Full-Length Article

The Role of Music in Improving Exercise Capacity in Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease as Measured by the 2-minute Walking Test

Anuk Kruavit[1], Eugene Teh[2], Imogen Clark[3], Vikas Wadhwa[2]

[1]*Royal Darwin Hospital, Darwin, NT, Australia*

[2]*Eastern Health, Melbourne, VIC, Australia*

[3]*University of Melbourne, Melbourne, VIC, Australia*

Abstract

Background: Studies have shown that music has positive effects on quality of life and increases exercise capacity of patients with chronic obstructive pulmonary disease (COPD). We evaluated the effects of music on exercise capacity in COPD inpatients.
Method: This was a prospective, interventional study involving patients with an acute exacerbation of COPD. Patients selected, from a pre-determined list, their preferred song rated as having the best motivational score, as per the Brunel Music Rating Inventory. A 2-minute walking test was undertaken with and without music. The walking distance and degree of dyspnoea were recorded after each walking test. Secondary outcomes included walking time, blood pressure, heart rate, respiratory rate and oxygen saturation with and without music. Results: 17 patients were recruited, with a mean age of 73.9 ± 8.6 years. 9 were males and 8 were females. There was a significant increase in the walking distance with music, with a mean increase in distance of 7.94 metres (95% CI, 3.58 – 12.31). There was a non-significant trend that patients could walk for a longer time with music therapy. Diastolic blood pressure also increased significantly with music therapy, but other physiological parameters did not show any significant changes. The motivational score of the preferred song used did not lead to any significant correlation with the outcome variables. Conclusion: The use of music with a patient-preferred song may lead to significant clinical benefits in hospital inpatients with acute exacerbation of COPD. Larger studies are warranted to provide further evidence for its potential use in routine clinical practice.

Keywords: ***Music, COPD, Exercise capacity, Walking, Acute***

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Introduction

Chronic obstructive pulmonary disease (COPD) is a long-term disease of the lungs, which leads to chronic airflow limitation, and is an umbrella term that includes emphysema, chronic bronchitis and chronic asthma [1]. COPD is the fourth leading cause of death in the world, and represents an important public health challenge that is both preventable and treatable [2]. The Global Burden of Disease Study projected that COPD, which ranked sixth as a cause of death in 1990, will become the third leading cause of death worldwide by 2020 [3]. It also leads to a substantial economic and social burden. In the European Union, the total direct costs of respiratory disease are estimated to be about 6% of the total health care budget, with COPD accounting for 56% (38.6 billion Euros) of this cost of respiratory disease [4]. In the United States, the estimated direct costs of COPD are $29.5 billion and the indirect costs $20.4 billion [5]. The economic burden may also be more significant in developing countries. Severely disabled COPD patients may not be well supported by long-term supportive infrastructure and services. This may, in turn, force two individuals to leave the workplace, the affected individual and a family member who must now stay home to care for the disabled relative. Since human capital is often the most important national asset for developing countries, the indirect costs of COPD may represent a serious threat to their economies [3].

The fundamental objectives in the management of COPD are to reduce symptoms such as breathlessness and anxiety, improve quality of life, increase exercise capacity and prevent hospitalisation. Treatment guidelines have long been well

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established [1,6]. The DALYs (Daily-Adjusted Life Years) for a specific condition are the sum of years lost because of premature mortality and years of life lived with disability, adjusted for the severity of disability [3]. This has been used to estimate the fraction of mortality and disability attributable to COPD in previous studies [7,8]. In 1990, COPD was the twelfth leading cause of DALYs lost in the world, responsible for 2.1% of the total. According to the projections, COPD will be the seventh leading cause of DALYs lost worldwide in 2020[9] A growing area of research is now focusing on the alternative therapies, which aim to improve the quality of life, that have yet to demonstrate sufficient evidence to be recommended for routine practice. Music therapy, also known as distractive auditory stimuli, is one such therapy along with others such as acupuncture, acupressure and psychotherapy [6]. We, therefore, aimed to investigate the role music in improving symptoms and exercise capacity in patients hospitalized with an acute exacerbation of COPD (AECOPD).

