were informed they would be listening to music or stories before they gave their informed consent. The nature of the music or stories was not disclosed, nor the mode of presentation, until they were about to listen and either a live presenter appeared or they were asked to watch a video or listen to an audio recording. However, there may have been an element of anticipation for some that the experience would be a relaxing one. When people choose to attend a musical event they can have premeditated eager expectations about the possibilities that the ensuing music will or may evoke intense emotional experiences (Lamont, 2011). However, with the nature of participants' upcoming experiences being less clear than if they were choosing to attend an event already aware of its performers and program, there may have been apprehension rather than eager anticipation for some.

Other researchers have reported unexpected negative outcomes with stress biomarkers, in particular sC, due to methodological, physiological, or even pathological issues. These include compliance with protocol, collection times, other stressful events colouring sC levels, or underlying disease and medications (Gröschl, 2008). In this study there was no way of controlling compliance with pre-collection protocols or external stressors. Collection times were a compromise between ideal times for some markers but not others, as well as practical considerations such as hospital routines.

Medications, particularly for the clinical cohort, were a likely moderator, masking the true levels of underlying anxiety and pain for some patients. Any

anxiety experienced before saliva collection, even stress associated with getting to the venue on campus, could have contributed to initial higher sC levels which subsequently fell across all student intervention groups. Final results may have been clearer if a cool down period of 15 minutes was included in the protocol before baseline measures were taken.

Baseline levels of salivary markers can also be affected by anticipation of a positive, or apprehension about a negative experience (Borgeat et al., 1984), such as expectations of relaxing with music, or anxiety about giving a saliva sample. Variations in baseline levels may have partly been due to participants' background moods (Balteş & Miu, 2014), which were not measured in this study. Underlying affective states were possible moderators of subsequent responses to the interventions.

The very act of collecting data can affect outcomes (Pearson et al, 2005). A phenomenon known in physics as the Heisenberg uncertainty principle poses that it is impossible to simultaneously measure both the position and momentum of a particle. Attempts at measurement change the behaviour of the particle, so corrupting the results. To a certain degree this principle can also be applied to data collection in the social science realm, as any information about behaviours, emotions, or physiological functioning can be influenced by the collection process itself. Hellhammer and his colleagues (2009) suggest that the process of self-reporting stress may actually increase stress levels. Saliva collection, or even the feeling of being scrutinised, may also contribute to stress, or at the very least increase arousal. Participants were given other tasks during saliva collection, such as filling in questionnaires and completing VAS scales, to minimise the focus on producing the sample. Even so, it was apparent that some found it embarrassing, or had "performance anxiety" around supplying enough saliva. Not every participant was affected by this to the same degree — some were matter-of-fact about the saliva collection process whilst other clearly appeared to be uncomfortable and self-conscious — a factor which increased the overall variance in the results.

Authors of a study comparing the properties of saliva, before and after a relaxation session or a stressful procedure, noted that both the pre- and post-procedural saliva samples differed between the two conditions. Their interpretation of this anomaly was that the changes in saliva were more related

to apprehension and anticipation of the situations than to the interventions themselves (Borgeat et al., 1984). Thus the psychosocial effects of taking part in an experiment can have a measureable moderating influence on outcomes. As discussed earlier, the overall fall in sC levels across all interventions may be an example of this moderating effect.

Consciously attending to pain and anxiety, as participants have been asked to do in this study, may undermine the effects of distraction that a music intervention is designed to facilitate. In a study aimed at clarifying the anomaly of rating subjective experiences, it was found that a delay of 10 minutes in rating pain after a cold-pressor pain test led to reduced reports of pain in highly distracted participants as compared to those who gave immediate pain ratings (Christenfeld, 1997). This may in part be explained by variations in memory of the pain, but it appears that the recalled pain is at least in part attenuated by the distraction during the acute pain experience.

Self-reports have inherent linguistic issues in defining the constructs of pain and anxiety. Variations in participants' understanding of these terms may have moderated some of the VAS results of both cohorts. In addition, low baseline VAS levels amongst both cohorts, but especially in the student sample, limited the amount of measurable symptom reduction.

The decision to reduce the length of interventions after the initial 30 students had participated in the music groups was a possible moderator when comparing music to stories. The students' absorption scale was higher for ML (8.2) than SL (7.3) but not for MA (6.0) compared to SA (6.2). However, the patients had music and story interventions of similar lengths, and their absorption scale showed a differential parallel to that of the students, with ML (9.3) higher than SL (7.9), and the reverse for the audio interventions of MA (5.5) and SA (8.0).

The presenters

Presenters were all briefed and instructed not to initiate conversations with participants. However, where a participant, especially in the clinical setting, spoke directly to a musician or reader it would have been unethical to intervene and curtail the interaction. In most cases there was only limited interaction, with a brief greeting from the presenter, or thank-you from the listener at the

end. One of the musicians did not adhere to the protocol, introducing the pieces as well as encouraging conversations with the patient. It was apparent that he had some anxiety and concern around being in the palliative care unit and playing for a patient who was facing death. The debriefing session afterwards indicated he was carrying unresolved taboos around death and dying.

Another musician faced a confronting situation when she played for a patient in exactly the same room where her grandmother had spent her last days. She disclosed this after the music session, but did not appear to be unduly upset by the experience at the time or in later follow ups. However, these two cases highlight the necessity to be aware of the needs of the presenters who are providing bedside interventions in an environment for which they are not specifically trained (Preti & Welch, 2012 & 2013). Ideally some form of training or initiation should be completed by musicians before they work in clinical settings.

Laboratory issues

Data collection was spread over nineteen months and, with the additional time taken to complete assaying of all samples, some saliva remained frozen up to twenty-one months. However, this long and variable freezing time is not considered to have had any deleterious effect on the integrity of the samples.

Freezing and several thaw-and-refreeze cycles may have affected the spH of samples through potential loss of carbon dioxide whilst the samples were open to the air. Ideally spH should be tested immediately when a participant provides a sample. Based on recent trials by this researcher using the same electronic meter on fresh saliva samples, it is likely that clearer results would have emerged from the spH measurements if they had been done in situ at the time of collection.

Internal validity

The researcher had no control over other activities that participants may have engaged in before or, in some cases, after the interventions. Perhaps a student was listening to music in her car on the way to the session. A patient may have had a hand massage or a relaxing chat with a volunteer or family member. On the other hand, a student could just have had an altercation with a friend, or a patient received some confronting news from a clinician. A cooling down period

of 15 minutes is therefore advised for future studies before the baseline measurements are taken to provide a buffer from such possible contamination.

Bias was managed as closely as possible. It was not altogether avoidable given that the researcher was also the data collector in this study, although all music and stories were deliberately presented by third parties. Being constantly aware of the possible effect of preconceived notions of likely outcomes, a reflective approach throughout data collection, analysis and reporting was applied to mitigate these potential influences.

External validity

Music and stories selected for the interventions were standardised in order to strengthen the internal validity of the study. However, as with other studies faced with the same issue (e.g., Knight & Rickard, 2001), this decision was made whilst being mindful of its effect on external validity.

As noted by other researchers (e.g., Chafin et al., 2004), a limited repertoire of classical pieces may not be generalisable to the whole genre of classical music. However, their study only used two baroque pieces to represent the classical genre, whereas this study used music from the baroque through to the romantic periods.

Two different cohorts were examined to increase external validity. Both a normal healthy population of students and a clinical population of critically ill palliative care patients and less ill surgical patients provided a range of adults to trial the methodology of salivary biomarkers as well as test the hypothesis of live versus recorded music.

Whilst the samples used for this study may have been affected by potential candidates not taking part, where such interventions are used therapeutically in clinical settings it is likely that the same will occur. Only those who like the idea of listening to music or stories, and who have the inclination to do so at the time it is available, are likely to be involved in such a program. This salient point segues neatly into the next chapter, which starts with a brief discussion on who may benefit most from music applied therapeutically.

Chapter 6: CODA - Conclusions

In the end, this music can only be experienced. Interpretation fails. Words are useless. Recordings do it no justice. You have to see the melody emerge from deep within the singer's body. To hear the melody being born out of the singer's mouth. To touch the melody as it travels through space. To smell the melody as it submerges into your own body. Echoing. Vibrating. Ecstatic.

(Kosky, 2008, p. 86)

So who will most benefit from music (and story) interventions?

