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A study on the effects of music on performance outcomes of Judo competitors

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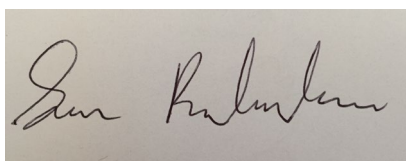
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A rectangular box containing a handwritten signature in black ink. The signature is written in a cursive style and appears to read 'Sam Richardson'.

Sam Richardson

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2. Abstract

This study examined the effect of genre and tempo as elements of music on sporting performance, measured by circuit completion time on a self-paced pyramid circuit (maximum ten minutes). A total of thirty-one participants (Mage = 30.13yrs, SD = 12.22 yrs; m = 24, f = 7) participated in a weekly pyramid circuit used as the warm up for a competitive training session over an eight-week period. The three exercises included in the circuit were Judo specific.

A series of three x two within-subjects study design tested for main and interaction effects of genre (Pop, Hip-Hop and Rock) and tempo (110bpm and 150bpm) on the outcome variables of circuit completion time, attentional focus, emotional affect, rate of perceived exertion, motivation and emotional attachment to music. Paired samples t-test were run to compare baseline and post condition (for circuit completion time, attentional focus, PANAS, RPE) to determine any potential learning effects.

A three (genre) x two (tempo) factorial repeated-measures ANOVA showed that there was a significant effect of genre [$F(1.89, 54.87) = 5.41, p = 0.008$] and tempo [$F(1, 29) = 34.894, p < 0.001$] but no interaction between Tempo and Genre [$F(2, 58) = 0.307, p = 0.734$].

Overall the findings showed that both musical elements had an impact on sporting performance with the genre of Pop and the tempo of 150bpm resulting in the fastest circuit completion time. The effects of psychological variables in mediating sports performance outcomes for judoka demonstrated that cognitive and emotional processing is an essential part of responding to music and as such deserves to be fully accounted for in future theoretical frameworks.

3. Introduction

A review of the effects of music on sporting performance by Karageorghis (2012) outlined the limitations and gaps in the literature including the lack of scientific basis for music selection, the longer-term effects of music use and the interpretation process. The British Judo Association (2015) provides a generalised online description of the known beneficial effects of music on sporting performance, but no research evidence of a link between music and judo performance.

A complication in the research literature on this topic is the lack of a standardised definition of "music" and its components. Previous studies have examined the role of musical genres and tempi in sporting performance (Karageorghis, 2012). Although Karageorghis (2008) indicated that musical tempo is the easiest musical element to test due to ease of manipulation it is not possible to test this in isolation since other key musical components such as pitch, harmony and melody would be altered as a result. Samson (2012) suggested that music should remain within a genre with similar characteristics of pitch, harmony and melody when tempo is being varied. Therefore, alongside tempo it is important to also study the effects of genre.

Although there is insufficient evidence to provide a comprehensive picture of the impact of music on sporting performance in general and its application to judo in particular, the theoretical frameworks point to areas for further research. Theoretical frameworks exist for the use of music before and during sporting situations although these lack several psychological variables that mediate the impact of music. There is ongoing debate regarding the effectiveness of music on sporting performance due to previous methodological issues, control of musical components, and inconsistent delivery and publication methodology (Terry, 2012). This study will therefore examine if previous findings are applicable to national Judo competitors. It will do this by examining the effect of musical genre and tempo on the completion times of a specially designed pyramid circuit for judoka.

Previous studies have tended to focus on the effects of musical genre and tempo on physiological responses. Since music is an auditory stimulus however, there is a need for cognitive and psychological processing to occur alongside the physiological responses of the sympathetic nervous system such as varying heart rate. This study will therefore investigate how these psychological variables may act as mediating variables in sporting performance outcomes.

4. Review of Literature

This section will outline current theoretical frameworks on the impact of music in sporting performance, address primary research and give a rationale for the current study.

The Effects of Music on Sporting Performance

A number of studies report enhanced performance outcomes for athletes exercising to music although the majority of research has been oriented towards performance outcomes in laboratory rather than in naturalistic settings. Such outcomes are typically measured by work rate (Karageorghis, 2008) potentially due to the ease of controlling variables in the laboratory and of measuring work rate (Byrne, 1992). Such studies have shown the performance benefits of an individual using music for movement synchronisation in aerobic activity (Karageorghis & Terry, 1995) and for anaerobic exercises in a circuit in mixed gender training sessions (Karageorghis et al., 2010).

These studies suggest that although music cannot increase maximum physiological output, it may improve performance outcomes in submaximal situations in lab settings (Karageorghis, 2017). Moss, S. et al. (2006) found that while exercising to music at a relatively low exercise intensity, participants maintained a wider attentional field and were therefore alternatively focused, reducing their tendency to perceive exertion. Previous research indicates that music also encourages task disengagement (Shepard, 2009; Noakes, 2011). Cross (2001) suggests that music requires cognitive processing to generate a physiological response, rather than simply resulting in an automatic physiological adjustment. Terry, P. et al. (2012) found that during maximal and supramaximal exercise, music had no effect on actual performance outcomes but did affect psychological states. Other studies have analysed the effects of music on psychological variables such as motivation, perceived exertion, environmental interpretation and emotional states:

Further evidence for a cognitive process in music perception can be found in its effect on motivational states. Schutz & Pekrun (2007) found improved intrinsic motivation in college netball shooting when music was played consistently throughout a training session (Pates et al., 2003). Karageorghis, C., Deeth, I. (2002) indicate that the presence of music throughout a multi-stage fitness test can facilitate several Flow State Scale factors known to have a positive effect on motivation (Allen, 2003). Further study by Deci, E. et al. (1999) confirms that extrinsic motivation in the form of music has an effect on intrinsic motivation; an emotional state. Extrinsic motivation can form an informative feedback loop with intrinsic motivation. Davids (2011) concludes that music may therefore be used as a motivational tool by trainers.

Structural Feature	Associated Emotions
Tempo	Fast tempo: happiness, excitement, anger. Slow tempo: sadness, serenity.
Rhythm	Smooth/consistent rhythm: happiness, peace. Rough/irregular rhythm: amusement, uneasiness. Varied rhythm: joy.
Genre	Happy/Sad, Aroused/Unaroused

Table 1: Effects of the structural features of music on Emotions

Another potential cognitive influence on physiological outcomes involves emotional responses to music which include increased heart and respiration rates (Zatorre et al., 2007) and the release of dopaminergic responses in neural reward circuits which facilitate motor actions (Salimpoor et. al.,2011; Karageorghis, 2008; Mazzone et. al., 2011). In 2007, Zatorre found that the supplementary motor area of the brain is key in perceiving musical rhythm and in rhythmic ordering of motor tasks. If rhythmic perception and motor processing are brain functions, cognitive processing may influence physiological outcomes and may be far more sophisticated than simple motor-neural stimulation in response to rhythmic sound. Gabrielle & Stromboli (2001) note that specific musical characteristics have a strong positive correlation with specific emotional responses and suggest associated emotions for different musical structures.

Definitions of “Music”

The definition of “music” as a reliable and valid concept in research studies is problematic since the definition of music itself is constantly evolving (Music Producers Guild, 2008). There is debate among leading musical theorists as to the number of variables that form music. These may or may not include; beat, meter, dynamics, harmony, melody, pitch, rhythm, tempo, texture and timbre. There is also "no limit to the number or the genre of variables that might intervene in a definition of the musical" (Molino 1975). Nattiez (1990) points out that “by all accounts there is no *single* and *intercultural* universal concept defining what music might be”. Nettl (2005) argues that the term “music” is a Westernized concept that is not found in the languages of most cultures. “Music” may therefore be socially defined according to culture (Molino, 1975).

According to Karageorghis (2008), tempo is the easiest musical component to manipulate. However, it is not possible to manipulate tempo as a single variable since several other key variables will also be manipulated as a result eg. pitch, harmony and melody (Webster, G, Weir, C. 2005). To minimise the impact of varying tempos, music needs to remain within a genre with similar characteristics despite the change in tempo (Samson, J., 2012). Therefore, genre needs additional consideration or testing alongside tempo.

Many previous studies on the application of music in sports settings have not published the musical tracks used for testing; therefore Karageorghis (2017) questions the validity and reliability of the vast majority of previous research. To prevent different interpretations of musical characteristics which may cause variations in research results, it is important to operationalize the term “music” and to specify the musical components being examined. The two main components of music most commonly applied in a sporting context are genre and tempo (Karageorghis, 2012). A previous undergraduate research project by Richardson et al. (2017) indicated that both musical genres and tempo may have an impact on increasing exercise intensity in judo practice sessions.

The Effects of Genre on Sporting Performance

The definition of genre appears to be widely disputed (Wong, J., 2011) although a standardised definition of genre would facilitate a common research language. Due to its evolution over time, the term “genre” has come to be used fluidly (Crauwels, K. 2016) and used as an inclusive concept with one genre overlapping and sharing characteristics with others. Crauwels developed an expansive theoretical framework to explain how genres have come to be inter-connected, describing five main “worlds” of music; Folk, Classical, World, Utility and Pop. Crauwels’ concept of “Pop” contains three “clusters”, covering twenty-three sub-genres. By describing such complexity, Crauwels raises issues psychological and sociological issues beyond the scope of purely musical characteristics but which are nonetheless highly relevant to the interpretation of genre. It is widely noted that musical genres are culturally and demographically specific (Cross, 2005; Crossen, A. et al., 2002). As a result, genres tend to be associated with specific sub-cultures which are influenced by socio-economic groupings and modified by geographical and/or historical variations (Lena, C. 2008). Further, some genres may give rise to individual psychological responses depending on the individual’s associated memories and experiences (Holm, J. et al., 2009, Hargreaves et al. (2002). Bhowmick & Welch (2005) argue that it is likely that each genre may feed into an individual’s sense of identity, musical self and social group status. It therefore appears clear that musical characteristics, as grouped by genre, are a crucial determinant of individual cognitive and emotional responses to music. Therefore, genre should form an important variable in studies of the motivational and performance enhancements offered by music in a sporting context.

The small number of previous music-in-sport studies on performance outcomes by musical genre report variable effects. Simpson & Karageorghis (2006) presented 400-meter runners with different genres of music, and with no music, and asked them to complete circuits of a running track at a self-selected pace. Results showed that improved performance by ~.5 seconds in the presence of music and performance was optimal when genres which were self-identified as “motivating” were played compared to other musical conditions, with the non-musical condition resulted in the slowest completion times. Although motivational music is not a musical genre it does suggest that the self-selection of genres may be beneficial, as corroborated by Johnson, V. (2004). Johnson, in a study in which nine adults (five male, four female) completed exercise on a cycle-ergometer for one hour while different musical genres (Rock, Country and Polka and without music) were played, matched for tempo. Results showed participant preference for Rock over Polka but showed that genres had no significant impact on sporting performance, though tempo had a small but significant effect.

Tenenbaum et al. (2004) used the genres of rock, dance and “Inspirational” music while runners completed endurance training (5000-meter run). Authors concluded that these genres had no impact on performance, but attributed this to the high intensity of the task, potentially causing a reduction in attentional field which caused participants to block out the music. The relatively small number of studies examining the impact of musical genre on sporting performance is concerning as the overall impact of many other components of music such as tempo are inextricably linked to the genre of the music.

The Effects of Tempo on Sporting Performance

It is common to find variations in interpreting musical tempos due to disagreements about which is the main beat within a bar; individuals may interpret every beat or every other beat as the main beat. Additionally, syncopation often occurs in music, which places a ‘fake’ emphasis on the offbeat and often makes it difficult to determine a regular tempo (Temperley, 1999). One piece of music may also contain varying tempos and rhythms (Peters, 2007). Peeters & Flocon-Cholet (2012) also identified that since tempo is mainly perceptual, perceived tempo is an estimation and may differ from actual tempo resulting in inconsistent interpretations of tempo between individuals. Given the variables involved, validated academic sources of tempo are required to ensure consistency in research studies.

Several existing studies examine the effects of musical tempo on sporting performance resulting in contradictory results. Whilst studies including that by Jarraya et al. (2012) and Terry et al. (2012) found that musical tempos impact sporting performance, studies by Mohammadzadeh et al. (2008), Dyer & McKune (2013) and Burket et al. (2014) all found that tempo did not have an effect on sporting performance.

Karageorghis & Priest (2012a) suggest that these inconsistencies are due to lack of methodological standardisation and control of musical variables as well as inconsistent delivery methods.

Dyer & McKune (2013) asked highly trained athletes to complete a 20km time trial cycle ride whilst listening to four tempo conditions (No Music, 110bpm, 120bpm and 140bpm) finding that tempo did not impact sporting performance. However, the study did not control for musical genres or participant demographics and relied on participant self-selection of music. Rendi et al. (2008) performed a 500-metre time trial study in which musical tempo was found to be positively correlated with completion time. It is well established that the tempo of music is a key determinant of the impact of music in a sports performance setting due to its effect on the autonomic nervous system which causes physiological adaptations (Ellis, R. Thayar, J. 2010; Karageorghis, 1999). Edworthy, J. & Waring, H. (2006) completed a study whereby participants completed a ten-minute run at a self-selected speed while five musical conditions were played. Results showed that music played with a fast tempo and loud volume improved the speed and distance of running of all participants compared to all other conditions. Slower music caused participants to run more slowly than if there had been no music, suggesting that music was regulating physiological processes to adversely affect performance.

Waterhouse, J. et al. (2010) completed a study whereby participants cycled at self-selected work-rates for 25 minutes to six musical tracks which were then varied in tempo by ten percent. Increasing the tempo of music also increased the speed and distance covered by participants, indicating that tempo alone may have been impacting sporting performance. Participants appear to be more emotionally positive when faster and higher pitched music is played than when with slower, deeper music is played (Bruner, 1990). Tempo therefore appears to affect both psychological and physiological arousal.

4.1.1. Theoretical framework of the benefits of music in sport

Evidence from the use of music in sporting contexts led to the initial development of a theoretical framework to link music perception and its physiological impact on sporting performance. A review by Karageorghis & Priest (2012) suggested that music had different interactions with exercise depending on its application: pre-task, in-task or post-task. In 2006, Terry & Karageorghis updated their original model (1999) and proposed a revised model for the use of “In-Task” music in sport. They proposed grouping the factors found to influence the use of music in sports as Antecedents, Intermediaries and Potential Benefits.

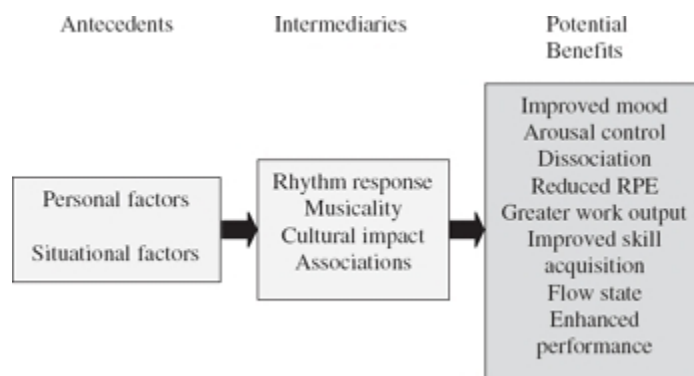


Figure 1: Theoretical framework of the benefits of music in sport (Terry & Karageorghis, 2006)

“Antecedents” considered both the participant and the context. “Personal factors” focus on the participant’s individual considerations. “Situational factors” provide a perspective of the sporting context and exercise environment. “Intermediaries” were presented as a causal link between the presence of music and a specified outcome. Intermediaries include both internal and external factors to the individual and are listed hierarchically, with internal factors being more important than external factors. The authors presented evidence to support this hierarchy although there does not appear to have been any further research to validate this. While the original framework only considered the use of asynchronous music the revised version incorporated the use of synchronous music and the benefits of this resulting in eight factors considered to be important, as corroborated by studies by Atkinson, Wilson & Eubank (2004) and Karageorghis (2006).