Literature Review: Use of music in exercise and COPD management

Music is an exercise aid that arouses psychomotor activity, cues synchronous rhythm, improves mood, and diverts attention, and may support improved exercise participation and capacity in patients with COPD [10,11]. Several trials have examined the effects of listening to music in patients with COPD during a 6-minute walk test (6MWT) [12-16]. Bauldoff et al. [12,13] compared participants exercising with and without commercial music during 4 and 8 week programs respectively, and found improved pre- to post-program 6MWT performance in groups that used music compared with those who did not. However, a recent systematic review of the current literature showed that other researchers have also compared the effects of music and no music during a one-off 6MWT and did not demonstrate any differences between the 2 groups [17]. An expert statement on the use of music in exercise did report positive ergogenic effects in exercise capacity while also promoting psychological (e.g. enhanced affect) and psychophysical (reduced ratings of perceived exertion) benefits [18]. More research is still required to observe the longitudinal effects of music on exercise before it can be recommended for routine clinical practice as an exercise aid.

What is, nonetheless, arguably most important in COPD management is the improvement in symptom control. Symptoms such as breathlessness and anxiety contribute significantly to the reduced quality of life of COPD patients. Two most recent systematic reviews included several randomized controlled trials among COPD patients [19,20]. The use of music listening consistently demonstrated improvement in quality of life, breathlessness and anxiety. This is more significant during exercise itself, rather than as a symptom management strategy at rest. Results were otherwise inconsistent with regards to the improvement of physiological outcomes such as forced expiratory volume (FEV) and forced vital capacity (FVC). Shingai et al. [21] also demonstrated that music listening, as a non-pharmacologic therapy, can be used to reduce the breathlessness sensation in COPD patients. Their subjects underwent cycling exercises at 40% maximum oxygen consumption and reported significantly lower exercise-induced breathlessness perception with music from 18 minutes after the start of exercise to 3 minutes after the end of exercise. Singh et al. [22] also showed that music had a greater impact on anxiety reduction than progressive muscle relaxation exercises in a randomized controlled trial of patients with COPD exacerbation.

Some researchers have also investigated the interesting use of singing, as a form of music intervention, to help manage the symptoms of breathlessness and anxiety [23-25]. Singing is thought to not only affect the psychological aspect of COPD sufferers, but to also contribute to the learning of breathing control and posture improvement. A randomized controlled trial was designed to compare a 6-week course of twice weekly singing classes to usual care in 28 COPD patients [25]. The singing group had a significant fall in the anxiety score, even though no improvement in single breath counting or shuttle walk distance was observed. This shows that music listening may not be the only type of music intervention that can be used in the long-term management of COPD patients in the future.

A review by Clark et al. [17] found that most previous studies investigating the effects of music in older adults with COPD had used researcher-selected music, and that these previous trials had also been conducted in the outpatient settings. Participant-preferred music is recommended to maximise the motivational effects of music during exercise,[10,11] and this may have contributed to a lack of positive outcomes in previous research. The concept of patient-preferred music as a motivational tool is an interesting one. A survey of people attending gymnasia across Britain found that different music played at different times of the day at the gymnasia affected their frequency and time of attendance. Age was also found to exert the greatest influence on their musical preference [26]. The other important component of motivational music is how uplifting and effective it is in sustaining exercise performance. Bacon et al. [27] demonstrated that subjects had lower mean oxygen consumption when they exercised synchronously with music that had a tempo of at least 123 beats per minute. This may imply that exercise becomes more efficient when performed with music that is preferred and is relatively fast and uplifting. The Brunel Music Rating Inventory has been validated to assess how motivational a song is [30]. This inventory will be used in this study to help determine the most motivational song rated by the subjects from a pre-determined list of fast, uplifting songs available.

The current study differs from previous research as it will ask participants to select their own preferred music with the highest motivational score, and will recruit participants from an acute rather than outpatient setting.

Methods

This was a prospective, non-randomized interventional study. Consecutive patients meeting the inclusion and exclusion criteria, who were admitted to the hospital with the primary diagnosis of acute exacerbation of COPD between November 2013 and January 2014, were recruited into the study. (Figure 1) The investigators had no clinical relationship with the recruited subjects.