Music's effects will vary as a consequence of what is being presented and how it is employed in the therapeutic context (Fancourt et al., 2014). The use of music in clinical settings is both idiosyncratic and at times ad hoc. It is delivered by a wide range of professional clinical and non-clinical staff, as well as untrained volunteers. Live music in particular is likely to encompass considerable variations in quality of musicianship as well as appropriateness of the music selected.

The literature makes a clear distinction between music therapy (MT) and music medicine, with MT based on a therapeutic relationship, whereas music medicine is described as involving only a stimulus and response (Archie et al., 2013). And there was a variable response to the stimuli in this study, with a measureable difference in the outcomes for those exposed to live music compared to those who did not have a musician in the flesh.

Music therapists contribute to both the research and application of music as a therapeutic intervention. However, as canvassed in the literature review, there are methodological and bias issues associated with many studies carried out by music therapists. As a result, there is a risk of overstating the benefits of music per se. In part this study confirms that, with stories providing similar positive effects to music in some cases. As with any human-delivered intervention, a proportion of the benefits can be attributed to psychosocial confounds inherent in the process, which this study attempted to tease out.

That said, there were differential effects observed both between live and recorded music, as well as music and stories. In the clinical setting it was noted

that patients exposed to live music or stories were more likely to have clinically significant (CS) benefits, as per their VAS scores. Live stories were particularly effective in promoting CS outcomes. Patients' other self-report data, as well as that of the students, also pointed to greater benefits from live interventions. However, there was little difference between music and stories on these scales.

In considering who is most likely to benefit from music, or for that matter also story interventions, it was also noted that the level of presenting symptoms moderated outcomes: those with higher baseline levels of anxiety or pain benefited most from their participation.

The potential to routinely use music as a pre-med for surgery patients has empirical support from this study as well as earlier research (e.g., Bringman et al., 2009; Leardi et al., 2007). The intervention is non-invasive, flexible, and low risk, may be self-administered in the case of recorded music, and has the real potential to reduce pre-operative anxiety and recovery time as less pharmaceutical therapies are required (Pearson et al., 2005).

The literature has explained the links between pain and anxiety. It also is apparent that early identification of pain, and the anxiety which has the potential to exacerbate the pain, is important in mitigating possible negative outcomes for patients (Vaughn et al., 2007). Music applied routinely in clinical settings can provide a safety net for those patients with symptoms that have not been diagnosed or adequately addressed by other psychosocial or pharmaceutical interventions. Being holistic in its effects, music targets both pain and anxiety simultaneously, which is the recommended approach for pain treatment (Vaughn et al., 2007). The benign nature of music, both live and recorded, means that it can be widely applied, even in a prophylactic capacity, without the risks associated with medications, such as premeds given before surgery. Reducing pre-operative anxiety has lasting positive benefits, including faster recovery rates and enhanced mental functioning even one month later (Pearson et al., 2005).

Compared to other psychosocial interventions available to tackle pain and anxiety — for example meditation, or psychotherapy — music offers the possibilities of relief from symptoms without any effort demanded of the listener. Music conveys non-verbal messages, allowing the listener to connect with emotions and thoughts, leading to both introspection and connection with

the social environment (Fraser & Al Sayah, 2011). As an intervention, music also does not require any invasion of equipment or the physical contact of another person, as is the case with other complementary therapies such as massage, reflexology, or acupuncture.

Walworth's (2010) study demonstrated the live music effect is apparent even when the music is not seen or heard face to face, but is experienced through headphones. Her participants were cocooned inside MRI machines whilst listening to recorded or live music. One explanation may be that live music, being generated in real time, offers more flexibility than the recorded modalities (Longhi et al., 2013). The ability of a live musician to entrain their music to the participant's emotions, movements, physiological rhythms as well as environmental noises and other cues, has no parallel with played-back recorded music.

PC patients also were shown to be beneficial recipients of the interventions offered in this study. They expressed gratitude and sincere appreciation for the music and stories. Patients were treated to quality musicianship and expressively presented story readings. This high standard was important in achieving the desired outcomes.

The methodology of salivary biomarkers

Saliva as a source of biomarkers for assessing outcomes in music psychology research has been demonstrated in this study as being a practical, simple, non-invasive methodology which is deserving of broader and more widespread application in the future (Singhal & Anand, 2013). However, it was not as effective in the vulnerable clinical population, with some patients unable or unwilling to provide saliva, or not able to produce enough volume for assaying.

With access issues, special skills required, and the high costs associated with laboratory assaying of biomarkers, the growing availability of lab-on-chip assaying systems is a promising development for both research and evaluation of music interventions in clinical settings. This study has already demonstrated the benefits of using a simple hand-held meter for measuring salivary pH. No training or expertise was required to use this instrument. Also, only tiny quantities are required (which addresses some of the issues that arose with the

clinical participants), and saliva can be tested in situ, so requiring no transport or lab storage, as well as providing immediate results.

Some final thoughts

When we talk about the value of arts and culture, we should always start with the intrinsic – how arts and culture illuminate our inner lives and enrich our emotional world. This is what we cherish.

(Mowlah, Niblett, Blackburn, & Harris, 2014, p. 4)

Research into the benefits of music for health and wellness is still in its infancy. There is so much to still discover. The early researchers in this field believed that music interventions could act via the immune system to bring benefits to our health and wellbeing (Gruzelier, 2002). Their convictions, confirmed by subsequent research, are now being given further support by the findings of this study.

This project adds to the growing understanding that music can impact positively on symptoms such as anxiety and pain, and even boost the immune response of the listener. Together with other increasing evidence of the flow-on effect when immune systems are better able to resist potential threats, as well as fight existing pathologies (e.g., Glaser & Kiecolt-Glaser, 2005), the potential for music to be integrated into healthcare settings is enormous. Music can be introduced into many settings, from waiting rooms to surgical theatres to treatment areas and palliative care facilities.

Despite the convincing body of evidence supporting the value of cultural and arts practices, their relevance to our health and wellbeing are not being actively discussed in vital areas of both health policy and arts funding (MacDonald et al., 2012). Some collaborative programs described in the literature review bring together professional musicians and clinical staff to integrate live music into healing environments (e.g., Richards, Johnson, Sparks, & Emerson, 2007; Rockwood Lane, 2006; Trythall, 2006).

What about the future role of musicians in healthcare settings? There is a clear need for the collaboration of musicians with healthcare providers to cultivate some of the positive outcomes that have been discussed in this thesis. The challenges lie in defining roles for musicians, who are neither therapists nor

healthcare specialists (Daykin et al., 2006), and in providing the appropriate professional development and training to allow them to feel confident and effective, as well as safe, whilst participating in this important role. Currently there are no clearly defined prerequisites for musicians who wish to be involved in this type of work, and virtually no formal training programs for them (Daykin, 2012). Undergraduate music students, with their two-pronged focus on performance and pedagogy, are rarely enlightened about the potential for using their skills in health-promoting capacities.

What underpins this narrow perspective is the lack of understanding in general of the value of music, and therefore musicians, in promoting health and wellbeing. In Australia, music is relegated to an extra-curricular activity in education and not given the weight and funding it rightfully deserves. If we fail to support the development of young musicians we are unable to infuse our communities with the quantity and quality of music required to bring health benefits to everyone.

In our technology based world it is refreshing and reassuring to be reminded of the relevance of human presence in delivering arts based interventions. Some of the reasons for this have been explained, and hopefully further research will throw more light on this important field. However, it is also possible that not everything will be explained by scientific pursuits. As Chemali (2010, p. 74) eloquently stated, “art cannot all be explained by science, particularly musical emotions, in a similar way that faith or love cannot be entirely quantified or explained fully”. There will likely remain many unanswered questions surrounding this complex and at times enigmatic meeting of the arts and science.

So I say
Thank you for the music, the songs I'm singing
Thanks for all the joy they're bringing
Who can live without it, I ask in all honesty
What would life be?
Without a song or a dance what are we?
So I say thank you for the music
For giving it to me.

(Ulvaeus & Andersson, 1977)

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APPENDIX A: Recruitment and information materials

The first of the three appendices includes recruitment forms and materials used in both settings of the study, as well as information materials and consent forms provided to hospital staff, and prospective participants and presenters.