The framework was developed based on the Brunel Music Rating Inventory (BMRI, Karageorghis, 1999) and incorporated previous evidence, giving validity and reliability to the framework due to its strong empirical support. Karageorghis’ framework also considers the physiological outcomes that are key considerations in a sporting situation. The use of a simplified structure also allows for the easy application of a research-backed framework in a real-world setting and gives a clearer future direction.

However, the framework would benefit from further development. It omits all known negative responses to music in sport, including depression, tensions and boredom (Terry et al. 2006). Potential routes or suggestions of how to use a negative stimulus for a positive outcome were also not considered. Another key omission is a feedback loop allowing for individuals to react to the effects of their own actions on their environment. Feedback is a key element of the learning and development process that incorporates memories of previous experiences in similar situations (see Welford's model below). In addition, research in music therapy suggests that an individual's responses to music may change over time (Stige, B. 2016) and this is also omitted from the framework.

Most strikingly, there is no consideration of the effects of cognitive interpretation in any of the factors included in "Antecedents" or "Intermediaries". It is also unclear as to whether the "Antecedent" factors influence the process before or after the introduction of music. An indication is needed of where the introduction and delivery of music occurs in this process. Elements of music processing models from outside the discipline of sports science could be integrated into this theoretical framework to improve its application to music in a sporting setting.

4.1.2. Theoretical Framework for the effects of music played before a sporting event

Karageorghis et al. (2017) addressed the “Pre-task” effects of the use of music by introducing a new grounded theory model built on the original model by Bishop et al. (2007). Despite the focus being on Pre-task rather than In-task music, the grounded theory model should be carefully considered since it is much more inclusive than the BMRI-based model above in identifying and incorporating additional factors for In-task music. Chamari & Souissi (2013) reported that many Judoka are using music pre-competition, indicating a potential positive relationship of music in Pre-task judo training.

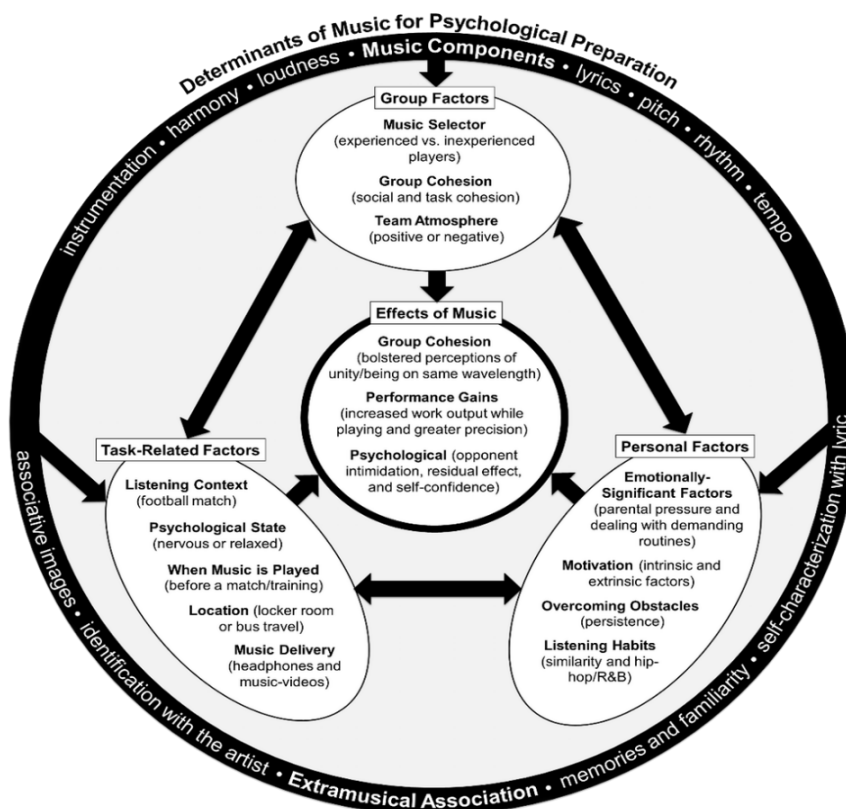


Figure 2: Theoretical Framework of the effects of music before sport (Karageorghis, 2017).

The model elaborates the context within which a sporting participant operates such as aspects of the musical stimulus including lyrics and harmony and pre-existing “Extramusical” associations that players have with music in the form of memories. The musical components are considered to interact with three groups of moderators that specifically influence the effects of music: task related, group and personal factors.

Although this framework is more complex and inclusive than previous In-task frameworks, it lacks a cognitive or information processing element. Whilst “the theory emphasizes the interrelationships or reciprocity amongst group, task-related and personal factors in predicting the effects of music....” (Karageorghis, 2017) it remains a linear model apart from the inter-relationships between the three moderators and again lacks a feedback loop from the effects of to their impact on any other factor. Additionally, whilst the framework is presented as a circular model rather than as a linear process it is difficult to understand any chronological processes. There is no indication of whether some sections are more important than others or the circumstances under which some conditions may or may not be relevant at all (eg. the use of “Group Factors” in an individual training session).

Further research would be beneficial to identify those factors identified in this model which could be incorporated with those identified in the “In-task” theoretical framework (2006) to provide a framework that is applicable to both contexts.

4.1.3. Information Processing Model

In 1968, Welford adapted the Information processing model to be specifically applied to a sporting context (Figure 5, below). This model suggests that all sensory stimuli require a form of processing to facilitate a given response. Both short-term and long-term memories are included as substantial factors in the interpretation of sensory stimuli such as music. Motivation also plays an important role in the interpretation and application of long-term memories alongside executive control. This process enables individuals to modify their responses to match desired outcomes. Most importantly, this model includes a feedback loop that is essential to understanding continual processing of external stimuli.

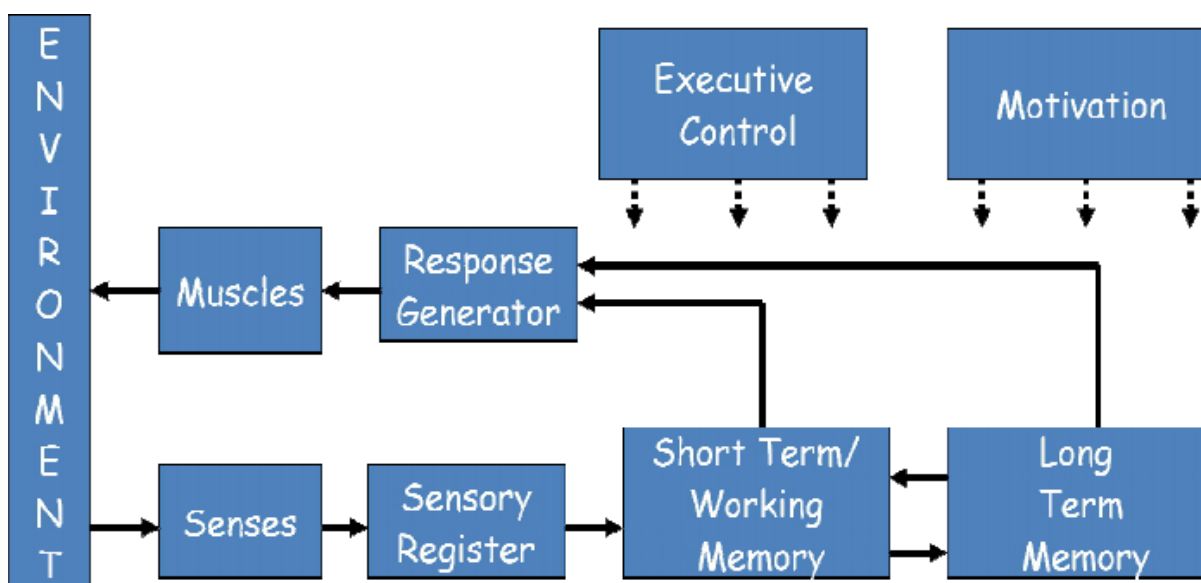


Figure 3: Welford's Information Processing Model (1968)

According to this model, information processing begins with the introduction of a sensory stimulus from the environment. Environmental stimuli go through sensory processing to enter the memory stores where short-term and long-term memories are compared and interpreted. This output is then processed alongside executive control functions and motivational factors. The decision-making process then reassesses the environment and formulates a response. Gropel (2018) suggests that “skilled motor performance is linked to brain processes associated with unconscious behaviour control” indicating that behaviour is controlled by a higher order executive function as suggested by Welford's Information Processing Model (1968).

This model shows that cognition is required during information processing, including processing of music and that cognitive processes as outlined by Welford may be appropriate to the theoretical frameworks of music in sport.

4.1.4. Models of the role of emotional effects of music

As well as the processing of information such as musical stimuli through cognition, Von Gorgi (2006) introduced a model to explain the integration of personality and different psychological processes influenced by music.

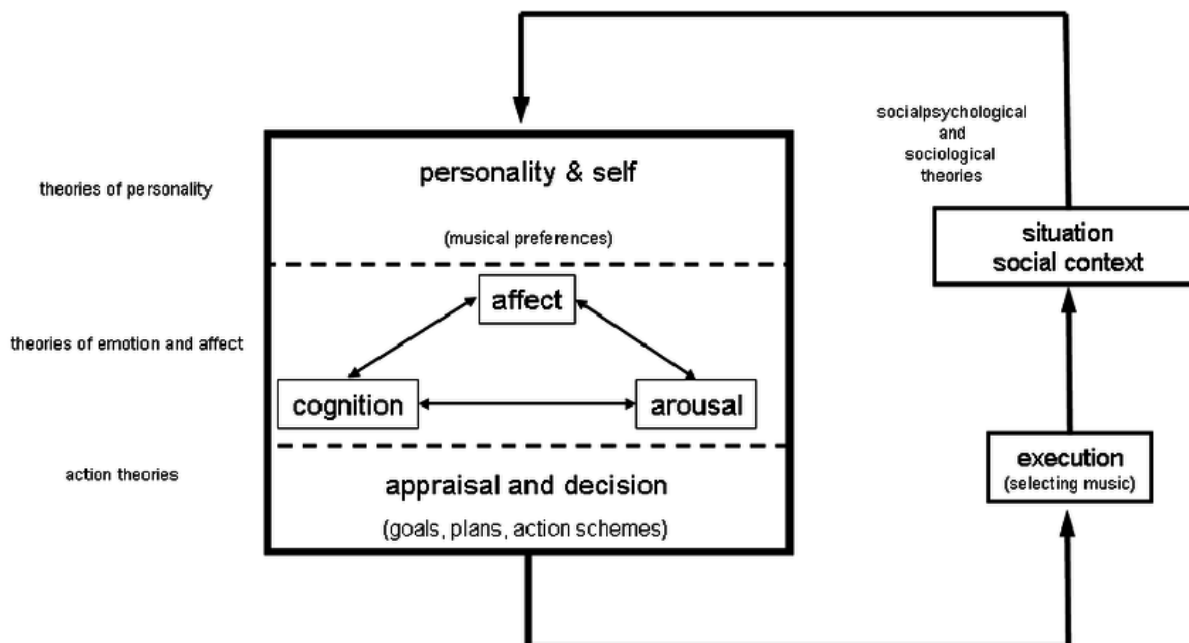


Figure 4: Model of the role of music in everyday life (von Gorgi, R. et al. 2006)

This model shows how different socio-psychological factors lead to a specific performance outcome. A key consideration in both this model and Welford’s Information Processing Model (1968) is the use of a feedback loop for sporting and musical considerations which will constantly vary. It considers the personal and situational factors of the use of music as included in the theoretical framework of Karageorghis (2017, 2006) as well as incorporating information processing, indicating applicability to both frameworks.

Peretz (2003) developed a model indicating that music may be analysed in several different ways before an individual can identify it as music. This process occurs alongside and independently of information processing, but works specifically to direct outputs into an “Emotion expression analysis” component, allowing individuals to experience an emotional response to the music being played. Although this model was developed from medical case studies and not from sporting examples, it indicates that emotional responses to music are important factors to be considered within cognition. Again, both cognitive and emotional interpretation and processing may occur in understanding music and both require investigation before applying music to achieve specific outcomes.

Finally, there is evidence to suggest that music can be used to regulate an individual's arousal level (Karageorghis, 2006) and that changes to brain chemicals may result (Yamamoto et al. (2003); Menon & Levitin (2005); Evers & Shur (2000)). The Individual Zone of Optimal Functioning (IZOF) theory (Hanin, 2000) proposes that individuals perform optimally within specific arousal ranges. If individuals perform above or below the specified range, they are unlikely to perform optimally.

There are therefore a variety of models which give additional insight into the theoretical framework of Terry & Karageorghis (2006) and which the framework could be adapted to include, in particular the cognitive and emotional processing of musical stimuli.

4.1.5. Rationale for study

This is an investigative study on how performance outcomes are affected by music in a training environment for judo. Since the term "music" lacks any consistent definition in the research literature, the study uses existing research literature to select specific musical variables to be studied (genre and tempo) and to provide evidence of the effects of these variables on sporting performance in the form of a completion time for a training circuit for judoka. It is hypothesized that both musical variables studied (genre and tempo) will have an impact on sporting performance.

With regard to genre as a musical variable, the direction of the impact of mediating psychological variables is unclear. Existing literature presents contradictory findings in this regard (Johnson, V. (2004); Tanenbaum D. (2004); Moss, S. (2006); Karageorghis C. (2013); Simpson S. (2006)).

With regard to tempo as a musical variable, it is hypothesized that a faster tempo will result in improved sporting performance (Karageorghis, 2006) due to an increase in motivation (Schutz & Pekrun, 2007). It is also hypothesised that at a higher tempo, there will be a more dissociative attentional focus that reduces distress levels, as indicated by evidence from Leow, Rinchon, Grahn (2015) and that a faster tempo will result in greater emotional attachment as supported by Sloboda (1992) and decreased perceived exertion as evidenced by Shepard (2009). At a slower tempo, emotional affect (interested, excited, strong, enthusiastic, alert, inspired, determined) is expected to be more positive as cognition is unable to support additional thought processes at a higher exercise intensity (Terry, P. et al., 2012).

Given the multi-disciplinary evidence for the importance of psychological variables in interpreting and mediating the effects of music, the effects of music on psychological variables will also be investigated to examine any mediating effects on sporting performance for judoka. The study will therefore investigate the

effects of music on emotional attachment, emotional affect, attentional focus, motivation and perception of exertion when applied to sporting performance. It is hypothesized that the effects of both genre and tempo on sporting performance will be mediated by these psychological variables.

5. Method

5.1.1. Participants

Participants in this study were drawn from judokas of national competition standard attending regular training sessions at two University Judo Clubs in two different cities in the UK. Seventeen participants were selected from Club A and fourteen participants from Club B making a total of thirty-one participants (Mage = 30.13yrs, SD = 12.22 yrs; m = 24, f = 7). Twenty-three participants (74.2%) reported no medical issues and eight participants (25.8%) reported a history of injury, but declared themselves fully healthy at the start of the study. Participants were selected according to four pre-determined criteria:

1. Competing at a minimum of national competition standard
2. Free from injury before and throughout the testing process
3. Previous experience of completing circuits
4. Training at the testing site a minimum of once a week

Anthropometric data was not collected on participants due to the time constraints of single-researcher testing.