During the admission, subjects were asked to perform a 2-minute walking test (2MWT) twice. The first time was without music and the second time was while listening to music. The subjects were allowed as much rest as required to return to baseline between the 2 walking tests. Owing to the reduced exercise capacity in patients with AECOPD, the 2MWT was used rather than the 6MWT utilised in previous research with patients from outpatient programs. This has been shown to be as effective as the formal 6MWT to demonstrate exercise capacity, particularly in frail, elderly individuals [29,29]. Not all subjects were able to complete the walking test for the full 2 minutes, and the walking times were recorded. An extensive list of 50 songs, ranging from the 1940s to 1970s, was provided to the subjects, with the help of a qualified music therapist. The eras selected were due to their older age. Classical songs were also included. The subjects were given as much time as they like to listen to various songs and were asked to score each of the songs they chose according to how motivational the songs are, as per the Brunel Music Rating Inventory [30] (Appendix 1). *Table 1* shows the 50 available researcher-determined songs that were specifically selected to be uplifting and to have a tempo greater than 100 beats per minute to maximise the motivational effects. The song, which has the highest motivational score as per the rating inventory, was then deemed the preferred and most motivational song and was used for his/her intervention.

The primary outcome was the distance walked during the test with and without music. The secondary outcomes, also measured with and without music, included the dyspnoea scale score, walking time, blood pressure, heart rate, respiratory rate and oxygen saturation. A simple visual analogue scale is used as the dyspnoea scale, whereby subjects could mark on the scale for a score of 0-10 (10 being the most severe) how breathless they were immediately after each walk. (Appendix 2) The average motivational score of the chosen song was also recorded for analysis.

The data were analysed using SPSS version 22.0, (SPSS, Chicago, IL, USA), with P values of <0.05 considered as statistically significant. Shapiro-Wilk test was used to examine the normality for the difference in change of each outcome variable. Associations between the presence of music and the difference in change of outcome variables were explored using paired t-test for variables that follow the normality assumption and Wilcoxon Signed-Rank Test for variables that do not follow the normality assumption.

Song Era/Category	Titles and Artists
1940s	1. In the mood; Glenn Miller and Joe Loss
	2. Rum & Coca-Cola; The Andrew Sisters
	3. Say something to your sweetheart; Ink spots
	4. Chattanooga; Glenn Miller
	5. Rambling rose; Perry Como
	6. Swinging on a star; Bing Crosby & Joe loss
	7. I'm beginning to see the light; Duke Ellington
	8. The woodpecker song; Glenn Miller
	9. On a slow boat to China; Dick Haymes
	10. Ferryboat serenade; The Andrews Sisters
1950s	1. Music, music, music; Teresa Brewer
	2. Rock around the clock; Bill Haley & His Comets
	3. Quicksilver; Bing Crosby and The Andrews Sisters
	4. Volare; Dean Martin
	5. Takes two to tango; Louis Armstrong
	6. Don't let stars get in your eyes; Perry Como
	7. A Fool Such as I; Elvis Presley
	8. Catch a Falling Star; Perry Como
	9. Mack the Knife; Frank Sinatra
	10. Wanted; Perry Como
1960s	1. Help; The Beatles
	2. Big Girl's Don't Cry; The Four Seasons
	3. My guy; Mary Wells
	4. Ob-la-di, ob-la-da; The Beatles
	5. Satisfaction; The Rolling Stones
	6. Surf city: Jan and Dean
	7. No milk today, Herman's Hermits
	8. Good vibrations; The Beach Boys
	9. Friday on My Mind; The Easybeats
	10. Paint it black; The Rolling Stones
1970s	1. I go to Rio; Peter Allen
	2. Eagle rock; Daddy Cool
	3. Dancing Queen; ABBA
	4. Stayin' alive; The Bee Gees
	5. You're the one that I want; John Travolta and Olivia Newton-John
	6. Lookin' out my back door; Credence Clearwater Revival
	7. Rivers of Babylon; Bony M
	8. Do ya think I'm sexy, Rod Stewart
	9. Whole lotta love; Led Zeplin
	10. You're so Vain; Carly Simon

Table 1: **The researcher-determined songs available to the subjects for selection.**

Classical	1. Tritsch-Tratsch-Polka (Gossip Polka), Op. 214; Strauss II 2. Music for the Royal Fireworks, HWV 351: III. La réjouissance; Handel 3. Messiah, HWV 56: Hallelujah Chorus; Handel 4. Piano Sonata No. 11 in A Major, K.331: III. Alla Turca – Allegretto; Mozart 5. The Four Seasons – Concerto for Violin in E Major, RV 269, Op. *:1, "Spring": I. Allegro; Vivaldi 6. Symphony No. 40 in G Minor, K.550: I. Allegro Molto; Mozart 7. Canon in D major; Pachelbel 8. Pomp and Circumstance, Op. 39: Land of Hope and Glory; Elgar 9. Symphony No. 9 in D Minor, Op. 125, "Choral": An die Freude; Beethoven 10. Bolero; Ravel