Edith Cowan University
School of Psychology and Social Science

INVITATION TO PARTICIPATE IN RESEARCH

♪ ♫ ♪

PhD STUDY COMPARING DIFFERENT MODES of MUSIC and STORIES

- ♪ INDIVIDUAL session on-campus LISTENING to 15 min of music or stories
- ♪ MUSICIANS and NON-MUSICIANS ALL WELCOME !
- ♪ Use of SALIVA SAMPLES to measure physiological effects
- ♪ BE PART of MULTI-DISCIPLINARY SCIENTIFIC RESEARCH STUDY bringing music, psychology and medical sciences together
- ♪ HELP CONTRIBUTE to BETTER UNDERSTANDING of COMPLIMENTARY THERAPIES that may help patients in various clinical settings

♪ ♫ ♪

Please contact researcher

RONNIET ORLANDO

[redacted]

♪ ♫ ♪

Cognition Research Group Telephone: +61 8 63045724 Email: rorlando@our.ecu.edu.au Web: http://www.ecu.edu.au/schools/psychology-and-social-science/research-activity/cognition-research-group

Edith Cowan University
School of Psychology and Social Science

INVITATION TO PARTICIPATE IN RESEARCH

♪ ♫ ♪

PhD STUDY USING MUSIC AND STORIES FOR PALLIATIVE CARE CANCER PATIENTS

- ♪ PERSONAL PRIVATE session, listening to 25 minutes of music or stories
- ♪ Use SALIVA SAMPLES to see effects
- ♪ GENTLE and NON-INVASIVE
- ♪ HELP CONTRIBUTE to BETTER UNDERSTANDING of ADDITIONAL treatments that may help patients in palliative care

♪ ♫ ♪

Please tell WARD STAFF if you are interested,

or

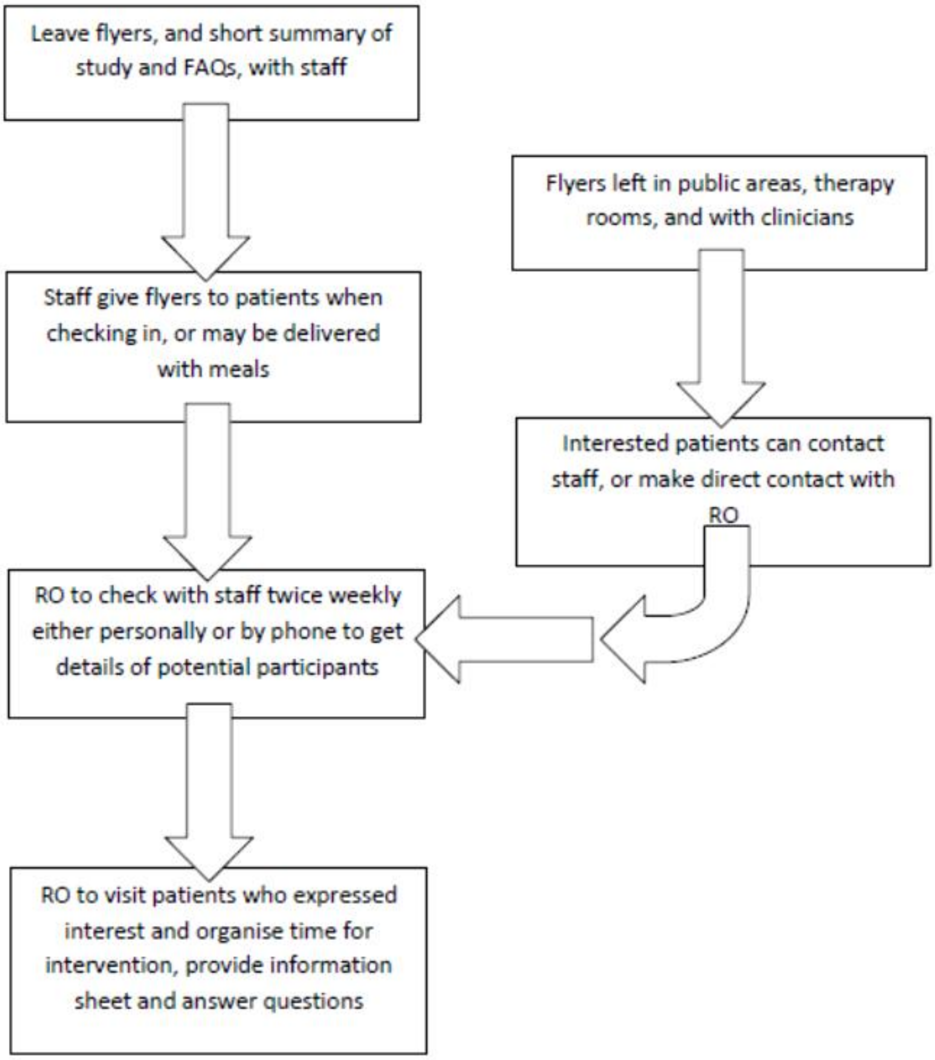
[redacted]

♪ ♫ ♪

Form no: RC 01

Cognition Research Group Telephone: +61 8 63045724 Email: rorlando@our.ecu.edu.au Web: http://www.ecu.edu.au/schools/psychology-and-social-science/research-activity/cognition-research-group

Recruitment flow chart



Edith Cowan University
Faculty of Health, Engineering & Science

LISTENING to CREATIVE ARTS: PhD STUDY

PhD candidate Ronniet Orlando is interested in comparing the effects of live and recorded music and book readings on pain, anxiety and immune responses of palliative care patients.

WHO

- Oncology patient s (total 100)
- 18 years or older
- Adequate English language skills to answer simple questions
- No cognitive or hearing impairment

WHAT

- Individual interventions, allocated quasi-randomly to conditions 1 to 5
- Live musician / reader will be recorded for other patients to receive audiovisual or audio interventions
- Instruments used: solo violin, viola or cello
- Patients asked to provide 3 saliva samples for objective biomarker data
- Subjective data : visual analogue scales, short questionnaires
- Patient charts will be accessed for pharmacological data
- TIME: setup, 15 min music or reading plus data collection, & 20 min rest, total less than an hour
- ALL interventions and data collection are responsibility of the researcher

WHERE & WHEN

- Patients' rooms: Mondays, Wednesdays and Fridays
- Commence mid-Jan 2014 – through to around Sept/Oct 2014

HOW – RECRUITMENT

- Flyers in reception, and handed to new patients when admitted
- Ronniet to liaise with staff and personally follow up any interested patients
- *Patients are under NO OBLIGATION to participate, and may withdraw at any time, even after agreeing to or commencing their participation. Their interests, comfort and well-being come first and foremost*
- Staff may also be asked for feedback on the project. Consent forms to be signed by these staff members for use of their responses in the study

CONTACT: Ronniet Orlando Telephone: 0402084765 Email: rorlando@our.ecu.edu.au

Edith Cowan University
Faculty of Health, Engineering & Science

LISTENING to MUSIC or STORIES: PhD STUDY

PhD candidate Ronniet Orlando is interested in comparing the effects of live and recorded music and book readings on pain, anxiety and immune responses of surgical patients.

WHO

- Pre-op surgical patients (total 100)
- 18 years or older
- Adequate English language skills to answer simple questions
- No cognitive or hearing impairment

WHAT

- Individual interventions, allocated quasi-randomly to conditions 1 to 5
- Live musician / reader will be recorded for other patients to receive audiovisual or audio interventions
- Instruments used: solo violin, viola or cello
- Patients asked to provide 3 saliva samples for objective biomarker data
- Subjective data : visual analogue scales, short questionnaires
- Patient charts will be accessed for pharmacological data, length of stay
- TIME: setup, 15 min music or reading plus data collection, & 20 min rest, total less than an hour
- ALL interventions and data collection are responsibility of the researcher

WHERE & WHEN

- Pre-op patients' rooms
- Commence mid-April 2014 – through to around Sept/Oct 2014

HOW – RECRUITMENT

- Flyers in reception, and handed to new patients when admitted
- Ronniet to liaise with staff and personally invite patients to participate
- *Patients are under NO OBLIGATION to participate, and may withdraw at any time, even after agreeing to or commencing their participation. Their interests, comfort and well-being come first and foremost*
- Staff may also be asked for feedback on the project. Consent forms to be signed by these staff members for use of their responses in the study

CONTACT: Ronniet Orlando Telephone: 0402084765 Email: rorlando@our.ecu.edu.au

Edith Cowan University
School of Psychology and Social Science

POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITALS: NON-CLINICAL PHASE of STUDY

My name is RONNIET ORLANDO. I am a PhD candidate at Edith Cowan University, carrying out a study about possible beneficial effects for people with cancer of listening to different artistic presentations, such as music and book readings.

You are invited to participate in this study on a purely voluntary basis, without any obligations. You are also free to withdraw from the study at any time after registering, without any explanations or repercussions.