5.1.2. Pilot study for Music Pre-Selection

The selection of genres in this study was based on those which typically had tempos which fell within tempo ranges used in previous research: 110bpm to 150bpm, as identified by Jog.FM (2018) resulting in the selection of Pop, Hip-Hop and Rock as the genres to be investigated. Jog.FM was selected as the source for both genre and tempo information since there were no validated academic resources that could filter music based on these two factors together.

To minimize behavioural bias during the testing process, a music pre-selection group consisting of two sub-groups of three male and three female students with similar demographics to the study participants was randomly selected from the same two Universities as the study participants (making a total of twelve pre-selection group members). Each member of the pre-selection group was tasked with completing the Group Music Selection Tool (GMST: Karageorghis, 2017) to determine the final selection of musical tracks to be played in the study by listing their three preferred and three non-preferred musical tracks to accompany a specific task from a list of seven tracks. A frequency analysis was used to select the three most preferred musical tracks for each musical condition (ie. tempo x genre) for the group, resulting in a final selection of eighteen musical tracks to be used in the study.

This generated list was used to identify musical tracks from each of the three genres and two tempos, resulting in a total list of forty-two musical tracks. The tracks were assumed to be familiar to the music pre-

selection group as well as to the study participants since they all fell into the Uk Top 40 music charts within four weeks of their release (iTunes, 2019).

Each selected musical track was chosen to fit within a standardised error margin (+/- 2bpm). All tempos were corroborated by an independent, blind testing of musical tracks by a member of the Incorporated Society of Musicians.

Table 2: Table of musical tracks for each musical condition of genre x tempo

Pop Music				
	Artist	Track	Tempo (bpm)	Song length (Minutes)
110bpm	Jason Derulo	Kiss the Sky	110	3:49
	Ariana Grande	Into You	108	4:00
	Jessie J	Thunder	108	3:36
150bpm	Justin Timberlake	What goes around	150	5:40
	Maroon 5	Harder to Breathe	150	2:54
	David Hasselhoff	True Survivor	149	3:40
Hip-Hop/Rap				
110bpm	2Pac ft. Talent	Changes	110	4:41
	NF	All I Do	112	3:48
	Usher	Caught Up	112	3:48
150bpm	Fetty Wap	Trap Queen	148	3:43
	NF	Let You Down	148	3:25
	Thi'sl ft. AD3	Snap Off	148	3:17
Rock Music				
110bpm	AC-DC	Meltdown	110	3:42
	Boston	More than a feeling	109	4:46
	Bon Jovi	Livin' on a Prayer	112	4:09
150bpm	Elton John	Saturday Night's Alright	152	4:57
	Guns N' Roses	Live and Let Die	150	3:09
	Twisted Sister	We're not gonna take it	149	4:31

In order to assess the potential impact of differences between perceived and actual tempi, it was deemed important to assess how accurately people were able to determine the tempo of the selected musical tracks. Therefore, the same music pre-selection group was asked to record whether they perceived the tempo range of each musical track to be “Slow” (110bpm) or “Fast” (150bpm), with results below. These preliminary results lend further emphasis to the notion that musical tempo is subjectively perceived, as outlined in the Literature Review above.

Table 3: Participant Classifications of Musical Tempo

Music Condition	Correct Classification	Incorrect Classification
Hip-Hop 110	10 (83.3%)	2 (16.6%)
Pop 110	11 (91.6%)	1 (8.3%)
Rock 110	6 (50%)	6 (50%)
Hip-Hop 150	12 (100%)	0 (0%)
Pop 150	11 (91.6%)	1 (8.3%)
Rock 150	7 (58.3%)	5 (41.6%)

5.1.3. Study Design

This study examined the effect of several musical genre-tempo combinations on sporting performance outcome, as measured by circuit completion time on a ten-minute circuit by using a three (genre: Pop, Hip-Hop and Rock) x two (tempo: 110 and 150bpm) within-subjects study design. The design ensured that all participants were exposed to all conditions, including pre- and post-intervention, meaning that each participant acted as their own control for multiple musical conditions.

Ten-minute testing sessions were held during the warm up for the weekly competitive judo session. Testing sessions were spread over an eight-week period allowing one session for each of the eight testing conditions. Since no other training programme took place within six hours of the competitive session, residual impacts from other training programmes are assumed to have been minimized. The one-week gap between testing conditions minimized any residual impacts between testing sessions.

In order to control for the possibility that subjects could anticipate a predictable order of tempo and genre and to eliminate researcher bias in presentation, the musical tracks were presented in the same digitally randomised order by the use of the “random sort” statistical function in Excel. The order of genres played was kept the same at both clubs every week to ensure consistency between the two small subgroups so that results could be measured as a larger single group giving greater statistical validity but this did then

prevent counterbalancing of the musical conditions between the groups. Although tempo and genre were important considerations in the analysis, they were not mentioned to participants to avoid creating behavioural bias.

5.1.4. Measures

5.1.4.1. Attentional Focus Questionnaire

Following each session an Attentional Focus Questionnaire (AFQ; Brewer et al., 1996) was given to participants to identify the relationship between attentional focus and sports performance as used previously in similar music-in sport-studies (Jones, et al., 2017). The questionnaire identified three subtypes of attentional focus; Association, Dissociation and Distress, using a seven-point Likert rating scale. Evidence from Emad, Neumann & Abel (2017) suggests that this is a valid and reliable measure of attentional focus. Although in applying the Attentional Focus Questionnaire to sport Karageorghis (2013) modified the questionnaire by removing the Distress component. In this study, the Distress component was retained to maintain the validity of the original questionnaire.

The scale gave an indication of how much each participant associated (scored between 11-77), dissociated (scored between 12-84) or was distressed (scored between 7-49) by a controlled variable (i.e., music).

		I did not do this at all						I did this all the time
		1	2	3	4	5	6	7
1	Letting your mind wander (Daydreaming)							

5.1.4.2. Modified PANAS

Participants also completed a modified PANAS (Positive and Negative Affect Scale - Watson & Tellegen, 1985) to identify words that they would associate with emotional qualities of the musical track being played, as shown in the example below. The original 1985 PANAS comprised twenty items (ten positive and ten negative items), but was later modified (Watson et al., 1988). The PANAS questionnaire in this study was therefore modified to measure how an individual's emotional response may be influenced by music and impact sporting performance. The resulting modified PANAS consisted of nine items (seven from the positive scale and two from the negative scale), each using a five-point Likert scale to rate an individual's emotional response to each musical condition, as shown in the example below.

		Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
1	Interested	1	2	3	4	5

5.1.4.3. Borg Scale

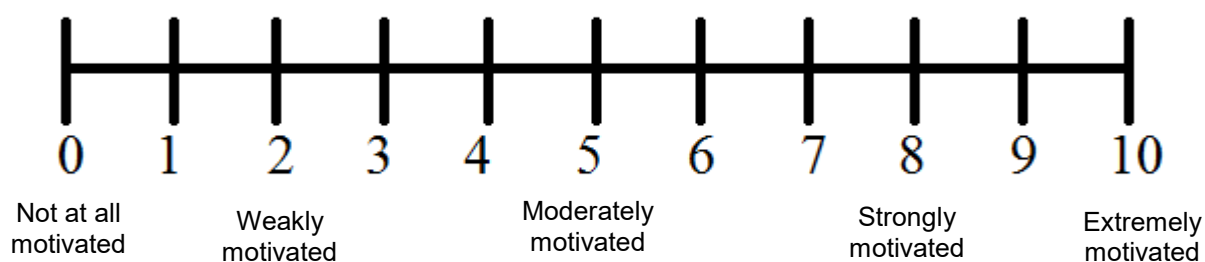
The Borg scale (1982) allows a participant to numerically quantify how hard they perceive themselves to be working. This scale can be easily applied to performance and physiological measures (Coutts et al. 2009) to determine whether a participant’s perceived work rate matches their actual physiological outcome.

The Borg Scale used in the present study asked participants to rank how hard they felt they were working on a rating scale of 6-20, as shown below.

rating	description
6	NO EXERTION AT ALL
7	EXTREMELY LIGHT
8	
9	VERY LIGHT
10	
11	LIGHT
12	
13	SOMEWHAT HARD
14	
15	HARD (HEAVY)
16	
17	VERY HARD
18	
19	EXTREMELY HARD
20	MAXIMAL EXERTION

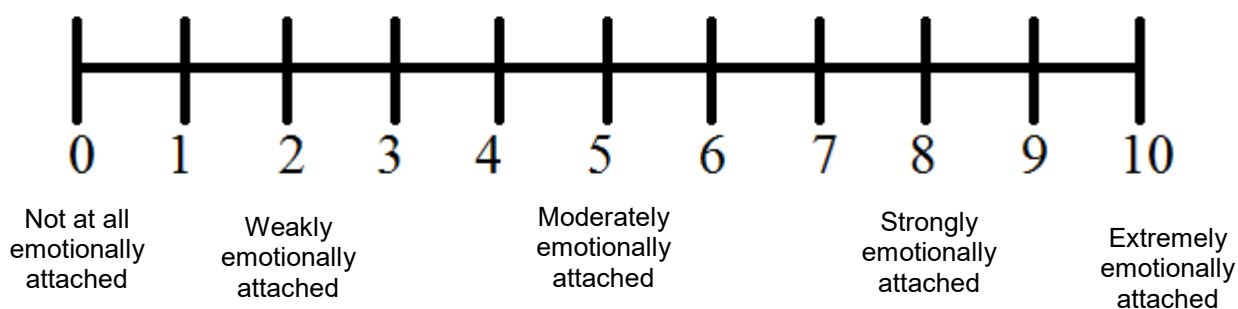
5.1.4.4. Motivational Scale

A Motivational Scale Instruction (MSI – Tenenbaum, 2001) was used to determine motivational qualities in musical tracks. The MSI was developed to maintain reliability and validity in measuring music in specific contexts and is regarded by Karageorghis (2017) as the best way to measure motivation for the specific effects of music in a sporting context.



5.1.4.5. Emotional Attachment to Music

The Emotional Attachment to Music (EAM) questionnaire (Karageorghis, 2017) was used to determine the extent of emotional attachment by each participant to the musical tracks being played and is referred to by Karageorghis as the only standardized and reliable measure of emotional attachment to music in sport. Constructed on the same basis as the Borg Scale, the EAM rates emotional attachment on a Likert scale from 0-10 inclusive as shown below.



5.1.4.6. Circuit Completion Time

Circuit completion time was the performance outcome measure for determining the effects of music in context. For consistency, circuit completion time was limited to ten minutes for each participant. Video recordings were made of each completed circuit to verify completion times and to verify that each participant had correctly completed the circuit. Each testing session was video recorded to allow the researcher to verify the participant's circuit completion time and ensure that the circuit was completed correctly and were independently verified by a Commonwealth Judo Silver Medallist. The order of presenting the musical conditions was digitally randomised to prevent researcher bias or participant behavioural bias.

5.1.5. Procedure

Once musical selection had been confirmed, ethical approval was granted on 8th January 2018 after submission of a Chairs Actions Request following an undergraduate study by Richardson, S. et al., (2017). During a training session one week before starting the study, potential participants were given an information pack containing an information sheet detailing the general structure of testing protocols, a voluntary participation form, and consent forms. These were also explained verbally.

The three exercises included in the circuit were specific to Judo (Roberts, 2015) and were Spiderman Push Ups, Jump Squats and Up Downs. The number of repetitions for each exercise was 5, 10, 15, 10, 5 so forming a pyramid circuit. Music was played using a Sony GTK-XB7 Extra Bass Bluetooth speaker, set at fifty percent volume during all testing sessions.

Following each session each participant completed an attentional focus rating scale, a motivational rating scale, an emotional attachment rating scale, a modified PANAS scale and a Borg scale of perceived exertion as shown below:

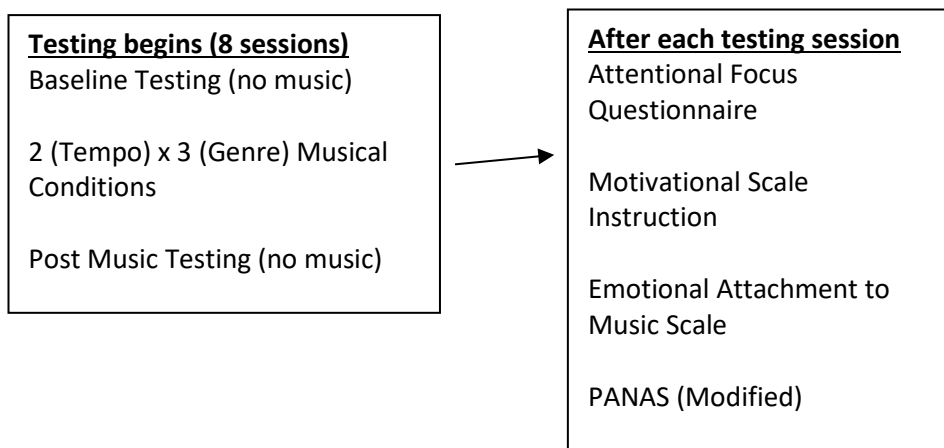


Figure 5: Study Procedure

Before the start of the study participants were also familiarized with the circuit without music to fully understand the circuit and exercises. Five less experienced participants (3 male, 2 female) from Club A were able to complete the circuit in nine to ten minutes. It was assumed that judoka of a higher competitive standard would also have a higher fitness level and so would be able to complete the circuit within that time.

Table 4: Presentation of Musical Conditions

Genre	Tempo
Hip-Hop	110
Rock	150
Hip-Hop	150
Pop	110
Rock	110
Pop	150

Data Analysis

A series of 3 (genre) x 2 (tempo) factorial repeated-measures analyses of variance (ANOVAs) were used to test for main and interaction effects of tempo and genre on the outcome variables of circuit completion time, attentional focus, emotional affect, rate of perceived exertion, motivation and emotional attachment to music. Pairwise comparisons were used to determine significant differences between variables using Bonferroni post-hoc test adjusted for simultaneous statistical tests on one data set. Paired samples t-tests were run to compare pre- and post- conditions (for circuit completion time, attention, PANAS, RPE) to determine any potential learning effects or habituation.

6. Results

6.1.1. Circuit Completion Time

A 3 (genre) x 2 (tempo) factorial repeated-measures ANOVA showed a significant effect of genre [$F(1.89, 54.87) = 5.41, p=0.008$] and tempo [$F(1, 29) = 34.894, p<0.001$] but no interaction between genre and tempo [$F(2, 58) = 0.307, p=0.734$]

Pairwise comparisons showed that circuit completion time was significantly faster for Pop in comparison to Hip-Hop. Circuit completion times for all genres were faster at 150bpm than at 110bpm.