***Table 1 (continued):* The researcher-determined songs available to the subjects for selection.**

This study was approved by the Eastern Health Human Research and Ethics Committee, Australia, and was considered of low risk in accordance with definitions given in the National Statement in 2007. (Reference number LR79/1213) All subjects gave written informed consent prior to participation in the study.

Results

Figure 1 summarizes the recruitment process of the study subjects. There were overall 23 patients who met the selection criteria and were admitted with a primary diagnosis of an acute exacerbation of COPD within the study period.

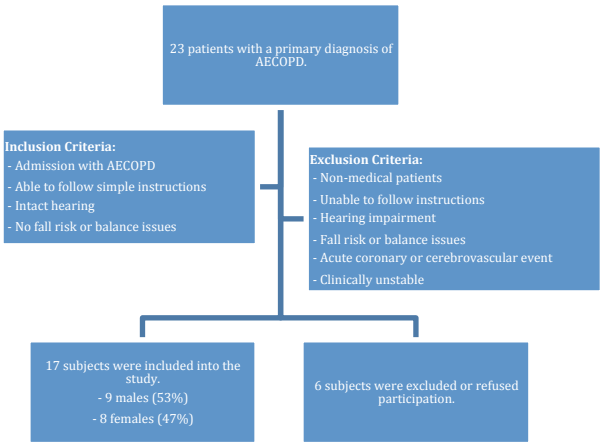

Figure 1: Recruitment process of study subjects, including inclusion and exclusion criteria.

However, 6 were excluded or refused to participate in the trial. Seventeen patients were consented and included into the study. There were 9 male (53%) and 8 female (47%) subjects. The mean age was 73.9 ± 8.6 years. There were no withdrawals from the study.

The walking distance increased significantly when subjects were listening to their preferred music, as shown in *Table 2*. *Table 4* shows that there was a mean increase in the walking distance of 7.94 metres (95% CI, 3.58 – 12.31). *Table 2* also demonstrates a trend that the subjects were able to walk for longer while listening to music.

	Without Music				With Music				p*
	mean	SD	median	IQR	mean	SD	median	IQR	
Dyspnoea scale score	5.7	1.9	6.0	2.5	4.7	2.1	4.0	3.5	0.105
Walking distance	35.59	27.0	20.0	43	43.53	29.6	30.0	48	0.003
Walking time	82.06	36.1	90.0	65	89.71	33.6	90.0	60	0.229

Table 2 The comparison of main outcome variables between with and without music; **Statistically significant difference in change in walking distance and time were determined using Wilcoxon signed-rank test, except for dyspnoea scale which was determined using paired t-test.*

There was also a significant increase in the mean diastolic blood pressure from 71.9mmHg to 75.4mmHg when walking with music. (*Table 3*) Other physiological parameters did not show significant changes. The motivational score of the preferred song used did not lead to any significant correlation with the outcome variables. (*Table 5*)

Discussion

The investigation into the role of music in improving exercise capacity and relieving symptoms of dyspnoea and anxiety in COPD patients appear to be gathering pace over the last 2 decades. Previous trials have shown mixed results so far. Panigrahi et al [19] showed in their review that music therapy in COPD patients led to improvement in the psychological outcomes such as quality of life, dyspnoea and anxiety, but had mixed results when it came to physiological outcomes such as FEV, FVC and vital signs. Karageorghis et al [18] demonstrated that music in general yielded ergogenic effects in exercise while also fostering psychological and psychophysical benefits. Earlier positive outcomes had also been shown, especially in the decline in the level of anxiety and dyspnoea [15,16]. Nevertheless, there were also trials that did not show significant benefits with the use of music therapy.