Your participation would involve listening to a 15 minute presentation and answering a few questions about how the experience was for you. We also require a few details about you, such as your age and health status, to help us analyse the results. This information will be kept separately from the other responses you provide us, so you can be assured your confidentiality will be maintained throughout the study.

We will be asking you to provide us with three saliva samples, which will be analysed for different chemical markers to help us understand what is actually happening in your body when you are listening to the presentation. This is a completely pain free collection method, and should only take a minute or two for each.

Some of the participants may have a sound or video recorder in the room, but there will be no audiovisual recordings made of the participants, although audio recordings cannot avoid including sounds and voices present at the time of the recordings. The video and audio recordings may be used for some of the other phases of the study.

This study has been approved by the Human Research Ethics Committees of Edith Cowan University. Such approval assures very high standards regarding how the study is planned and carried out, as well as secure record keeping and confidentiality. The names and contact details of my principal supervisors, as well as contact person for the Research and Ethics committee, are printed below. They may be contacted should you wish to discuss this study with someone other than myself.

I can also be contacted for more information about the study, and would be pleased to hear from you if you would like to participate. It should be a positive experience for everyone involved, and will hopefully lead to a better understanding of additional approaches that may support cancer patients' treatments in hospital.

RONNIET ORLANDO [redacted]

Prof Craig SPEELMAN c.speelman@ecu.edu.au Phone: 08 63045834
Prof Anne WILKINSON anne.wilkinson@ecu.edu.au Phone: 08 63043540
Ms Kim GIFKINS research.ethics@ecu.edu.au Phone: 08 63042170

[redacted] Ronniet Orlando DATE: August 2014

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STUDY of POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITALS

My name is RONNIET ORLANDO. I am a PhD candidate at Edith Cowan University carrying out a study about possible beneficial effects of different arts interventions, such as music and book readings, in hospitals and hospices.

You are invited to participate in a pilot study as a presenter on a voluntary pro bono basis. Your participation would involve preparing a varied 25 minute solo musical presentation for a volunteer student participant. All the music will be supplied ahead of time for you to practice and prepare. Your live presentation will be videoed so that it can be used in other phases of the study. You are welcome to do one or more of such presentations. These recordings will be destroyed at the end of the study, in accordance with the requirements of the Australian Code for the Responsible Conduct of Research.

Dates and times for the presentations will be arranged in advance, at a time suitable for both yourself and the student participant listening to your music. The study will be held at the Joondalup campus of ECU. As a participant you are free to withdraw from the study at any time, without any explanations or repercussions. Notifying me of your intentions to do so would be appreciated.

This study has been approved by the ethics committee of Edith Cowan University. Such approval assures very high standards regarding how the study is planned and carried out, as well as secure record keeping and confidentiality. The names and contact details of my principal supervisors, Prof Craig Speelman and Prof Anne Wilkinson, are printed below, as well as contact persons for the ethics committees of ECU. They may be contacted should you wish to discuss this study with someone other than myself. I can also be contacted for more information about the study.

I hope that you will be happy to participate in my study, and look forward to working with you. It should be a positive and rewarding experience for everyone involved, and will hopefully lead to a better understanding of the effects of different arts interventions in clinical settings.

RONNIET ORLANDO	[redacted]	
Prof Craig SPEELMAN	c.speelman@ecu.edu.au	Phone: 08 63045834
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Ms Kim GIFKINS	research.ethics@ecu.edu.au	Phone: 08 63042170

[redacted]

Ronniet Orlando DATE:

Edith Cowan University
School of Psychology and Social Science

STUDY of POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITAL

My name is RONNIET ORLANDO. I am a PhD candidate at Edith Cowan University, carrying out a study about possible beneficial effects for people with cancer of listening to different artistic presentations, such as music and book readings.

- You are invited to participate in this study on a purely voluntary basis, without any obligations. You are also free to withdraw from the study at any time after registering, without any explanations or repercussions. My primary focus will be your comfort and well-being.
- Your participation would involve listening to a 15 minute presentation and answering a few questions about how the experience was for you. We also require a few details about you, such as your age and diagnosis, to help us analyse the results. This information will be kept separately from the other responses you provide us, so you can be assured your confidentiality will be maintained throughout the study.
- We will ask you to provide us with three saliva samples, which will be analysed for different chemical markers to help us understand what is actually happening in your body when you are listening to the presentations. This is a completely pain free collection method, and should only take a few minutes for each.
- We will also ask you for permission to view your medical charts and records for the 24 hours before and 24 hours after we see you to gain more insight into any effects the intervention may have had.
- Some of the participants may have a video recorder in the room, but there will be no audiovisual recordings made of them, although audio recordings cannot avoid including sounds and voices present at the time of the recordings. The video and audio recordings may be used for some of the other phases of the study, but any identifiable material will be removed to retain the anonymity of anyone, other than the presenter, who was there at the time of the recording.

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Edith Cowan University
School of Psychology and Social Science

This study has been approved by the Human Research Ethics Committee of Edith Cowan University, and the Medical Advisory Committee of Bethesda Hospital. Such approvals assure very high standards regarding how the study is planned and carried out, as well as secure record keeping and confidentiality. The names and contact details of my principal supervisors, as well as contact persons for the two Research and Ethics committees, are printed below. They may be contacted should you wish to discuss this study with someone else.

I can also be contacted for more information about the study, and would be pleased to hear from you if you would like to participate. It should be a positive experience for everyone involved, and will hopefully lead to a better understanding of additional approaches that may support your other treatments in hospital.

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Ms Kim GIFKINS	research.ethics@ecu.edu.au	Phone: 08 63042170

[redacted]

Ronniet Orlando

DATE: January 2014

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Edith Cowan University
School of Psychology and Social Science

STUDY of POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITALS

My name is RONNIET ORLANDO. I am a PhD candidate at Edith Cowan University carrying out a study about possible beneficial effects of different arts interventions, such as music and book readings, in hospitals and hospices.

You are invited to participate in a pilot study as a presenter on a voluntary pro bono basis. Your participation would involve preparing a 15 minute selection of three short stories for a volunteer student participant. The readings will be supplied ahead of time for you to practice and prepare. Your live presentation will be recorded so that it can be used in other phases of the study. You are welcome to do one or more of such presentations. These recordings will be destroyed at the end of the study, in accordance with the requirements of the Australian Code for the Responsible Conduct of Research.

Dates and times for the presentations will be arranged in advance, at a time suitable for both yourself and the student participant listening to your reading. The study will be held at the Joondalup campus of ECU. As a participant you are free to withdraw from the study at any time, without any explanations or repercussions.

This study has been approved by the ethics committee of Edith Cowan University. Such approval assures very high standards regarding how the study is planned and carried out, as well as secure record keeping and confidentiality. The names and contact details of my principal supervisors, Prof Craig Speelman and Prof Anne Wilkinson, are printed below, as well as contact persons for the ethics committees of ECU. They may be contacted should you wish to discuss this study with someone other than myself. I can also be contacted for more information about the study.

I hope that you will be happy to participate in my study, and look forward to working with you. It should be a positive and rewarding experience for everyone involved, and will hopefully lead to a better understanding of the effects of different arts interventions in clinical settings.

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Ms Kim GIFKINS	research.ethics@ecu.edu.au	Phone: 08 63042170

[redacted]

Ronniet Orlando DATE: August 2014

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Edith Cowan University
School of Psychology and Social Science

STUDY of POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITALS

My name is RONNIET ORLANDO. My PhD study is comparing beneficial effects of different arts interventions, such as music and book readings, in hospitals and hospices.

- You are invited to participate in this study as a presenter on a voluntary pro bono basis.
- Your participation would involve preparing a 15 minute solo musical presentation or book reading for a patient in a hospital or palliative care setting.
- All the music or reading materials will be supplied ahead of time for you to practice and prepare.
- Your live presentation will be videoed so that it can be used in other phases of the study. You are welcome to do more than one of these presentations. The recordings will be destroyed at the end of the study, in accordance with the requirements of the Australian Code for the Responsible Conduct of Research.

Palliative care settings can be emotional places, with very ill and dying patients.

- You will be provided with as much information and support as you need before and after your involvement in this project.
- Also, I will be present at all times during the presentations.
- Remember, you are free to withdraw from the study at any time, without any explanations or repercussions.

Dates and times for the presentations will be arranged in advance, but due to the fluctuating nature of patients' conditions, changes in arrangements may need to be made at short notice.