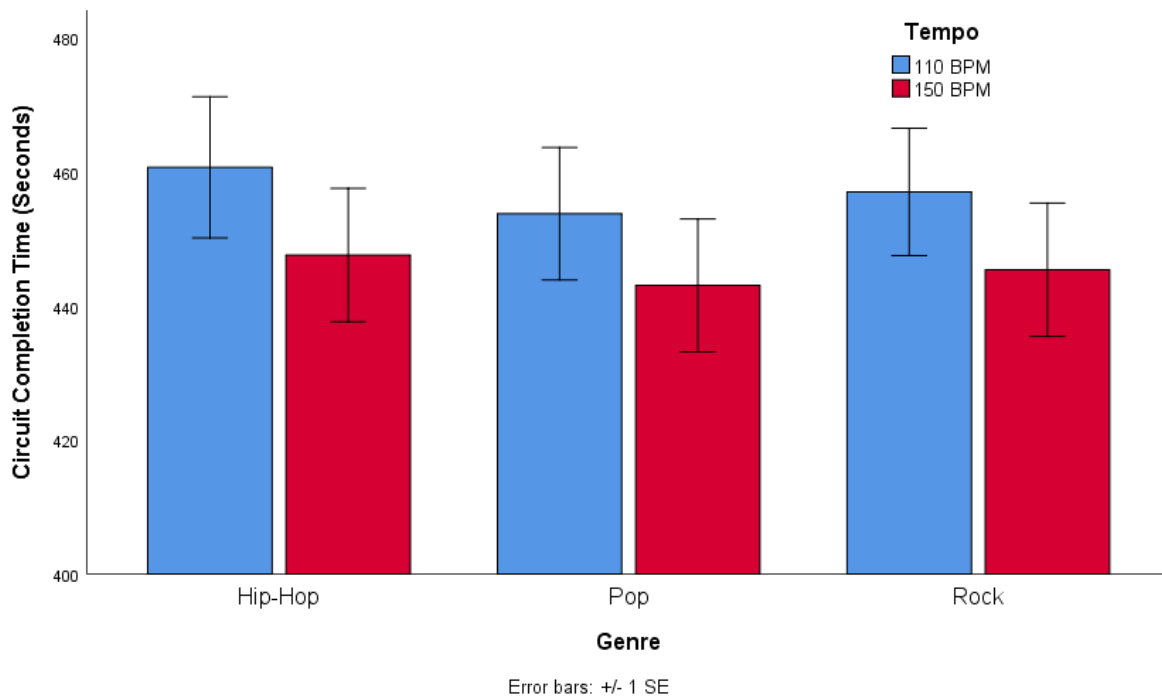


Figure 6: Mean Circuit Completion Time (SE error bars)

A paired samples t-test [$t(29) = 4.42, p<0.001$] indicated a significant difference of circuit completion times (ie. faster circuit completion times) between pre- ($M= 488.57, SD= 55.16$) and post-intervention testing ($M= 452.53, SD= 57.71$).

6.1.2. Attentional Focus

6.1.2.1. Association

A 3 (genre) x 2 (tempo) mixed design ANOVA showed a significant effect of genre [$F(1.8, 53.89) = 26.41, p < 0.001$] and tempo [$F(1, 30) = 29.89, p < 0.001$] and a significant interaction between genre and tempo [$F(1.46, 43.71) = 3.87, p = 0.041$]

Pairwise comparison showed that at 110bpm Rock scores were significantly higher than Hip-Hop and Pop, and at 150bpm Rock scores higher than Hip-Hop and Pop. Rock scores were significantly higher at 110bpm than 150bpm.

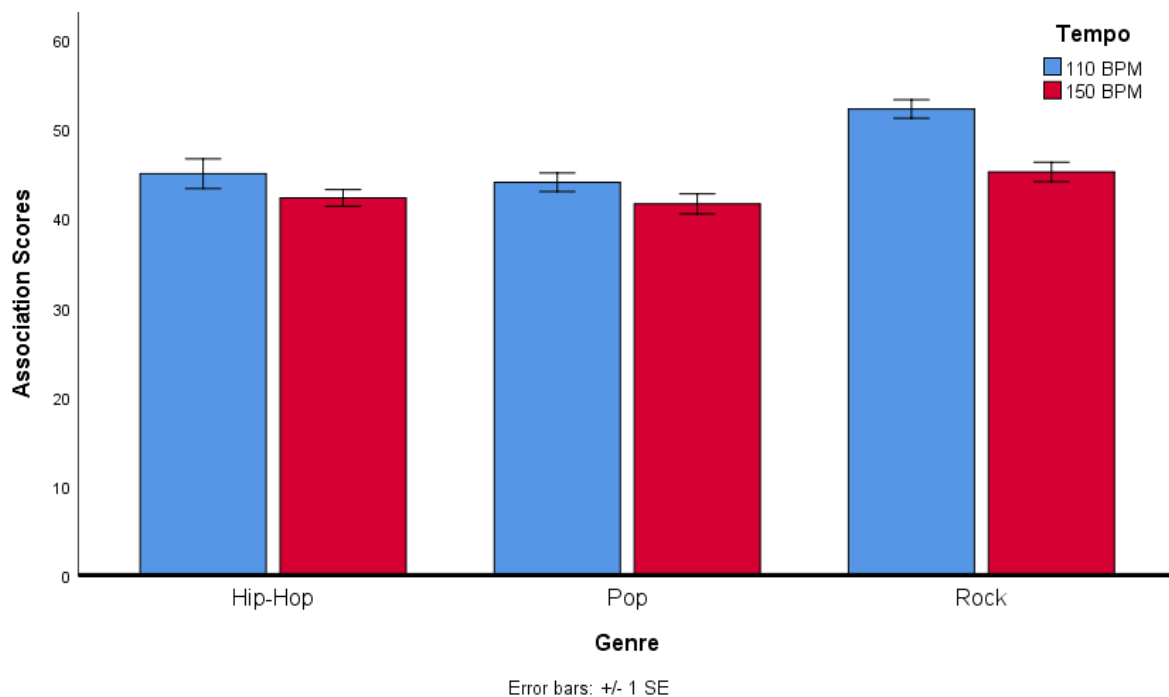


Figure 7: Mean Association Scores (SE error bars)

A paired samples t-test [$t(29) = -2.34, p = 0.026$]. indicated a significant difference between pre ($M = 39.90, SD = 7.38$) and post-musical condition ($M = 44.42, SD = 7.58$) on Association scores.

6.1.2.2. Dissociation

A 3 (genre) x 2 (tempo) mixed design ANOVA showed a significant effect of genre [$F(2, 60)= 9.65, p <0.001$] and tempo [$F(1, 30)= 5.28, p=0.029$] but no interaction between genre and tempo [$F(2, 60)= 0.026, p=0.961$].

Pairwise comparisons showed that dissociation scores were higher at 110bpm, and higher for Rock compared to Hip-hop.

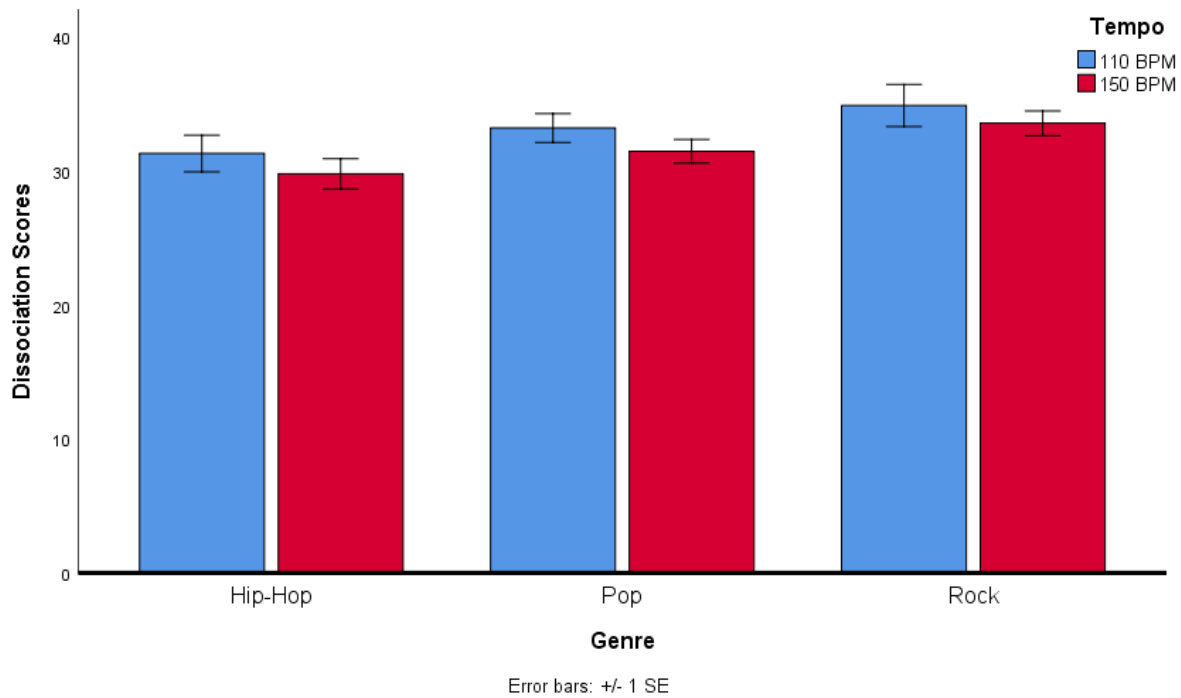


Figure 8: Mean Dissociation Scores (SE error bars)

A paired samples t-test [$t(29)= -6.89, p<0.001$] indicated a significant difference between pre- ($M= 27.63, SD= 8.62$) and post-musical condition ($M= 36.80, SD= 4.64$) on dissociation scores.

6.1.2.3. Distress

A 3 (genre) x 2 (tempo) mixed design ANOVA showed, a significant effect of genre [$F(1.77, 51.44) = 45.29, p < 0.001$], tempo [$F(1, 29) = 10.99, p = 0.002$] and an interaction between genre and tempo [$F(1.63, 47.08) = 32.47, p < 0.001$].

Paired comparisons showed that at 110 bpm Pop scores were significantly higher than Hip-Hop and Rock. At 150bpm, Hip-Hop scored significantly higher than Pop and Rock, and Pop scored significantly higher than Rock.

Hip-Hop scored also significantly higher at 150bpm than 110bpm, while Pop scored significantly higher at 110bpm than 150bpm.

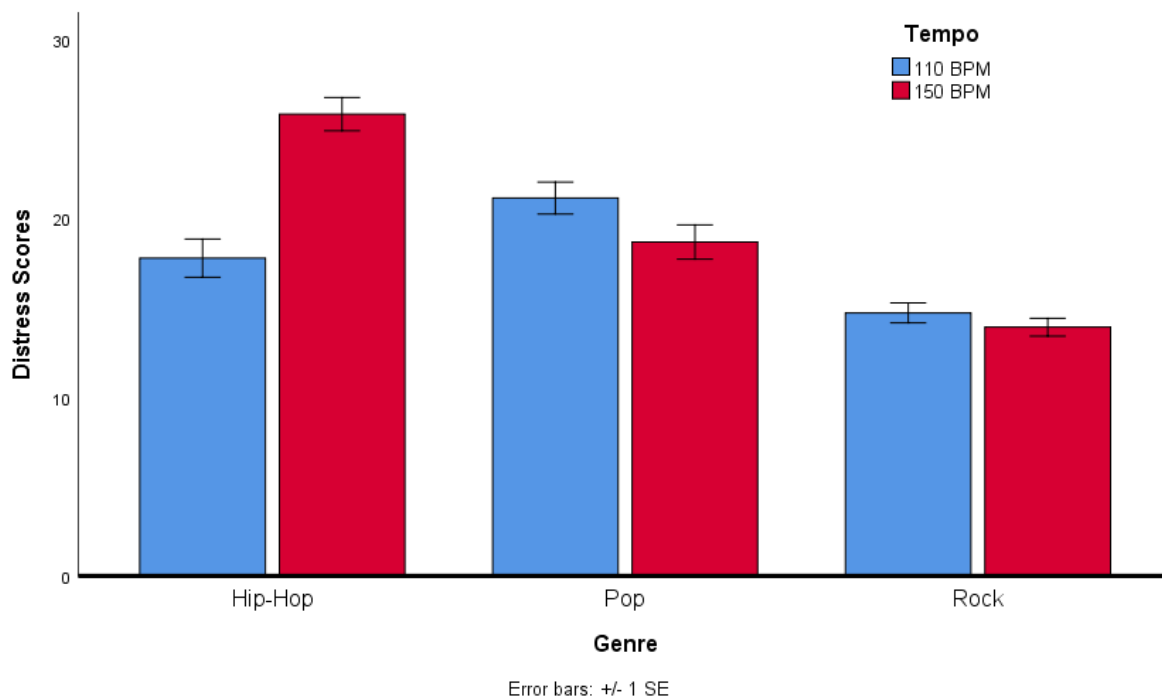


Figure 9: Mean Distress Scores (SE error bars)

A paired samples t-test [$t(29) = -11.96, p < 0.001$] indicated a significant difference between pre ($M = 16.60, SD = 6.21$) and post-musical condition ($M = 35.23, SD = 5.44$) on Distress scores.

6.1.3. Affect

Each word used in the modified PANAS were analysed to give insight into the relationship between the effects of musical characteristics on emotional response in a sporting situation. This may indicate the impact of each condition on circuit completion time.

6.1.3.1. Interested

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no significant effect of genre [$F(2, 58) = 0.218, p = 0.805$]. However, significant effect was shown of tempo [$F(1, 29) = 6.37, p = 0.015$] and significant interaction between genre and tempo [$F(1.80, 52.19) = 5.82, p = 0.007$]

Pairwise comparisons showed that Hip-Hop was significantly higher at 110bpm than 150bpm and Rock was significantly higher than Hip-Hop at 150bpm.

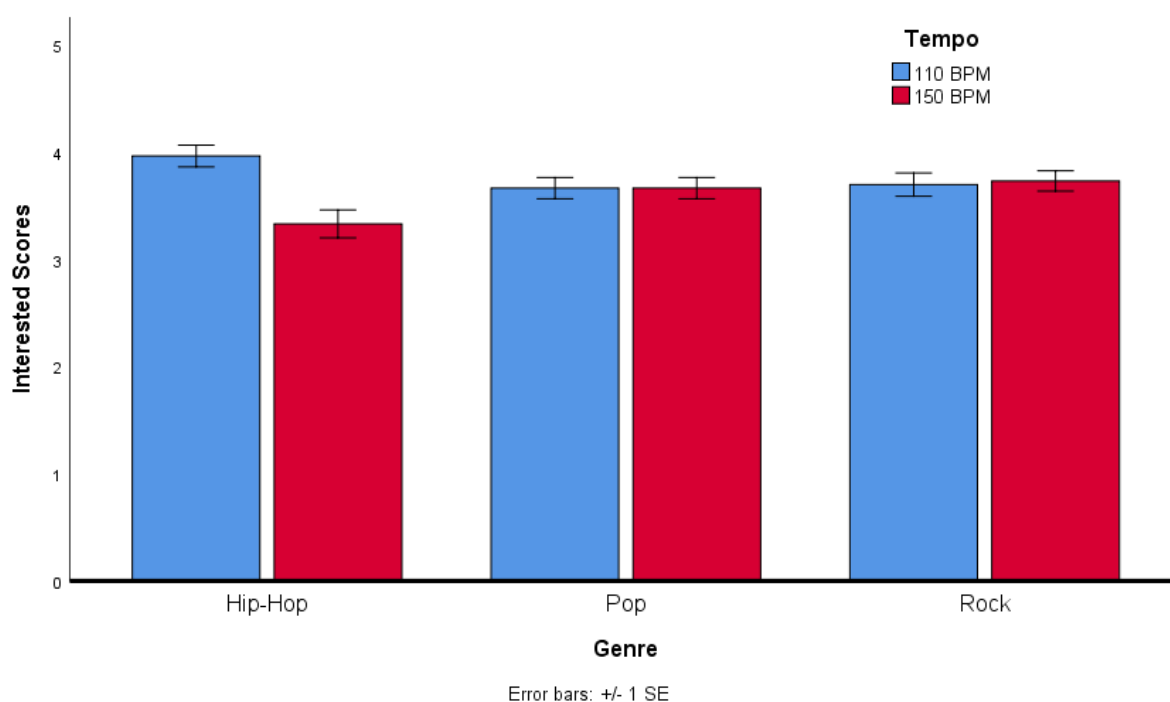


Figure 10: Mean "Interested" Scores (SE error bars)

A paired samples t-test [$t(29) = 6.30, p < 0.001$]. indicated a significant difference between pre ($M = 3.97, SD = 0.49$) and post-musical condition ($M = 2.87, SD = 0.94$) on "Interested" score.