	Without Music								With music								p*
	Before Walking				After Walking				Before Walking				After Walking				
	mean	SD	med	IQR	mean	SD	med	IQR	mean	SD	med	IQR	mean	SD	med	IQR	
Systolic Blood pressure (mmHg)	128.5	21.5	124	18	134.8	18.8	134	34	128.0	22.2	124	28	138.3	18.7	133	33	0.195
Diastolic Blood pressure (mmHg)	72.8	12.2	72	18	72.6	11.2	71	18	71.9	11.6	72	21	75.4	13.7	72	18	0.027
Heart Rate (per minute)	85.9	12.0	86	21	96.4	13.6	97	21	85.1	11.5	84	19	97.9	13.1	100	23	0.196
Respiratory rate (per minute)	18.5	1.8	20	4	26.4	3.0	26	4	18.5	1.8	20	4	26.1	2.8	26	4	0.579
Oxygen Saturation (%)	91.7	3.4	91	4	86.4	6.9	88	10	92.0	2.9	92	4	86.7	7.3	90	12	0.874

Table 3: Comparison of physiological outcome variables between with and without music; ** Statistically significant difference in change in all outcomes variables were determined using paired t-test, except for oxygen saturation which was determined using Wilcoxon signed-rank test.*

Outcome variable without music and with music	Difference in change		
	Mean	95% CI	
Change in dyspnoea scale score (0-10)	1.0	-0.2	2.2
Change in walking distance (metres)	7.94	3.58	12.31
Change in walking time (seconds)	7.65	4.14	19.43
Change in systolic blood pressure (before and after walking) (mmHg)	4.06	2.31	10.43
Change in diastolic blood pressure (before and after walking) (mmHg)	3.71	0.49	6.92
Change in heart rate (before and after walking) (beats per minute)	2.29	-1.31	5.90
Change in respiratory rate (before and after walking) (breaths per minute)	0.24	-0.65	1.12

Table 4: Mean difference in the change between without and with music for each outcome variable.

Both Pfister et al [14] and Brooks et al [32] showed no statistically significant differences in the distance walked, perceived dyspnoea and anxiety levels. Our study showed that there was actually an increase in the dyspnoea level on normal walking while listening to music, though this was not statistically significant. What we did demonstrate, however, was that there was a significant increase in the walking distance achieved with music. The mean increase in distance was 7.94 metres. This may seem modest, but it can be beneficial for COPD patients who chronically experience severe dyspnoea at rest or on minimal exertion.

To our knowledge, previous research has only concentrated on the cohort of COPD patients in the outpatient setting. Further studies of patients with an AECOPD in an inpatient setting are therefore still required. We must strive to find strategies to reduce the length of hospital stay as well as to prevent hospital presentations, with dyspnoea and anxiety often as the main factors. We attempted to verify the benefits of listening to music in hospitalised COPD patients in this study. We did not obtain positive outcomes in terms of reducing the symptom of perceived dyspnoea, but this may have been due to a relatively small sample size.

A longitudinal music program starting during the hospital admission journey through to the post-discharge recovery period should be encouraged. Clark et al [17] found in their review that exercise programs with music over 4 and 8 weeks may lead to cumulative benefits.

In this study, we specifically provided the subjects with only songs that were uplifting and had a relatively fast tempo of at least 100 beats per minute. The intervention song was then chosen on the basis of the highest preference with the highest average motivational score, as per the Brunel Music Rating Inventory. There is evidence that motivational music confers greater endurance and exercise capacity relative to relaxing, sedative music [33]. Some mechanisms that are used to explain the role of music therapy include attentional processing, synchronous response to musical rhythm, stimulative relationship between exercise heart rate and music tempo, and emotional response to music [10]. Ultimately, motivational music was thought to promote the chronic benefit of increased exercise adherence. Bacon et al [27] demonstrated that conducting exercises synchronously with music at the high tempo of at least 123 beats per minute was associated with significantly reduced oxygen consumption. Another recent study also showed that the use of paced

Outcome Variables	*r*	*p-value*
Walking distance with music	-.235	.364
Walking time with music	-.157	.548
BP(Systolic) after walking (With music)	.085	.745
BP(Diastolic) after walking (With music)	.345	.175
Heart rate after walking (With music)	-.005	.985
Respiratory rate after walking (With music)	-.058	.825
Oxygen saturation after walking (With music)	-.301	.240
Change in BP(Systolic) (before and after walking)(With music)	-.152	.562
Change in BP(Diastolic) (before and after walking)(With music)	.045	.864
Change in heart rate (before and after walking)(With music)	.119	.648
Change in Respiratory rate (before and after walking)(With music)	-.185	.477
Change in Oxygen saturation (before and after walking)(With music)	-.299	.244

Table 5: Correlation between the mean motivational score of the intervention song and the various outcome variables.

walking with rhythmic, upbeat music was beneficial in assisting with exercise intensity at home for COPD patients [34]. The incremental shuttle walking test showed a gain in distance of 60 metres from baseline to 16 weeks, with improvement in all domains of the St George Respiratory Questionnaire (SGRQ). We strongly recommend that patients are able to choose their preferred music that appears to motivate them the most.