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This study has been approved by the Human Research Ethics Committee of Edith Cowan University and the Medical Advisory Committee of Bethesda Hospital.

- Such approvals assure very high standards regarding how the study is planned and carried out, as well as secure record keeping and confidentiality.
- The names and contact details of my principal supervisors, Prof Craig Speelman and Prof Anne Wilkinson, are printed below, as well as contact person for the ethics committees of ECU. They may be contacted should you wish to discuss this study with someone other than myself. You can also ask me for more information about the study.

I hope that you will be happy to participate in my study, and I look forward to working with you. It should be a positive and rewarding experience for everyone involved, and will hopefully lead to a better understanding of the beneficial role of different arts interventions in clinical settings.

RONNIET ORLANDO	[redacted]	
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[redacted]
Ronniet Orlando

DATE:

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WHAT TO DO and NOT TO DO BEFORE SALIVA SAMPLING

These guidelines are to avoid contamination of the sample with food or chemicals which may interfere with the markers we are measuring

- Avoid ALCOHOL 12 hours before collection
- NO MAJOR MEAL within 60 minutes of collection
- Avoid TOOTH BRUSHING within 45 minutes of collection
- Avoid DAIRY PRODUCTS within 20 minutes of collection
- Avoid food high in SUGAR, or ACIDITY, or high CAFFEINE content, immediately before collection
- RINSE mouth with water to remove any food residue 10 minutes before sampling

HOW SALIVA SAMPLE IS TAKEN

- You will be given a small plastic vial and a drinking straw
- Saliva pools in the mouth and can be passed through the straw into the vial
- It may help to think about some yummy food to stimulate the saliva flow
- Only around 3ml is required for each sample
- This usually takes two to three minutes

Edith Cowan University
School of Psychology and Social Science

STUDY of POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITALS
PILOT STUDY

I...am over 18 years old, and agree to participate in the PhD study of RONNIET ORLANDO about possible beneficial effects of listening to different artistic presentations in hospital settings.

I understand that my participation in this study is on a purely voluntary basis, without any obligations, and that I am free to withdraw from the study at any time after registering, without any explanations or repercussions.

I have read the information sheet provided by the researcher, and agree to provide the information and responses requested. I understand that I will be asked to provide three saliva samples. I also understand that there may be an audiovisual recording device in the room. Whilst no visual recording of me will take place, audio recording cannot be ruled out.

I know I can seek further information from the researcher and her supervisors, and have been given their contact details.

SIGNED:..

DATE:..

RONNIET ORLANDO	[redacted]	
Prof CRAIG SPEELMAN	c.speelman@ecu.edu.au	08 63045834
Prof ANNE WILKINSON	anne.wilkinson@ecu.edu.au	08 63043540

Edith Cowan University
School of Psychology and Social Science

STUDY of POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITALS

I...am over 18 years old, and agree to participate in the PhD study of RONNIET ORLANDO about possible beneficial effects of listening to different artistic presentations in hospital settings.

I understand that my participation in this study is on a purely voluntary basis, without any obligations, and that I am free to withdraw from the study at any time after registering, without any explanations or repercussions. I may also withdraw my consent to the use of my information for this research at any time.

I have read the information sheet provided by the researcher, and agree to provide the personal details and responses requested. I also understand that I will be asked to provide three saliva samples. I grant permission for access to my Bethesda Hospital medical charts and records. I understand my identifying personal details from the research and medical records will not be disclosed in any research literature, report, publication or presentation.

I also understand that there may be an audiovisual recording device in the room. Whilst no visual recording of me will take place, audio recording cannot be ruled out, but any identifying material will be edited out.

I know I can seek further information from the researcher and her supervisors, and have been given their contact details.

SIGNED:..

DATE:..

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Edith Cowan University
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STUDY of POTENTIALLY SUPPORTIVE ARTS INTERVENTIONS in HOSPITALS

I...am over 18 years old, and agree to participate as a presenter in the PhD study of RONNIET ORLANDO about possible beneficial effects of listening to different artistic presentations in hospital settings.

I understand that my participation in this study is on a purely pro bono voluntary basis, without any obligations, and that I am free to withdraw from the study at any time after volunteering, without any explanations or repercussions.

I have read the information sheet provided by the researcher, and understand the nature and setting of the study. I also understand that my presentation(s) will be videoed for use in other phases of the study.

I know I can seek further information from the researcher and her supervisors, and have been given their contact details.

SIGNED:..

DATE:...

RONNIET ORLANDO	[redacted]	
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I know I can seek further information from the researcher and her supervisors, and have been given their contact details.

SIGNED:..

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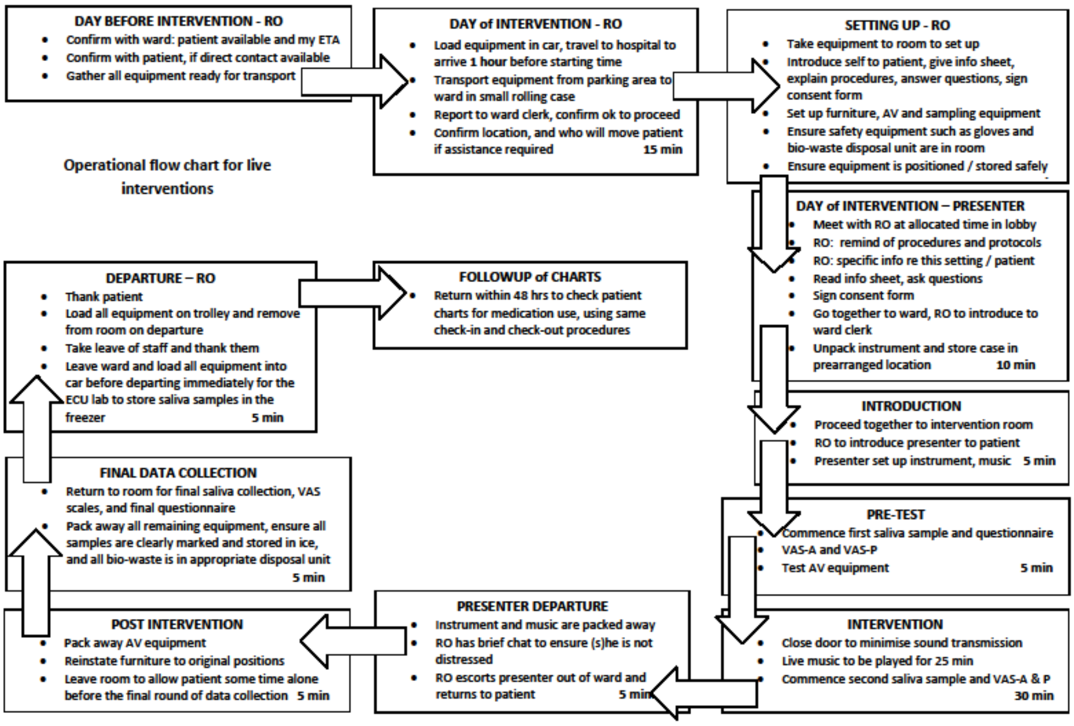
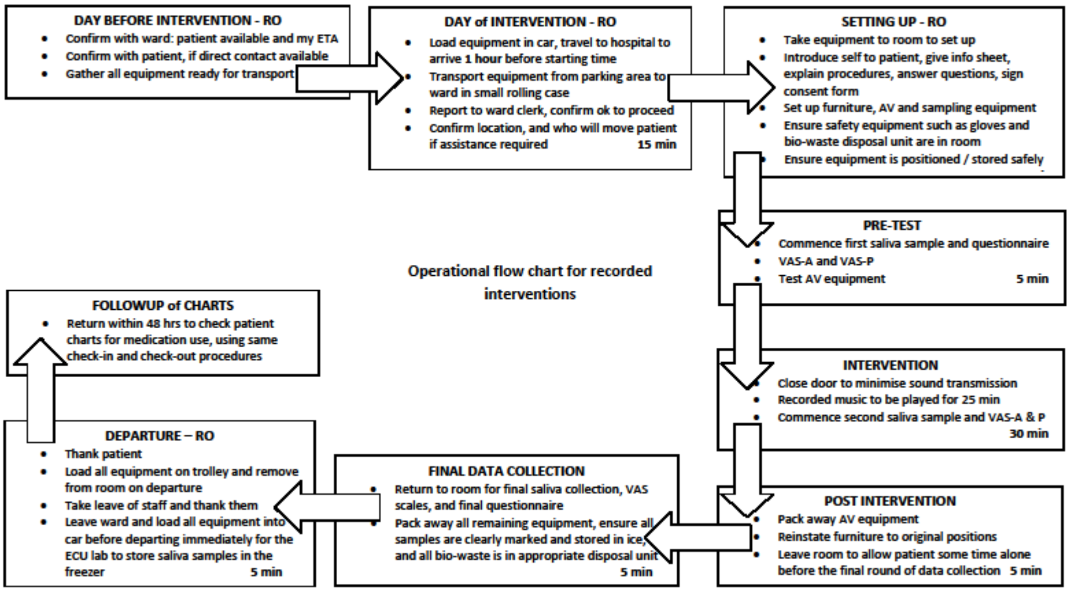
APPENDIX B: Protocols and materials for interventions

This second appendix includes details of the protocols followed for the interventions and data collection, lists of music and stories presented to participants as well as instructions given to the presenters.