6.1.3.2. Excited

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no significant effect of genre [$F(2, 58) = 0.091, p = 0.914$], tempo [$F(1, 29) = .45, p = 0.506$] and no interaction between Genre and tempo [$F(2, 58) = 0.42, p = 0.66$].

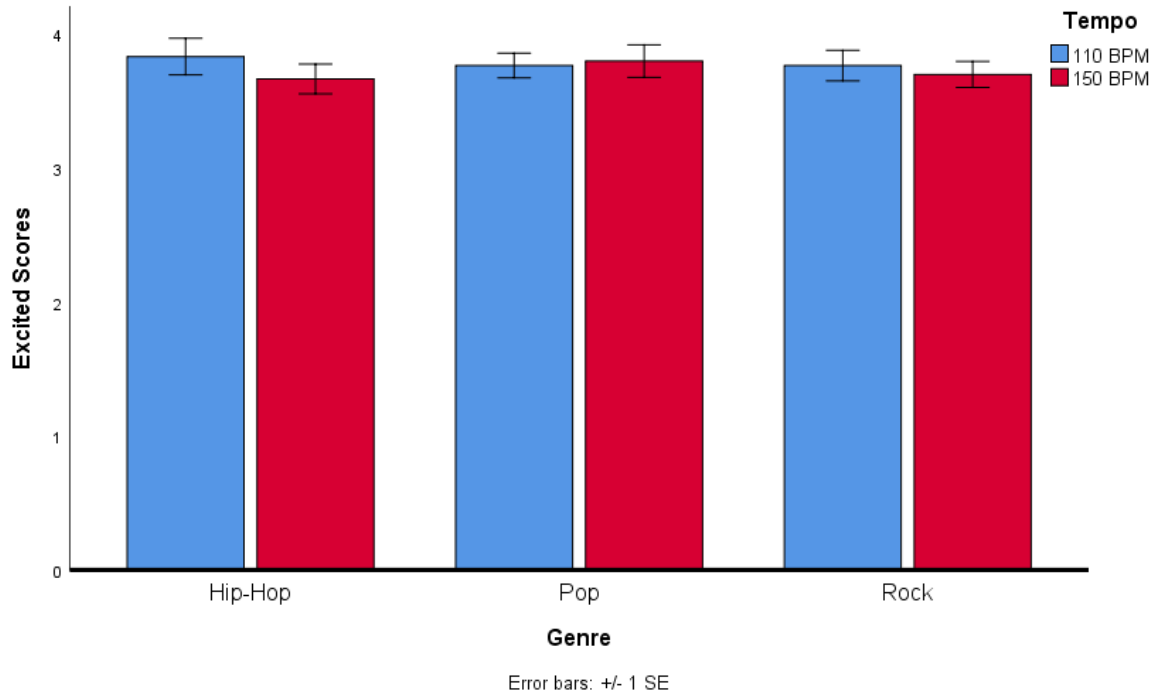


Figure 11: Mean "Excited" Scores (SE error bars)

A paired samples t-test [$t(29) = 4.38, p < 0.001$] indicated a significant difference between pre ($M = 3.57, SD = 0.77$) and post musical condition ($M = 2.67, SD = 0.96$) on "Excited" score.

6.1.3.3. Strong

A 3 (genre) x 2 (tempo) mixed design ANOVA showed a significant effect for genre was shown [$F(1.98, 57.54) = 4.33, p = 0.018$], but not for tempo [$F(1, 29) = 3.79, p = 0.061$]. There was no significant interaction between genre and tempo [$F(2, 58) = 0.00, p = 1$].

Pairwise comparisons revealed that Pop elicited significantly higher “Strong” scores than Hip-Hop.

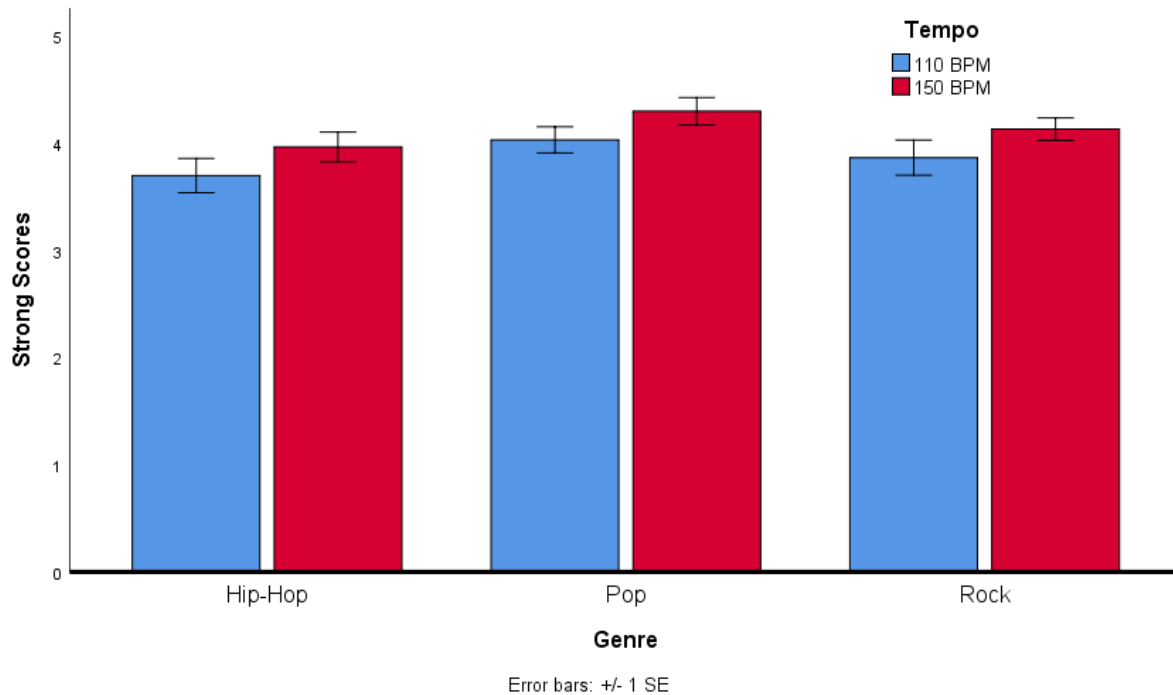


Figure 12: Mean “Strong” Scores (SE error bars)

A paired samples t-test [$t(29) = 1.31, p = 0.20$] indicated no significant difference between pre ($M = 3.73, SD = 1.01$) and post-musical condition ($M = 3.47, SD = 0.97$) on “Strong” score.

6.1.3.4. Hostile

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no effect was shown for genre [$F(2, 58) = 0.970, p = 0.385$] tempo [$F(1, 29) = 0.035, p = 0.852$] or interaction between genre and tempo [$F(2, 58) = 1.55, p = 0.221$].

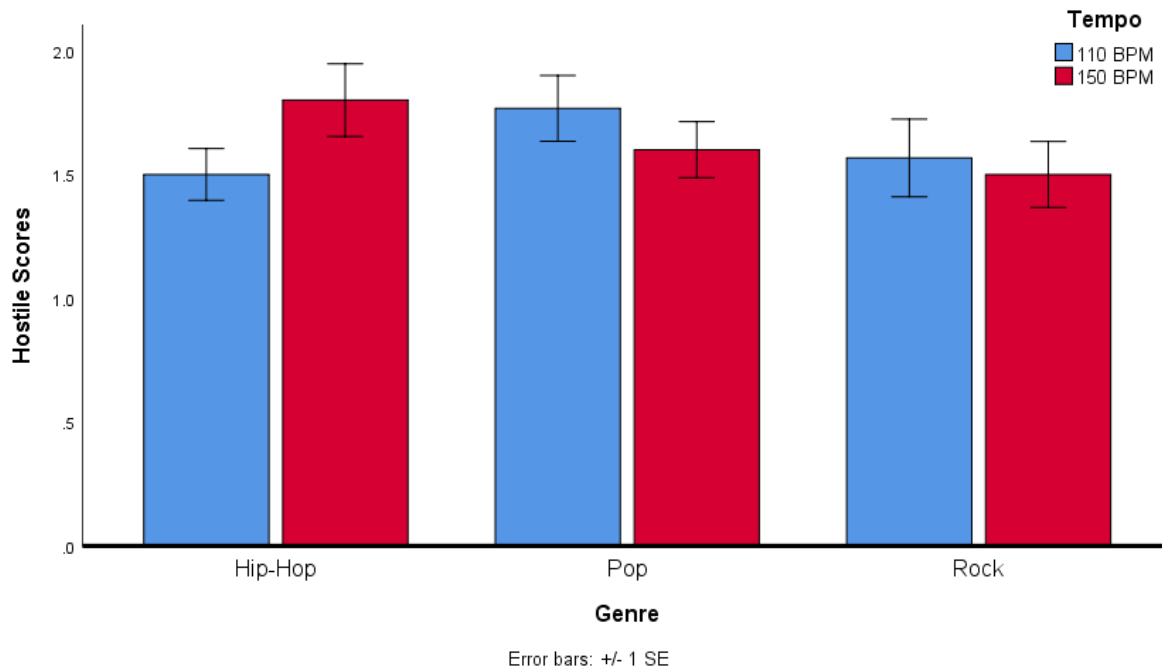


Figure 13: Mean "Hostile" Scores (SE error bars)

A paired samples t-test [$t(29) = -1.92, p = 0.065$] indicated no significant difference between pre- ($M = 1.93, SD = 0.94$) and post-musical condition ($M = 2.40, SD = 0.86$) on "Hostile" score.

6.1.3.5. Enthusiastic

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no significant effects of genre [$F(2, 58) = 2.20, p = 0.123$] but significant effects were found for tempo [$F(1, 29) = 18.10, p < 0.001$]. There was no interaction between genre and tempo [$F(2, 58) = 0.942, p = 0.396$]

Pairwise comparisons showed that Enthusiastic was significantly higher at 110bpm than 150bpm.

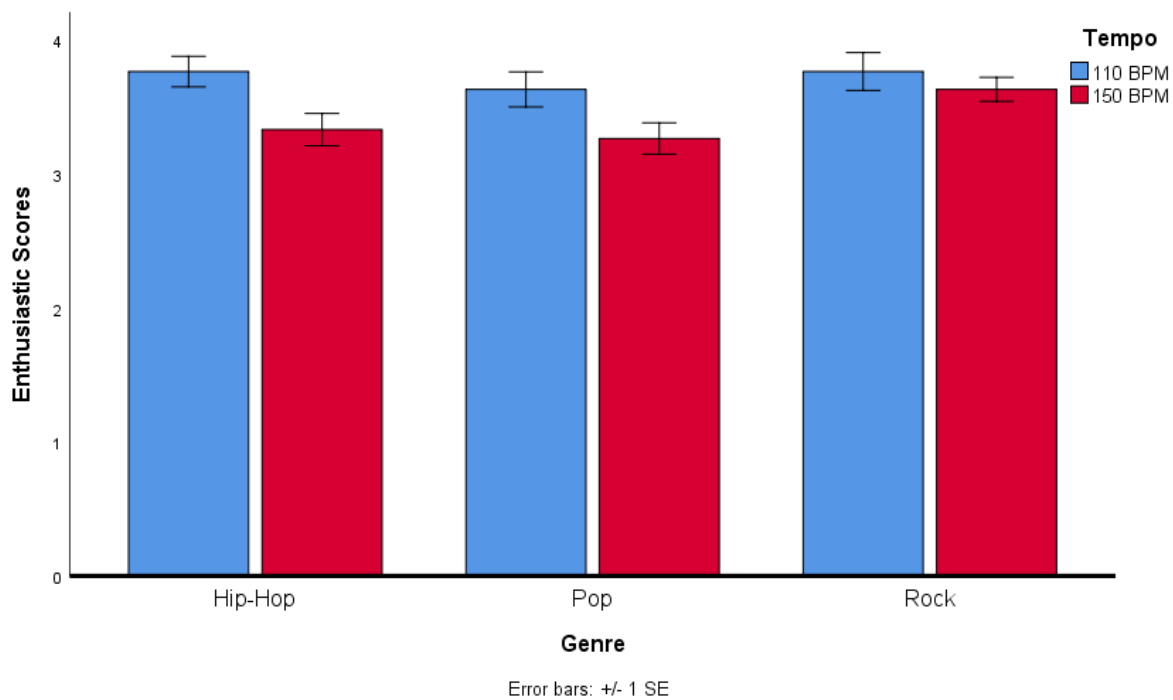


Figure 14: Mean "Enthusiastic" Scores (SE error bars)

A paired samples t-test [$t(29) = 5.36, p < 0.001$]. indicated a significant difference between pre ($M = 3.87, SD = 0.68$) and post musical condition ($M = 2.77, SD = 0.97$) on "Enthusiastic" score.

6.1.3.6. Irritable

A 3 (genre) x 2 (tempo) mixed design ANOVA showed a significant effects of genre [$F(1.63, 47.34) = 66.55, p < 0.001$], tempo [$F(1, 29) = 27.99, p < 0.001$] and an interaction between genre and tempo [$F(1.52, 44.18) = 14.99, p < 0.001$].

Pairwise comparisons showed that “Irritable” scores for genres Hip-Hop and Pop was significantly higher at 150bpm than 110bpm. Pop scored significantly higher than Hip-Hop and Rock at 150bpm, with Hip-Hop being significantly higher than Rock. Pop scored significantly higher than Hip-Hop and Rock at 110bpm.

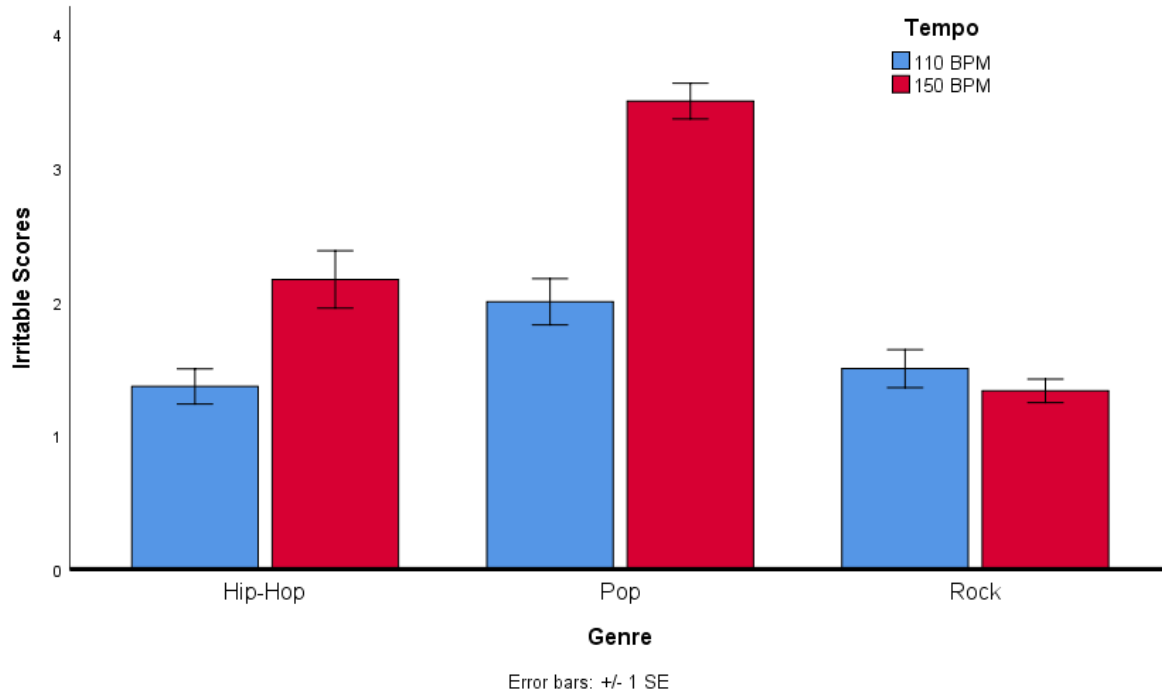


Figure 15: Mean “Irritable” Scores (SE error bars)

A paired samples t-test [$t(29) = -5.09, p < 0.001$] indicated a significant difference between pre- ($M = 1.50, SD = 0.68$) and post-musical condition ($M = 2.77, SD = 1.10$) on “Irritable” score.