There were some limitations within this study. Firstly, the sample size is relatively small. This made it difficult to achieve statistical significance. There was for example, a positive trend to suggest that there was an increase in the length of time the patient could walk, or in other words greater endurance, but this was not statistically significant. The dyspnoea scale score may also have yielded a more positive outcome had the sample size been larger. We aim to use this study as a pilot study to expand the current body of knowledge. Further investigations will be made to recruit a higher number of subjects.

Due to the frail nature of our patients during an episode of AECOPD, the authors thought that the conventional 6MWT might not be an appropriate measurement tool. We elected to use a 2MWT instead. It has been validated as a tool to measure exercise capacity and functional performance in the geriatric population [28,29]. It has also been shown to be a reliable tool in other patient cohorts such as younger asthmatics [35], cardiac surgery patients [36], transtibial amputees [37], and pediatric patients with cystic fibrosis [38]. We believe that this did not negatively affect the reliability of our outcome measurement. However, the use of a 6MWT may be a feasible alternative closer to discharge when the patients have been stabilised.

A larger sample size will, in addition, allow us to stratify the COPD patients according to the severity of their disease, and to observe whether there is correlation between the benefits of music and the degree of COPD. Other variables may have also been included such as the timing into admission that the intervention takes place. Ideally, a difference between the intervention within the first 48 hours of admission and the intervention prior to discharge should be measured. These ideas will allow us to better implement a pulmonary program within the hospital that has a clear, evidence-based focus and to make better use of the limited resources. If successful, this will broaden the scope of investigation and intervention for other chronic respiratory diseases as well as non-respiratory disorders.

Conclusion

This was a pilot study investigating the effect of listening to music on hospitalised patients with an acute exacerbation episode of chronic obstructive pulmonary disease. There is a significant increase in exercise capacity with the use of patient-preferred, motivational music. However, the use of music is still yet to be recommended for routine clinical practice in COPD inpatients. Larger, randomised trials are warranted to provide more conclusive evidence to support its implementation.

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Biographical Statement

Dr Anuk Kruavit is a fellow of the Royal Australasian College of Physicians in General and Acute Care Medicine, who is currently completing his post-fellowship training in Respiratory and Sleep Medicine. His main research interests include chronic obstructive pulmonary disease, remote and public health medicine, and sleep-disordered breathing. He is also involved as a lecturer in the Northern Territory Medical Program at the Charles Darwin University, Australia.

Appendix A: *The Brunel Music Rating Inventory-2*

Please read following statement and complete the rating for your preferred songs.

"The purpose of this questionnaire is to assess the extent to which the piece of music you are about to hear would motivate you while walking. For our purposes, the word "motivate" means music that would make you want to walk harder and/or longer. As you listen to the piece of music, indicate the extent of your agreement with the statements listed below by circling <u>one</u> of the numbers to the right of each statement. We would like you to provide an honest response to each statement. Give the response that <u>best</u> represents your opinion and avoid dwelling for too long on any single statement."

		Strongly disagree		*In-between*				*Strongly agree*
1	*The rhythm of this music would motivate me while walking*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
2	*The style of this music (i.e. rock, dance, jazz, hip-hop, etc.) would motivate me while walking*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
3	*The melody (tune) of this music would motivate me while walking*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
4	*The tempo (speed) if this music would motivate me while walking*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
5	*The sound of the instruments used (i.e. guitar, synthesizer, saxophone, etc.) would motivate me while walking*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
6	*The beat of this music would motivate me while walking*	*1*	*2*	*3*	*4*	*5*	*6*	*7*

The Brunel Music Rating Inventory – 2 (Karageorghis et al., 2006, p.909)

Appendix B: ***Visual Analogue Scale***