Operational flow chart for live interventions
DAY BEFORE INTERVENTION - RO
Confirm with ward: patient available and my ETA
Confirm with patient, if direct contact available
Gather all equipment ready for transport
DAY of INTERVENTION - RO
Load equipment in car, travel to hospital to arrive 1 hour before starting time
Transport equipment from parking area to ward in small rolling case
Report to ward clerk, confirm ok to proceed
Confirm location, and who will move patient if assistance required 15 min
SETTING UP - RO
Take equipment to room to set up
Introduce self to patient, give info sheet, explain procedures, answer questions, sign consent form
Set up furniture, AV and sampling equipment
Ensure safety equipment such as gloves and bio-waste disposal unit are in room
Ensure equipment is positioned / stored safely
DAY of INTERVENTION – PRESENTER
Meet with RO at allocated time in lobby
RO: remind of procedures and protocols
RO: specific info re this setting / patient
Read info sheet, ask questions
Sign consent form
Go together to ward, RO to introduce to ward clerk
Unpack instrument and store case in prearranged location 10 min
INTRODUCTION
Proceed together to intervention room
RO to introduce presenter to patient
Presenter set up instrument, music 5 min
PRE-TEST
Commence first saliva sample and questionnaire
VAS-A and VAS-P
Test AV equipment 5 min
INTERVENTION
Close door to minimise sound transmission
Live music to be played for 25 min
Commence second saliva sample and VAS-A & P 30 min
PRESENTER DEPARTURE
Instrument and music are packed away
RO has brief chat to ensure (s)he is not distressed
RO escorts presenter out of ward and returns to patient 5 min
POST INTERVENTION
Pack away AV equipment
Reinstate furniture to original positions
Leave room to allow patient some time alone before the final round of data collection 5 min
FINAL DATA COLLECTION
Return to room for final saliva collection, VAS scales, and final questionnaire
Pack away all remaining equipment, ensure all samples are clearly marked and stored in ice, and all bio-waste is in appropriate disposal unit 5 min
DEPARTURE – RO
Thank patient
Load all equipment on trolley and remove from room on departure
Take leave of staff and thank them
Leave ward and load all equipment into car before departing immediately for the ECU lab to store saliva samples in the freezer 5 min
FOLLOWUP of CHARTS
Return within 48 hrs to check patient charts for medication use, using same check-in and check-out procedures


Operational flow chart for recorded interventions
DAY BEFORE INTERVENTION - RO
Confirm with ward: patient available and my ETA
Confirm with patient, if direct contact available
Gather all equipment ready for transport
DAY of INTERVENTION - RO
Load equipment in car, travel to hospital to arrive 1 hour before starting time
Transport equipment from parking area to ward in small rolling case
Report to ward clerk, confirm ok to proceed
Confirm location, and who will move patient if assistance required 15 min
SETTING UP - RO
Take equipment to room to set up
Introduce self to patient, give info sheet, explain procedures, answer questions, sign consent form
Set up furniture, AV and sampling equipment
Ensure safety equipment such as gloves and bio-waste disposal unit are in room
Ensure equipment is positioned / stored safely
PRE-TEST
Commence first saliva sample and questionnaire
VAS-A and VAS-P
Test AV equipment 5 min
INTERVENTION
Close door to minimise sound transmission
Recorded music to be played for 25 min
Commence second saliva sample and VAS-A & P 30 min
POST INTERVENTION
Pack away AV equipment
Reinstate furniture to original positions
Leave room to allow patient some time alone before the final round of data collection 5 min
FINAL DATA COLLECTION
Return to room for final saliva collection, VAS scales, and final questionnaire
Pack away all remaining equipment, ensure all samples are clearly marked and stored in ice, and all bio-waste is in appropriate disposal unit 5 min
DEPARTURE – RO
Thank patient
Load all equipment on trolley and remove from room on departure
Take leave of staff and thank them
Leave ward and load all equipment into car before departing immediately for the ECU lab to store saliva samples in the freezer 5 min
FOLLOWUP of CHARTS
Return within 48 hrs to check patient charts for medication use, using same check-in and check-out procedures

PROTOCOL

BEFORE INTERVENTION – SETTING UP (15 minutes)

1. Introduce self to participant, carers and staff
2. Set up video recorder or laptop
3. Set up microphone or speaker
4. Ensure all power cables and equipment are not potential hazards for tripping
5. Set up a chair for the presenter and one for self to do the observations
6. Set up collection materials:
    - Test tubes and straws
    - Labels and pens
    - Gloves
    - Specimen bags
    - Disposal unit (if available)
    - Water to rinse mouth
    - Ice chest for samples
7. Prepare forms and questionnaires
    - Information and consent forms – participants
    - Information and consent forms – presenters
    - Demographic questionnaire
    - VASA
    - VASP
    - Post-intervention questionnaire (response scales)
    - Observation checklist

FIRST ROUND OF DATA COLLECTION (15 minutes)

8. Ask participant to read the information sheet
9. Meet presenter at ward reception, usher them to "green room" and ask them to warm up / tune up. Give a brief preview of the set up in the room and ask if they have any questions. Remind them that they are there purely to present, without any further interaction with the participant. (Consent form will have already been signed at a prior meeting with the presenter)
10. Participant to <u>sign consent form</u> before anything else can occur
11. Ask participant to rinse their mouth out with water
12. Complete demographic questionnaire, VASA and VASP
13. With gloved hand give participant a collection tube and cut straw. Ask them to drool through the straw into the tube. Suggest they think of their favourite food, or a lemon, to stimulate salivation. Explain that only a small amount (less than 5 mls) is required, and it should only take a minute or two
14. When enough saliva is collected, with gloved hands: seal the tube, dispose of the straw safely, label the tube and place it in specimen bag and then in the icebox

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INTERVENTION (25 minutes)

15. Start the video recording, checking that it is working and aimed at the presenter's chair
16. Invite the presenter into the room, introduce and ask him / her to start the presentation OR
17. For recorded intervention: start the laptop playback or the video or audio recording
18. Sit self down to commence observations, checking time on watch
19. Give presenter a signal to commence their presentation
20. Turn off AV equipment after presentation is finished
21. Thank presenter and usher them out of the room. Ask them to wait for a few minutes

SECOND ROUND OF DATA COLLECTION (5 to 10 minutes)

22. With freshly gloved hands give participant a collection tube and straw. Ask them to drool again as before, collecting tube again with gloved hands, disposing of straw, sealing and labelling sample and placing in specimen bag in icebox
23. Complete VAS-A and VAS-P
24. Clear AV equipment
25. Tell participant you will return in 30 minutes for final sample

PRESENTER

26. Chat with presenter, thanking them again, and hand them information sheet with contacts for free counselling if they want to talk to a professional about issues that may have arisen, and usher them out of ward

THIRD ROUND OF DATA COLLECTION – 30 minutes after second round of collection (5 to 10 minutes)

27. With freshly gloved hands give participant a collection tube and straw. Ask them to drool again as before, collecting tube again with gloved hands, disposing of straw, sealing and labelling sample and placing in icebox
28. Complete VASA and VASP
29. Complete post-intervention questionnaire
30. Ask the participant for one word which sums up the experience for them. Record this and any other comments they make on the back of the observation sheet

FINALISING

31. Clear all remaining equipment, samples, securely-filed forms
32. Reinstate room to original arrangement of furniture
33. Thank participant again, as well as carers and staff, before leaving