6.1.3.7. Alert

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no significant effect of genre [$F(2, 58)=1.55, p=0.221$] or tempo [$F(1, 29)= 0.211, p=0.650$] and no interaction between genre and tempo [$F(2, 58)= 0.716, p=0.493$].

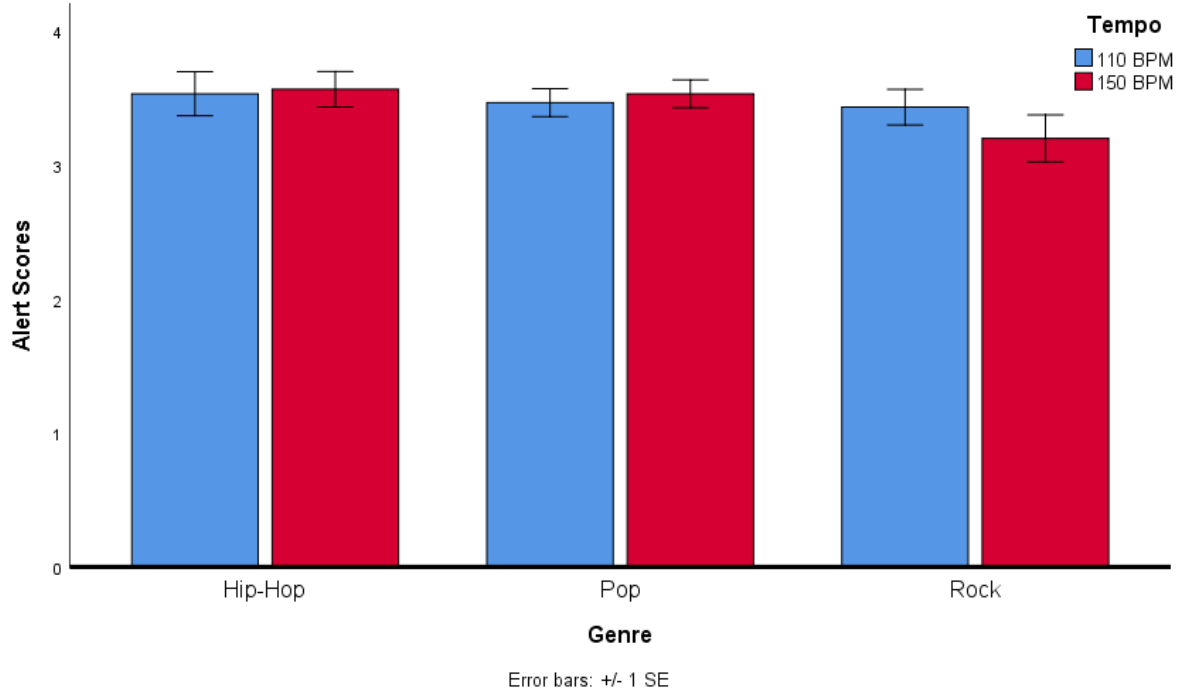


Figure 16: Mean "Alert" Scores (SE error bars)

A paired samples t-test [$t(29) = 0.47, p=0.64$]. indicated no significant difference between pre- ($M= 3.17, SD=0.95$) and post-musical condition ($M= 3.03, SD=0.93$) on "Alert" score.

6.1.3.8. Inspired

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no significant effect of genre [$F(2, 58) = 2.07, p = 0.135$], tempo [$F(1, 29) = 1.29, p = 0.266$] and no interaction between genre and tempo [$F(2, 58) = 0.045, p = 0.956$].

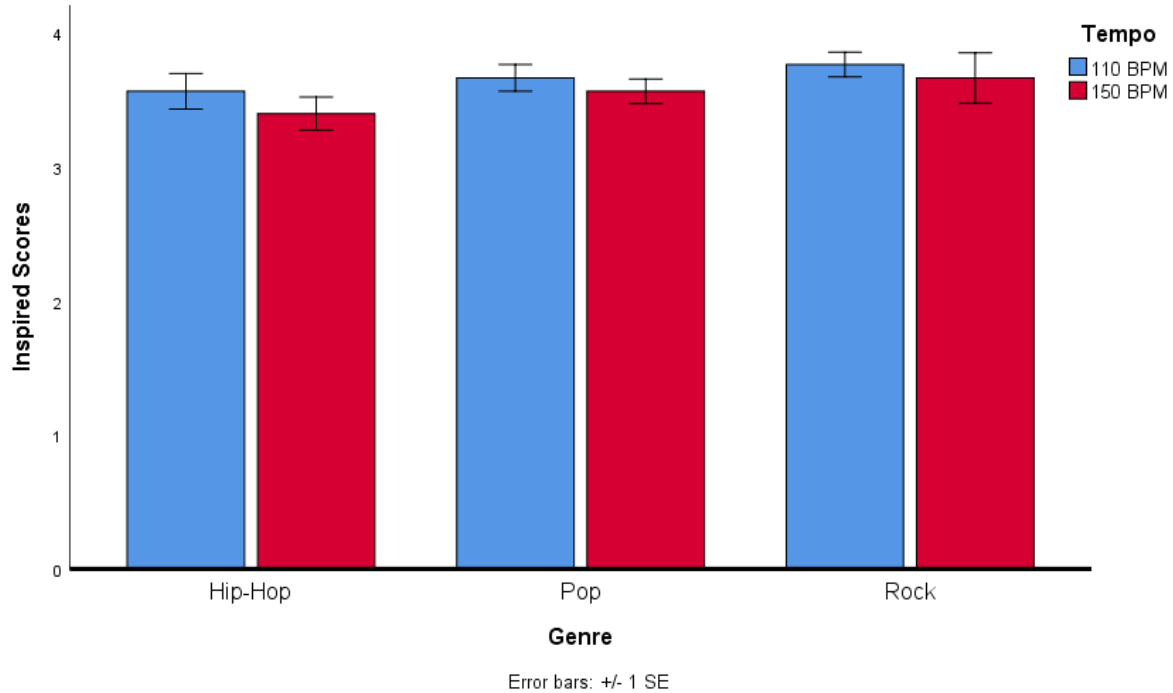


Figure 17: Mean "Inspired" Scores (SE error bars)

A paired samples t-test [$t(29) = 3.79, p = 0.001$]. indicated a significant difference between pre- ($M = 3.40, SD = 0.86$) and post-musical condition ($M = 2.60, SD = 0.89$) on "Inspired" scores.

6.1.3.9. Determined

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no effect of genre [$F(2, 58) = 1.71, p = 0.192$], tempo [$F(1, 29) = 1.14, p = 0.293$] and no interaction between genre and tempo [$F(2, 58) = 0.05, p = 0.856$].

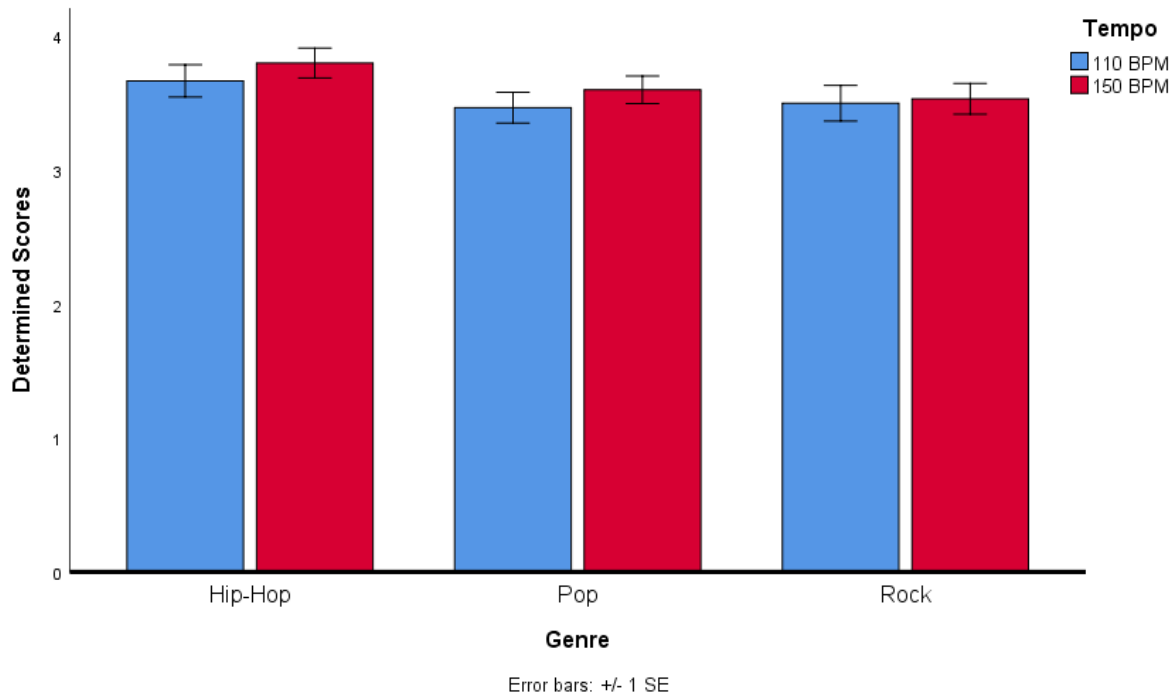


Figure 18: Mean Determined Scores (SE error bars)

A paired samples t-test [$t(29) = 2.92, p = 0.007$]. indicated a significant difference between pre- ($M = 3.47, SD = 0.86$) and post-musical condition ($M = 2.77, SD = 0.97$) on “Determined” scores.

6.1.4. Borg Scale

A 3 (genre) x 2 (tempo) mixed design ANOVA showed no significant effect of genre [$F(2, 58) = 1.32, p = .276$], but a significant effect for tempo [$F(1, 29) = 14.17, p = 0.001$] and an interaction between genre and tempo [$F(2, 58) = 2.93, p = .062$] were found.

Pairwise comparisons showed that Borg scale scores were higher at 150bpm than 110bpm.

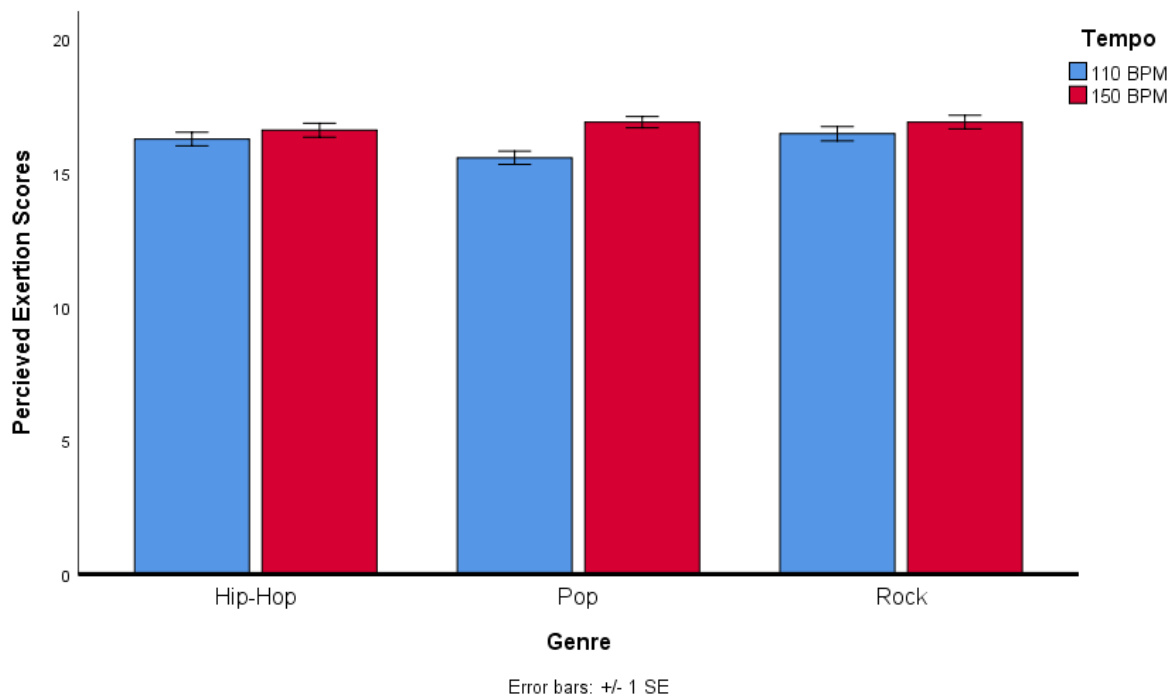


Figure 19: Mean RPE Scores (SE error bars)

A paired samples t-test [$t(29) = -3.31, p = 0.002$] indicated a significant difference between pre- ($M = 15.97, SD = 1.25$) and post-intervention ($M = 16.77, SD = 1.36$) for scores on the Borg Scale.

6.1.5. Motivation

A 3 (genre) x 2 (tempo) mixed design ANOVA showed a significant effect of genre [$F(1.43, 43.17) = 37.17, p < 0.001$], tempo [$F(1, 30) = 8.49, p < 0.05$] and a significant interaction between Genre and tempo [$F(1.21, 36.35) = 6.70, p = 0.010$].

Pairwise comparisons showed that motivation scores were higher for Rock than Hip-Hop and Pop at 150bpm. Rock was significantly higher than Hip-Hop and Pop at 110bpm, and Hip-Hop was significantly higher than Pop at 110bpm. Pop and Rock were significantly higher at 150bpm than 110bpm. Hip-Hop was significantly higher at 110bpm than 150bpm.

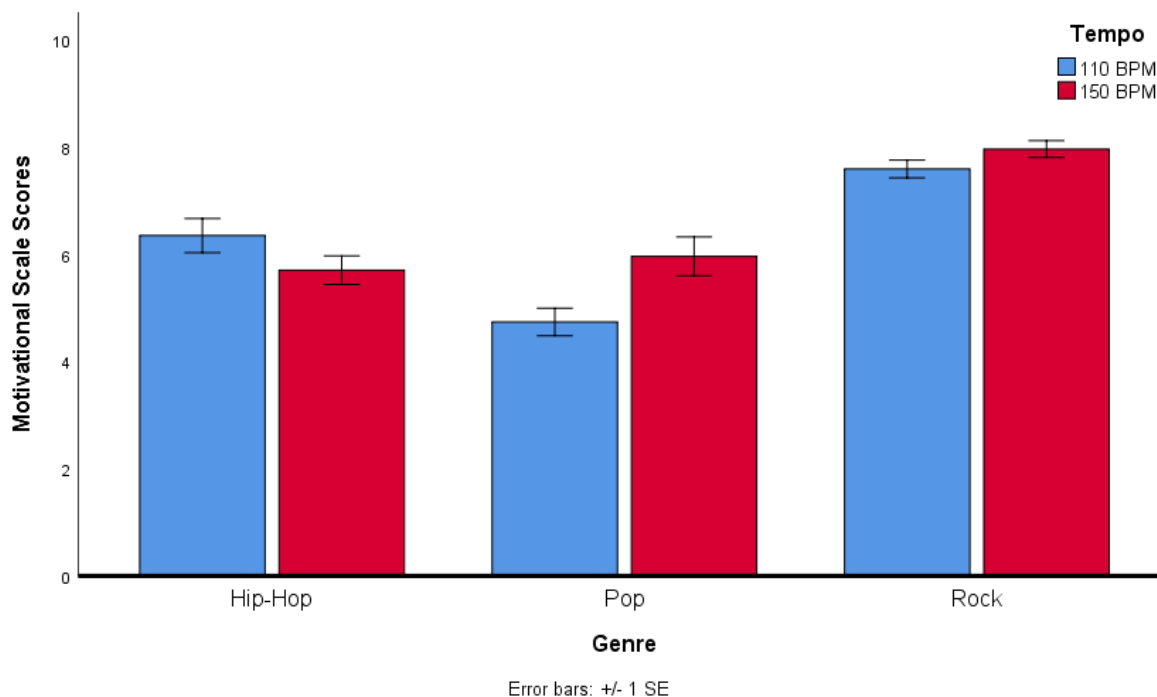


Figure 20: Mean Motivation Scores (SE error bars)

Motivation scores were not tested with a dependant t-test for learning/training effects because music was not played at Pre or Post–Intervention testing.

6.1.6. Emotional Attachment to Music

A 3 (genre) x 2 (tempo) mixed design ANOVA showed a significant effect of genre [$F(1.44, 43.26) = 42.02, p < 0.001$], tempo [$F(1, 30) = 33.88, p < 0.001$] and interaction between Genre and tempo [$F(1.99, 59.56) = 3.64, p = 0.033$].

Pairwise comparisons showed that at 150bpm Pop and Rock scored higher than at 110bpm. At 150bpm, Rock had significantly higher scores than Pop and Hip-Hop and Pop had significantly higher scores than Hip-Hop.

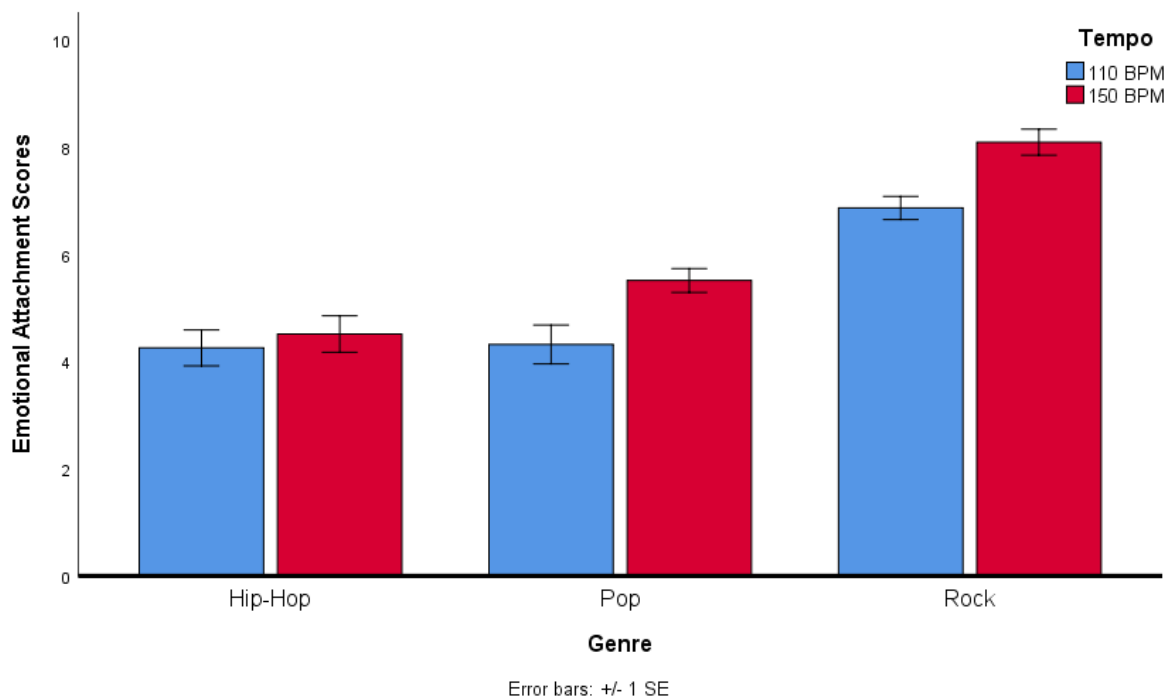


Figure 21: Mean Emotional Attachment Scores (SE error bars)

Emotional Attachment scores not tested with a dependant t-test for learning/training effects because music was not played at Pre or Post–Intervention testing.

6.1.7. Music Preference

Participants were asked an open-ended question on personal musical preferences, which were then grouped under the main three genres used during the testing process based on evidence by Crauwels (2016), as shown in table 16 below.

Genre	Frequency	Percent (%)
Rock	16	51.6
Pop	9	29.0
Hip-Hop	6	19.4

Table 5: A frequency analysis of musical genre preferences

7. Discussion

All musical genres and tempos tested had a significant effect in improving circuit completion times. This finding supports the notion that listening to music before and during training can have a significant positive effect on sporting performance, supporting previous research in this area (Karageorghis, 2006, 2008, 2012, 2017).

Significant differences were found in circuit completion times between the genres Hip-Hop, Pop and Rock within each tempo. The genre of Pop elicited a significantly faster circuit completion time than both Hip-Hop and Rock. Since Pop often has the most regular rhythm with fewest musical complexities of these three genres (Gfeller, 2003), it is possible that Pop music was the easiest to interpret accurately enabling greater physiological synchronicity (Karageorghis, 2012). Similarly, a study by Johnson (2004) found that participants synchronised movement most easily to Polka music and attributed the finding to a clear downbeat in this genre. Therefore genre differences in rhythmic regularity may play a significant part in determining sporting performance outcomes.

In the present study, circuit completion times improved significantly between pre- and post-testing along with an increasingly positive emotional reaction to the musical stimuli over time. Scores for post-testing also reflect increased distress. These results suggest that music might be thought of as a form of positive reinforcement in sporting contexts.

Across genre categories, Rock returned the highest ratings for motivation and emotional attachment and the lowest for irritability and distress. In addition, participants both associated and dissociated more strongly with Rock than with Hip-Hop. It is plausible that positive emotional association with music enables dissociation from that activity when needed which would account for the apparently contradictory finding of both Association and Dissociation rated as high for the same genre. This is supported by Karageorghis' theoretical framework (2006) which lists Association as an Intermediary cognitive factor whereas Dissociation is listed as a Potential Benefit to sporting performance, indicating a behavioural outcome. The cognitive aspects of Dissociation may benefit from being considered alongside those of Association within the framework.

Sabbe (1986) suggests that significant emotional responses to music are likely to increase an individual's speed and perceived exertion. Pop as a genre scored significantly higher than Hip-Hop for "Strong" and "Irritable" responses and, at 110bpm, for "Distress." Paradoxically, performance benefits for Pop were greater than those for Hip-Hop. This is an unexpected finding of a negative stimulus having a positive impact on performance outcomes and is in contrast to the strong positive emotional response to Rock, suggesting that some genres may improve performance by negative reinforcement. This finding is currently

not accounted for in the framework presented by Karageorghis (2006), where it could be included as a Potential Benefit.

The effects of tempo on sporting performance were considered by analyzing the significant differences in scores on circuit completion times between tempos 150bpm and 110bpm within each genre. Results showed that participants had faster circuit completion times when any of the three genres were played at 150bpm compared to 110bpm, supporting previous evidence showing that a faster musical tempo is likely to engage a faster psychophysiological response (Karageorghis, 2017, 2013; Van Dyck, 2015; Thakare et al., 2017). This finding therefore confirms the hypothesis that a faster tempo will improve circuit completion time.

With regard to the effects of tempo on psychological variables, Pop and Rock music both elicited significantly higher scores for motivation and emotional attachment to music at the higher tempo. This finding supports Bruner's conclusion (1990) that a faster tempo elicits a more positive emotional attachment to the music. A study published by Karageorghis (2012) removed the motivational qualities of music from the 2006 theoretical framework due to the lack of a clear definition, and were instead split between "Arousal control", "Reduced RPE" and "Improves mood" within the list of Potential Benefits. The current study suggests that despite the difficulties both of defining and of measuring "motivation", it may be a useful concept to retain (as in Welford's Information Processing Model), as greater motivation appears to link directly to faster circuit completion times.

If Karageorghis (2006) was correct in linking greater motivation through music to increased arousal, this may fit the Individual Zones of Optimal Functioning model described by Hanin (2000). Although it has been found that exercisers prefer a narrow tempo band of 125-140bpm (Karageorghis, 2012), in the present study 150bpm resulted in a faster completion time for all genres, suggesting that 150bpm may in fact be the optimal range for some individuals.

Previous studies suggest that music may reduce perceptions of increased perceived exertion at slower exercise intensities (Shepard, 2009. Karageorghis, 2006). Marcona (2009) showed that higher perceived exertion led to a faster circuit completion time as in the findings of this study. At the higher tempo all genres had higher scores for perceived exertion as well as faster circuit completion times suggesting that participants had an awareness that they were working at a higher exercise intensity. This raises the possibility that at higher tempos actual and perceived exertion may become more synchronized. The effects of higher tempo on perceived exertion and exercise intensity therefore warrants further study.

Scores for the Distress scale differed significantly between genres. Pop music elicited a significantly higher Distress score at the lower tempo but not at the higher tempo, indicating that genre may impact distress differently according to tempo. This suggests that participant responses are very individual and may cause negative reactions. However, if used for negative reinforcement, it may lead to an improved sporting performance. The measurement of Distress was originally included in the standardised Attentional Focus Questionnaire, but has since been commonly discounted in sports settings since it is seen as an emotional state rather than a psychological technique (Rossman, R., 1992). The results of this study would suggest that distress would be worthy of further study, as it may act as a negative reinforcement to elicit a positive performance outcome.

The findings suggest that participants processed music more fully at a lower tempo. At the lower tempo of 110bpm, Hip-Hop had higher scores for “Interested” and all genres had higher scores for “Enthusiastic”. With regard to attentional focus, for all genres a lower tempo elicited higher scores for Association as well as for Dissociation suggesting that the slower tempo may facilitate the processing of music.

This may also be because participants were unable to process emotional and cognitive responses at higher tempos in that attentional focus is restricted when working at a higher intensity (Kamijo, K. et al., 2007). The finding that Rock at both tempos had high scores on association and dissociation perhaps indicates that the preferred genre introduces more positive emotional responses but less new information and so requires less processing. This is an area that requires more research.

Between pre- and post-intervention testing, circuit completion times improved significantly for all genres as did scores on the psychological variables of Association, Dissociation, “Interested”, “Excited”, “Enthusiastic”, “Inspired”, “Determined” and Perceived Exertion. This suggests that participants were developing a positive reaction to musical stimuli over time. These positive responses suggest that long-term memories may be built while responding to musical stimuli, as corroborated in evidence presented by Fredrickson, B. (2001). Long term memories are included as an essential component in Welford’s information processing model suggesting that long term memories may be needed in a feedback loop between the Potential Benefits and Antecedents within theoretical framework of Karageorghis (2006).

However, scores for both Distress and “Irritable” also increased significantly between pre- and post-intervention alongside the improved circuit completion times. Although this appears to be a counter-intuitive, it is possible that the scores for post-intervention reflect distress at the removal of the music rather than its presence. This would be an important inclusion for the model by Terry & Karageorghis (2006) as a negative response to the removal of music was not included in the framework. The psychological variables which showed no significant differences pre- and post- intervention testing were

the emotional affect words of “Strong”, “Hostile” and “Alert”. This suggests that participants differentiating between specific emotional affect variables.

8. Summary of Findings

Overall the findings showed that both genre and tempo had an impact on sporting performance and this hypothesis is therefore accepted. With regard to genre, Pop had the greatest positive impact on sporting performance possibly due to its rhythmic qualities and ease of interpretation. Rock elicited the most emotional responses whereas these were mainly absent for Pop and Hip-Hop. A genre which enables an easy interpretation of downbeats and rhythm may therefore have a more positive effect on performance than a genre selected for personal preference and emotional attachment.

The findings confirm the hypothesis that a faster tempo will result in improved sporting performance due to an increase in motivation and as a result of higher emotional attachment. The hypothesis that there will be a more associative attentional focus was only partially accepted since this applied only when the preferred genre was present. The hypothesis that decreased perceived exertion with a higher tempo is rejected since the findings were opposite to those expected.

The study confirmed significant effects of tempo on emotional attachment, emotional affect, attentional focus, motivation, personality and perception of exertion when applied to sporting performance. Therefore the hypothesis that the effects of both genre and tempo on sporting performance will be mediated by these psychological variables is accepted.

9. Limitations

Although genre and tempo were chosen in this study as important musical elements, this choice omits a large number of other musical elements which may have been relevant. In addition, whilst this study has endeavoured to be explicit in how “genre” and “tempo” are operationalized, issues still remain. The selection of genres and tempos as identified by Jog.FM (2018) is a pragmatic solution using a well-established radio source but has not been academically validated. This limitation is also shared by other studies in this field due to the lack of a standardized academic source and seriously hinders the replicability of studies, as noted by Karageorghis (2012a).

The potential for genres to be interpreted differently by different participants may also impact results. Self-selection of musical genres by each participant might have minimized the effects of demographic background (Moss et al., 2006), although this would then have introduced issues in the delivery of individualised music and would have required a larger sample size to ensure that each genre was adequately represented.

Establishing musical tempo may have presented difficulties to the participants in terms of how well they were able to identify actual and perceived musical tempos and therefore interpret the main beat accurately. This would therefore limit the reliability and conclusions that can be drawn from the results of this study. This may also be an issue for practitioners in a training setting, but can be controlled for by determining a participant’s rhythm response and developing musical conditions which are easier to interpret if participants are unable to appropriately identify specific tempos.

The majority of data collection was based on subjective rating scales rather than objective or observable data (Gopher 1984). Nevertheless, the rating scales were standardised and used in several other studies including those by Karageorghis (2017) and Jones (2017) and were also quantifiable. It is possible that the addition of a more qualitative approach such as a thematic analysis of written comments would yield more insight into cognitive processes.

The selection of appropriate outcome measures was determined mainly by reference to their use in other studies. As there were pre-existing issues with the reliability of the PANAS scales (Watson, 1988), specific PANAS words were chosen by the researcher to determine an emotional response. However, the balance of positive and negative affect words chosen for this study was heavily imbalanced (7 positive, 2 negative) making it more difficult to measure negative participant affect. It may have been more appropriate to use the whole scale or another validated scale such as the Music in Mood Regulation Scale (Saarikallio, 2008).

Physiological outcome measures were limited to circuit completion time, restricting the analysis of possible relationships between psychological and other physiological measures or their respective contributions to performance outcomes. Manipulating both psychological and physiological measures would require a more extensive interdisciplinary study. This study has nonetheless demonstrated that the consideration of psychological factors deserves more attention in research studies involving the application of music to sports performance outcomes. A more sophisticated understanding of the effects of psychological factors could and should be included in the development of future theoretical frameworks.