♫♪♫

LIST of PIECES

♫♪♫

COMPOSER	TITLE
Camille SAINTS-SAENS (1835-1921)	Le Cygne (The Swan)
Johann Sebastian BACH (1685-1750)	Prelude, Suite 1 for Cello
Wolfgang Amadeus MOZART (1756-1791)	Minuet, Eine Kleine Nachtmusik
Johann Sebastian BACH (1685-1750)	Arioso
Scott JOPLIN (1868-1917)	The Entertainer
Edward ELGAR (1857-1934)	Salut d'Amour (Liebesgruß)

♫♪♫

N.B. *This is the music program handed to participants after they finished providing data.*

LIST of PIECES for PhD STUDY

Saints-Saens, C	Le Cygne (The Swan)	Originally for cello	Legato, full tone, and dynamics	2 m
Bach, J.S	Prelude, Suite 1	Originally for cello	Check with a cellist for interpretation	3 m 20
Mozart, W.A	Romanza	Eine Kleine Nachtmusik	Elegant and graceful	4 m 40
Mozart, W.A	Minuet	Eine Kleine Nachtmusik	Light and dance-like	2 m 10
Joplin, Scott	The Entertainer	Originally for piano	Keep to metronome marking	5 m 20
Bach, J.S	Arioso	Originally for strings	No need to go to high positions	4 m
Elgar, E	Salut d'amour	Originally for piano	Light and sweet, expressive dynamics	2 m 40
			TOTAL playing time	24 m 10

NB: There is time for a short gap between pieces to turn pages, resettle yourself, etc.

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LIST of PIECES for PhD STUDY

Saints-Saens, C	Le Cygne (The Swan)	Originally for cello		2 m 15
Bach, J.S	Prelude, Suite 1	Originally for cello		2 m 40
Mozart, W.A	Minuet	Eine Kleine Nachtmusik	Both repeats Minuet, 1st repeat Trio	1 m 45
Bach, J.S	Arioso	Originally for strings	Repeat 1st section only	3 m 25
Joplin, Scott	The Entertainer	Originally for piano	NO repeats	2 m 50
Elgar, E	Salut d'amour	Originally for violin		2 m 50
			TOTAL playing time (approx)	15 m 45

NB: There is time for a short gap between pieces to turn pages, resettle yourself, etc.

N.B. *These are the instructions supplied to the musicians, firstly for the original program used for the students, and played by music students; and secondly for the abbreviated program played by professional musicians at the hospital.*

These are the book excerpts that were read to you:

1. Barrie KOSKY (2008) *On ecstasy*
   Melb Uni Press, *pp. 1-7*

2. Jon McGREGOR (2002) *If nobody speaks of remarkable things*
   Bloomsbury: London, *pp. 1-4*

3. Kenneth GRAHAME (1908) *The wind in the willows*
   Methuen: UK, *pp. 1-4*

N.B. *This is the list of stories handed to participants after they finished providing data.*

KOSKY, Barrie (2008). ***On ecstasy.*** Melb Uni Press, *pp. 1-7*

In the beginning, there was no smell. She simply cut the carrots, onions, parsnips and celery into pieces and threw them over the raw chicken. I never liked that raw chicken sitting dead and motionless in that big saucepan. Didn't like it. Didn't trust it. I was always happy when the vegetables were thrown in and the water was poured over the dead chook, drowning it forever. There was nothing to smell and certainly, nothing to taste. I had to wait for that. A whole twenty-four hours of waiting, waiting, waiting.

Any serious connoisseur of chicken soup will tell you that the Chicken Soup Ritual is divided into three distinct and clear sections: Preparation. Expectation. Consumption. Any 7-year-old Jewish child will tell you that Preparation and Expectation are infuriating, tortuous obstacles to Consumption. Is it finished yet? That big saucepan with that big lid boiling that strange brew of chunky veggies and dead chook. Is it finished yet? The steam emerging from under the lid of the saucepan, as if my Uncle Sol were sitting underneath the lid, blowing out his cigar smoke. Is it finished yet? Whack, as my grandmother's hand slapped my paws away from the stove.

My Polish grandmother made a chicken soup like no other chicken soup. To this day, to my knowledge and experience, it has never been bettered. She made a chopped liver that melted in your mouth, she made a gefilte fish that bounced for days on your tongue, she made a chocolate cake the likes of which Western cuisine will never, ever taste again; but her chicken soup surpassed even the superlatives of these creations. Her chicken soup was the Caravaggio of soups. The Rainer Maria Rilke of soups. The Arturo Benedetti Michelangeli of soups.

But we are not there yet. We are a long, long way from Consumption. And didn't I know it. After a couple of hours, my grandmother tilted the saucepan over a big glass bowl and poured the liquid into it. And what a liquid, oh, what a liquid. Gold, like Howard Carter glimpsed when he saw wonderful things through the hole in Tutakhamen's tomb. Gold, like the wheels on my grandfather's Bechstein piano I used to sit under and rub, in the hope that the gold would come off on my hands. Gold, like the box on my Hungarian grandmother's mantelpiece, where her bridge cards lay waiting for the ladies who lunch. It was a Nile, an Amazon, a Euphrates of liquid gold heaven. But it was not yet mine.

The fridge door slammed shut and I was told, as always, not to disturb the soup, which my grandmother said was sleeping. Sleeping soup. Every now and then I would sneak a peek to see if there was any change in the bowl. I was always shocked to witness the transformation next day of the once sparkling, golden liquid into darkish wobbly sludge. How could something that smelt so incredible and looked so dazzling end up, twenty-four hours later, like miserable brown jelly? I just didn't get it.

What I did get, however, was the beginning of part three of the ritual: Consumption. If I had been a good boy, done my homework, practiced the piano and washed my hands, my grandmother would let me slowly scrape the white, congealed fat off the top of the soup. I loved this part. With the skill, patience

and dexterity of a plastic surgeon, I removed the thick layer of fat with a wooden spoon, making sure not to pierce the skin of the dark sludge underneath.

My grandmother would ladle the brown slop into a saucepan and tell me to get out of the kitchen. Sit. Wait. It was unbearable. I wanted to scream. Sometimes I did. Like the famous Chicken Soup Tantrum of 1977. Is it finished yet? And there, before my eyes, it appeared. The Chicken Soup.

That first spoonful, as the hot soup washed my mouth and glided down my throat, was intense, cosmic rapture. The second spoonful. Bliss. The third spoonful. Transcendental bliss. The Chicken Soup Room at the end of Kubrick's *2001.* A soup that took you to the beginning and end of time itself. A dazzling, pure, clear Rhapsody in Gold.

McGREGOR, Jon (2002). If nobody speaks of remarkable things.

Bloomsbury: London, pp. 1-4

If you listen, you can hear it.
The city, it sings.
If you stand quietly, at the foot of a garden, in the middle of a street, on the roof of a house.
It's clearest at night, when the sound cuts more sharply across the surface of things, when the song reaches out to a place inside you.
It's a wordless song, for the most, but it's a song all the same, and nobody hearing it could doubt what it sings. And the song sings the loudest when you pick out each note.

The low soothing hum of air-conditioners, fanning out the heat and smells of shops and cafes and offices across the city, winding up and winding down, long breaths layered upon each other, a lullaby hum for tired streets.
The rush of traffic still cutting across flyovers, even in the dark hours a constant crush of sound, tyres rolling across tarmac and engines rumbling, loose drains and manhole covers clack-clacking like cast-iron castanets.
Road menders mending, choosing the hours of least interruption, rupturing the cold night air with drills and jack-hammers and pneumatic pumps, hard-sweating beneath the fizzing hiss of floodlights, shouting to each other like drummers in rock bands calling out rhythms, pasting new skin on the veins of the city.
Restless machines in workshops and factories with endless shifts, turning and pumping and steaming and sparking, pressing and rolling and weaving and printing, the hard crash and ring and clatter lifting out of echo-high buildings and sifting into the night, an unaudited product beside the paper and cloth and steel and bread, the packed and the bound and the made.
Lorries reversing, right round the arc of industrial parks, it seems every lorry in town is reversing, backing through gateways, easing up ramps, shrill-calling their presence while forklift trucks gas and prang around them, heaping and stacking and loading.

And all the alarms, calling for help, each district and quarter, each street and estate, each every way you turn has alarms going off, coming on, going off, coming on, a hammered ring like a lightening drum-roll, like a mesmeric bell-toll, the false and the real as loud as each other, crying their needs to the night like an understaffed orphanage, babies waawaa-ing in darkened wards.
Sung sirens, sliding through the streets, streaking blue light from distress to distress, the slow wail weaving urgency through the darkest of the dark hours, a lament lifted high, held above the rooftops and fading away, lifted high, flashing past, fading away.

And all these things sing constant, the machines and the sirens, the cars blurting hey and rumbling all headlong, the hoots and the shouts and the hums and the crackles, all come together and rouse like a choir, sinking and rising with the

turn of the wind, the counter and solo, the harmony humming expecting more voices.

So listen.
Listen, and there is more to hear.
The rattle of a dustbin lid knocked to the floor.
The scrawl and scratch of two hackle-raised cats.
The sudden thundercrash of bottles emptied into crates.
The slam-slam of car doors, the changing of gears, the hobbled clip-clop of a slow walk home.
The rippled roll of shutters pulled down on late-night cafes, a crackled voice crying names for taxis, a loud scream that lingers and cracks into laughter, a bang that might just be an old car backfiring, a callbox calling out for an answer, a treeful of birds tricked into morning, a whistle and a shout and a broken glass, a blare of soft music and the blam of hard beats, a barking and yelling and singing and crying and it all swells up all the rumbles and crashes and bangings and slams, all the noise and the rush and the non-stop wonder of the song of the city you can hear if you listen the song

and it stops

in some rare and sacred dead time, sandwiched between the late sleepers and the early risers, there is a miracle of silence.

Everything has stopped.

And silence drops down from out of the night, into this city, the briefest of silences, like a falter between heartbeats, like the darkness between blinks. Secretly, there is always this moment, an unexpected pause, a hesitation as one day is left behind and a new one begins.
A catch of breath as gasometer lungs begin slow exhalations. A ring of tinnitus as thermostats interrupt air-conditioning fans.
These moments are there, always, but are rarely noticed and they rarely last longer than a flicker of thought.

We are in that moment now, there is silence and the whole city is still.

N.B. *The section shown in italics was cut for the shorter version used in the clinical setting.*

GRAHAME, Kenneth (1908). *The wind in the willows.* Methuen: UK, *pp. 1-4*

THE RIVER BANK

The Mole had been working very hard all the morning, spring-cleaning his little home. First with brooms, then with dusters; then on ladders and steps and chairs, with a brush and a pail of whitewash; till he had dust in his throat and eyes, and splashes of whitewash all over his black fur, and an aching back and weary arms. Spring was moving in the air above and in the earth below and around him, penetrating even his dark and lowly little house with its spirit of divine discontent and longing. It was small wonder, then, that he suddenly flung down his brush on the floor, said "Bother!" and "O blow!" and also "Hang spring-cleaning!" and bolted out of the house without even waiting to put on his coat. Something up above was calling him imperiously, and he made for the steep little tunnel which answered in his case to the gravelled carriage drive owned by animals whose residences are near to the sun and air. So he scraped and scratched and scrabbled and scrooged, and then he scrooged again and scrabbled and scraped, working busily with his little paws and muttering to himself, "Up we go! Up we go!" till at last, pop! His snout came out into the sunlight, and he found himself rolling in the warm grass of a great meadow.

"This is fine!" he said to himself. "This is better than whitewashing!" The sunshine struck hot on his fur, soft breezes caressed his heated brow, and after the seclusion of the cellarage he had lived in so long the carol of happy birds fell on his dulled hearing almost like a shout. Jumping off all his four legs at once, in the joy of living and the delight of spring without its cleaning, he pursued his way across the meadow til he reached the hedge on the further side. "Hold up!" said an elderly rabbit at the gap. "Sixpence for the privilege of passing by the private road!" He was bowled over in an instant by the impatient and contemptuous Mole, who trotted along the side of the hedge chaffing the other rabbits as they peeped hurriedly from their holes to see what the row was about. "Onion sauce! Onion sauce!" he remarked jeeringly, and was gone before they could think of a thoroughly satisfactory reply. Then they all started grumbling at each other. "How *stupid* you are! Why didn't you tell him – " "Well, why didn't *you* say – " "You might have reminded him –" and so on, in the usual way: but, of course, it was then much too late, as is always the case.

It all seemed too good to be true. Hither and thither through the meadows he rambled busily, along the hedgerows, across the copses, finding everywhere birds building, flowers budding, leaves thrusting – everything happy, and progressive, and occupied. And instead of having an uneasy conscience pricking him and whispering "Whitewash!" he somehow could only feel how jolly it was to be the only idle dog among all these busy citizens. After all, the best part of a holiday is perhaps not so much to be resting yourself, as to see all the other fellows busy working.

He thought his happiness was complete when, as he meandered aimlessly along, suddenly he stood by the edge of a full-fed river. Never in his life had he

seen a river before – this sleek, sinuous, full-bodied animal, chasing and chuckling, gripping things with a gurgle, and leaving them with a laugh, to fling itself on fresh playmates that shook themselves free, and were caught and held again. All was a-shake and a-shiver – glints and gleams and sparkles, rustle and swirl, chatter and bubble. The Mole was bewitched, entranced, fascinated. By the side of the river he trotted as one trots, when very small, by the side of a man who holds one spellbound by exciting stories; and when, tired at last, he sat on the bank, while the river still chattered on to him, a babbling procession of the best stories in the world, sent from the heart of the earth to be told at last to the insatiable sea.

APPENDIX C: Measurement instruments

This final appendix contains questionnaires and scales used to gather subjective data from participants.

DEMOGRAPHICS QUESTIONNAIRE

Please answer the following questions to give us some background information about you.

No information you provide here will be stored together with your identity, so you can be assured that full confidentiality will be maintained throughout the study.

Please state your current age, in years and months .... YEARS .... MONTHS

What course (and year) are you studying?...

What is/are your favourite activity or activities for relaxing or unwinding?

....

What style / genre of music do like listening to? ....

Please circle the answers which apply to you for the following questions:

MALE FEMALE

Have you ever learnt a musical instrument?

YES NO

Thank you!

....

For office use:

ID # DATE TIME SITE ORAL or WRITTEN

DEMOGRAPHICS QUESTIONNAIRE

Please answer the following questions to give us some background information about you.

No information you provide here will be stored together with your identity, so you can be assured that full confidentiality will be maintained throughout the study.

Please state your current age, in years and months .... YEARS .... MONTHS

What is your medical diagnosis? ....

What is/are your favourite activity or activities for relaxing or unwinding?

....

What style / genre of music do you like listening to? ....

Please circle the answers which apply to you for the following questions:

MALE FEMALE

Have you ever learnt a musical instrument?

YES NO

Thank you!

....

For office use:

ID # DATE TIME SITE ORAL or WRITTEN

No pain **Worst pain imaginable**

Please mark a cross (X) on the lines above and below to indicate how you are feeling **right now** with regards to your **pain** and **anxiety** (or stress) levels

No anxiety **Worst anxiety imaginable**

POST-INTERVENTION QUESTIONNAIRE

PLEASE MARK ON THE FOLLOWING SCALES YOUR RESPONSES TO EACH QUESTION.

Circle the number which best represents your answer.

1. **Did you like the music presented to you?**

1	2	3	4	5	6	7	8	9	10
really disliked it				neither disliked nor liked					really loved it

2. **How expressive was the person's performance?**

1	2	3	4	5	6	7	8	9	10
extremely bland				neither bland nor expressive					extremely expressive

3. **How much emotion did you feel?**

1	2	3	4	5	6	7	8	9	10
no emotion									extremely emotional

4. **How engaged and absorbed did you feel during the presentation?**

1	2	3	4	5	6	7	8	9	10
extremely bored				neither bored nor engaged					completely absorbed

---

For office use:

ID # DATE TIME SITE ORAL or WRITTEN

POST-INTERVENTION QUESTIONNAIRE

PLEASE MARK ON THE FOLLOWING SCALES YOUR RESPONSES TO EACH QUESTION.

Circle the number which best represents your answer.

1. Did you like the stories presented to you?

1	2	3	4	5	6	7	8	9	10
really disliked it				neither disliked nor liked					really loved it

2. How expressive was the person's performance?

1	2	3	4	5	6	7	8	9	10
extremely bland				neither bland nor expressive					extremely expressive

3. How much emotion did you feel?

1	2	3	4	5	6	7	8	9	10
no emotion									extremely emotional

4. How engaged and absorbed did you feel during the presentation?

1	2	3	4	5	6	7	8	9	10
extremely bored				neither bored nor engaged					completely absorbed

---

For office use:

ID # DATE TIME SITE ORAL or WRITTEN