Due to the naturalistic setting of this study, the testing environments could not be fully controlled for extraneous variables. Although music was played at the same volume for both groups, the size of the sports halls varied resulting in different acoustics, sound penetration and variation in echo. For both groups, the musical conditions were presented as ambient music in large sports halls whilst other sports were also taking place. Equal hearing sensitivity in all participants and an ability to screen out other stimuli was also assumed. The presence of others in the same hall and uncontrolled changes in participant's naturalistic behaviour when being observed were additional variables. Although attention was paid to reducing non-natural behaviours by using a researcher who was also a judoka and therefore not an unexpected or intrusive presence, other issues such as presenting a favourable image to the researcher as well as the presence of the video camera may have impacted on performance outcomes. Both clubs were competitors for the other and were aware of the involvement of each other in the study so that interpersonal variables such as competitiveness may have been introduced between clubs as well as between participants. As noted, music itself is complex and so it also was not possible to control for the variables within the music itself such as lyrics, volume and variable rhythms.

It is acknowledged that a number of variations in the study design would have given greater validity to the results. In presenting the musical conditions it would have been an advantage to use a counterbalanced design to vary the order of presentation of different musical conditions to each of the two groups so minimising any residual impacts of learning effects from one musical condition to another. This was not included in the study design and this omission limits the conclusions that can be drawn from this study.

In addition, since both Judo clubs had at least three other training sessions per week, it would also have been possible to randomize the sessions in which music was played to lower the expectation of the presence of music in any one session. There could also have been variation introduced into the order in which each exercise in the circuit was presented. The repetition of the same circuit weekly may have allowed participants to develop techniques and tactics that would speed up circuit completion times. This therefore may mean that faster circuit completion times were partly a result of each participant's conscious learning processes alongside the use of music. It should be noted though that circuit completion times

significantly increased post-test when the music was withdrawn completely suggesting that music rather than learning was having the main effect.

Some limitations were necessarily introduced to the study as result of the limited resources of a single researcher. This study focused on performance outcomes from a short training session of a maximum of ten minutes duration. Further resources would have enabled the use of music over longer time periods to consider the effects of factors such as habituation, boredom and/or fatigue which may start to have an impact in a typical judo circuit training session of thirty minutes. In addition, in this study just one week was allocated for familiarization with music so that novelty may have impacted on the start of the testing process. Participants may also have benefitted from additional training sessions prior to the start of the study to habituate to the presence of music.

Recruitment of study participants was challenging in that it was necessary to recruit from more than one location resulting in two testing groups in two separate locations. As different environments are likely to elicit specific behaviours (Karageorghis, 2012a), the two different environments may have resulted in different behaviours in each testing group. Although it was possible to balance participant groups by demographic, recruiting more judoka would have required expanding the number of testing sites which was beyond the resources of a single researcher. This did result in a small sample size and so limits the generalizability of the findings.

A number of additional assumptions were made which may limit the validity of this study. With regard to the participants, the focus of this study was on judoka experienced to a competitive level. The findings may not be applicable to less experienced players. Another assumption was that the music pre-selection group and study participants would have the same responses to musical tracks due to sharing similar demographics. It was also assumed that the pre-selection group and the study participants were familiar with the music presented to them. This may not have been the case especially for Hip-Hop music which is a less well-known genre compared to the other two (Crauwels, 2016).

10. Practical Applications

The duration of Judo fights is five minutes maximum split into high intensity blocks of approximately 30 seconds. Judo fights are typically interactive, fast-paced and based on a regular rhythm of movements.

The results of this study have direct implications for the training of judo athletes. The overall finding that music has beneficial effects on the training performance of judoka indicates that music may be an important training aid during practice sessions.

Judo fights are based on a regular rhythm of movements suggesting that judoka may be able to synchronize well with music with a regular downbeat which has been shown by this study to have a beneficial effect on performance outcomes as well as on motivation and emotional attachment to the music. The rhythmic qualities of Pop music may therefore be beneficial when increasing work rate to a higher level.

Competitive judo is also fought at a high intensity suggesting that the use of a higher tempo would be beneficial in training to allow synchronization of movement and to support the ability to narrow the attentional field when required in a high intensity fight. The findings suggest that psychological variables such as attentional focus and motivation would also be positively impacted by higher tempos. Increased emotional responsiveness to music at a higher tempo and this may be used to facilitate a positive association within memory to enhance future performance.

Self-selecting a preferred genre could be used sporadically in training settings to enhance association to music and dissociation from a high intensity condition. In competition settings which typically involve high intensity bouts of 30 seconds duration within a five-minute time period, training in associating with the activity but dissociating from the exercise intensity would be beneficial. Due to the interactive nature of the sport however, dissociation would be a negative consequence and therefore music played at low tempo in a preferred genre in a training session may enhance the ability to associate with positive emotional responses and remain engaged with the environment.

11. Future Research

It is clear from this study that both tempo and genre have an effect on performance outcomes and deserve more attention. Researchers could also examine the relationship between psychological variables and physiological responses to understand the process of using a cognitive stimulus may facilitate a sports performance outcome.

In terms of the theoretical framework developed by Terry & Karageorghis (2006), it could be argued that the psychological variables addressed in the current study be considered as Personal Factors within the Antecedents cluster. However, the lack of a feedback loop in the framework implies that Personal Factors are static and neglects the possibility that they may be dynamic, changing within a session as a result of feedback. Therefore, a feedback loop between Potential Benefits and Antecedents would allow a more comprehensive and expanded cognitive model to be included. The variables of motivation, emotional attachment to music, emotional affect and dissociation and distress would then fit appropriately within Personal Factors of the framework.

It may be appropriate to move away from the linear presentation of current theoretical frameworks and models to develop a more interactive cross-disciplinary model which includes a feedback loop. A preliminary cognitive behavioural model has been developed based on the assumption that “the way a music piece/song is interpreted, experienced and cognitively appraised will directly influence our thoughts, feelings, behaviours and physiological responses” (Muntaha, 2019). Intended for use in clinical practice, this illustrates the need for cross-disciplinary exchanges of models and frameworks in order to develop more sophisticated models and integrate the research findings from both.

12. Conclusions

The effects of music on performance outcomes of judo competitors is a contentious research area due to the lack of standardized definitions and tools by which to operationalize the term “music” and which may have led to discrepancies in research outcomes. Whilst this study has tried to overcome some of these issues by specifying terms and measures used, the establishment of standardized databases for the academic study of tempo and genre deserves high priority before progress can be made in integrating and interpreting the findings of studies in this field.

The findings of this study are supportive of the general finding in the research literature that music has beneficial effects on sports performance in general. This study has also presented evidence that cognitive and emotional processing is an essential part of responding to music and as such deserves consideration in future theoretical frameworks. Multi-disciplinary research and frameworks will be needed to ensure that both psychological and physiological factors are adequately considered and applicable to sports settings.

However, cognitive and psychological processing of music has not been investigated in depth in previous studies nor adequately included in theoretical frameworks of the use of music in sport. In particular, theoretical frameworks present the use of music as a linear and static event rather than a dynamic and constantly monitored cognitive process.

The findings from this study were specific to judoka who may have sport-specific cognitive and emotional responses. These findings may not therefore be generalized to other sports participants without further research to establish the sport-specific responses to music. In a similar vein, the participants in the current study shared similar demographics and caution should be maintained when considering how these findings may apply to more diverse populations.

13. References

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Ethics Form

E3/FH&LS

Oxford Brookes University
Faculty of Health and Life Sciences
Decision on application for ethics approval

The Departmental Research Ethics Officer (DREO) has considered the application for ethics approval for the following project:

Project Title: Is music an effective ergogenic aid to pyramid circuits in Judo training?

DREC Reference: 0118_36

Name of Applicant/s: Sam Richardson

Name of Supervisor/s: Adam Bibbey


Please tick one box

- 1. The Departmental Research Ethics Officer / Faculty Research Ethics Committee gives ethical approval for the research project.

Please note that the research protocol as laid down in the application and hereby approved must not be changed without the approval of the DREO / FREC

- 2. The Departmental Research Ethics Officer / Faculty Research Ethics Committee gives ethical approval for the research project, subject to the following::

- 3. The Departmental Research Officer / Faculty Research Ethics Committee cannot give ethical approval for the research project. The reasons for this and the action required are as follows:

Signed: ... 
Approval Date: ...06/01/2018.....

Designation: Departmental Research Ethics Officer

(Signed on behalf of the Faculty Research Ethics Committee)

Date when application reviewed (*office use only*):.....06/01/2018.....

H&LS/FRec/E3 August 2011

Is music an effective ergogenic aid to pyramid circuits in Judo training?

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

Purpose of the study?

The aim of this study is to assess within judo if different music genres and beat frequencies have an impact on exercise intensity, psychological variables and pace setting in practice settings. The study aims to run for approximately five months from January 2018 until May 2018.

Why have I been invited to participate?

You have been invited to participate in this study because you are a known Judo player at a sufficient technical and competitive standard with no injury and currently taking part in training sessions to have a positive impact on the future of Judo research. This research aims to understand the effects of music on judo training and the potential positive impact of genre and tempo.

Do I have to take part?

Because the research is voluntary, all individuals participating in the study have the right to remove themselves from the study without warning at any time, as well as to withdraw any unprocessed data. Taking part in this study will have no impact on your training, team selection, role selection or any other impact on processes within your training, club or competitive activities. This research will not impact any ongoing assessment/grades/ management or treatment of health as relevant to anyone who is or is not part of a dependant relationship. There may be other individuals who are consenting to their data to be collected during the same training sessions which you are taking part in (where music may or may not be played), but if you do not consent then no data will be recorded of/from you.

What will happen to me if I take part?

The study will take place within regular training sessions (1/week), so will not take any additional time commitments. However, participants will be asked to complete questionnaires as appropriate, at a coach-approved time during/after a session. As a one-off measure at the beginning of the study, you will be asked to complete a personality and emotional intensity questionnaire (~5-10 minutes).

Before your normal judo training session you will be asked to complete a pyramid circuit of Spiderman Pushups, Jump Squats and Up Downs, lasting around 10 minutes (11 times in total). There will be a baseline and follow-up with no music and in-between these sessions music of either Pop, Hip-Hop/Rap and Rock music will be played during the session, and a researcher will observe how music will impact your training frequency via a video recording and heart rate data captured via a watch and heart rate strap (one individual will be invited to wear a gas analysis mask during, with a finger prick blood sample taken at the end of the session). Immediately following the pyramid circuit you will complete a questionnaire reflecting on the psychological and emotional impact of the music. The number of attacks in the following training session will also be observed. At the end of the study, an open-ended questionnaire will be given to ask your overall reflection of the music sessions.

The session will be controlled by trained, insured instructors with all participants covered by British Judo Association (or equivalent) insurance; therefore, participants will not be at any increased risk.

What are the possible benefits and risks of taking part?

You will be involved in research which could improve your training effectiveness in the future and provide guidelines around music beat frequency and genre for the wider judo community. There are no known risks above day to day risk of training.

Will what I say in this study be kept confidential?

All data collected from the study will be stored with password protection on the Oxford Brookes University secure server and the personal computer of the non-principle investigator for data collection. The only three individuals with access to any data are the named investigators, with data remaining confidential to all other individuals at all times.

All data collected on paper will be transferred to electronic storage and destroyed. All data will either be destroyed or stored by the principle investigator (Dr John Jakeman and Dr Adam Bibbey) in paper or electronic form for a maximum of ten years after completion of the study in accordance with the University Policy for Academic Integrity.

What should I do if I want to take part?

If you wish to take part contact a named researcher (17015705@brookes.ac.uk, Tel: 07510 739707), or inform your coach. A researcher will then contact you to facilitate your inclusion in the study. You are also able to sign up on the google form upon request.

What will happen to the results of the research study?

The purpose of the study is for academic use as part of the completion of a postgraduate dissertation, with potential publication in journal articles and media outlets (all data will be confidential). Upon completion of the dissertation, the data will be shared with a participant upon request. However, all other data regarding individual participants will remain confidential.

Who is organising and funding the research?

This research is being undertaken for the purpose of postgraduate research at Oxford Brookes University, Faculty of Life Sciences, Department of Sport and Health Sciences. There is no external funding.

Who has reviewed the study?

The study has been reviewed and approved by the Faculty Research and Ethics Committee. If you have any concern about the study, you may contact the Chair of the Faculty Research Ethics Committee Anne Delextrat by email; adelextrat@brookes.ac.uk

Contact for further information

If you would like to take part in the study please contact Mr Sam Richardson, MSc (Research) student by emailing 17015705@brookes.ac.uk, calling/texting 07510 739707. A Google Form will be sent for completion to confirm enrolment.

If you have any questions, concerns, feedback or perspective on the study please contact Sam for further information. If, in the unlikely event of need, the Director of Studies is Dr. John Jakeman, Subject Co-ordinator for Sport and Exercise Science, jjakeman@brookes.ac.uk, 01865483815. The Principle Investigator is Dr Adam Bibbey, Lecturer in Sport Psychology, abibbey@brookes.ac.uk, 01865 483655.

CONSENT FORM

Full title of Project: Is music an effective ergogenic aid to pyramid circuits in Judo training?

Name, position and contact address of Researcher: Samuel Richardson (Masters by Research student). 17015705@brookes.ac.uk

Supervisor's name: Dr. Adam Bibbey (abibbey@brookes.ac.uk) & Dr. John Jakeman (jjakeman@brookes.ac.uk)

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.
3. I agree to take part in the above study.

Please initial box

5. I agree to the training session being video recorded
6. I agree that my data gathered in this study may be stored (after it has been anonymised) in a specialist data centre and may be used for future research.

Yes No

_____	____ / ____ / 2018	_____
Name of Participant	Date	Signature
 Sam Richardson	 ____ / ____ / 2018	 _____
Name of Researcher	Date	Signature

Participant Details

Participant Details



Name:

Email Address:

Contact Number:

Club:

Licence Number:

Preferred song/band/musical genre:

Any current injuries:

Attentional Focusing Questionnaire

Please put an X in the space that indicates how much you engaged in each of the following activities during circuit training.

		I did not do this at all						I did this all the time
		1	2	3	4	5	6	7
1	Letting your mind wander (daydreaming)							
2	Monitoring specific body conditions (e.g., leg tension, breathing rate)							
3	Trying to solve problems in your life							
4	Paying attention to your general level of fatigue							
5	Focusing on how much you are suffering							
6	Singing a song in your head							
7	Focusing on staying loose and relaxed							
8	Wishing the circuit would end							
9	Thinking about work, school, social relationships etc.							
10	Focusing on your performance goal							
11	Wondering why you are even completing circuits in the first place							
12	Making plans for your future							
13	Getting frustrated at yourself over your performance							
14	Writing a letter or a paper in your head							
15	Paying attention to your technique							
16	Reflecting on past experiences							
17	Paying attention to your circuit rhythm							
18	Thinking about how much you want to quit							
19	Focusing on surrounding environment							

20	Thinking about strategy								
21	Counting (eg objects in your environment)								
22	Monitoring how hard you are working								
23	Thinking about how much the rest of the circuit will hurt								
24	Meditating (focusing on the mantra)								
25	Encouraging yourself to complete the circuit fast								
26	Trying to ignore all physical sensations								
27	Concentrating on the circuit								
28	Wondering whether you will be able to complete the circuit								
29	Thinking about pleasant images								
30	Monitoring the time of the circuit								

Borg Scale

Post Circuit Training Qs

Please rate your perception of exertion. This feeling should reflect how heavy and strenuous the exercise felt to you, combining all sensations and feelings of physical stress, effort, and fatigue. Do not concern yourself with any one factor such as leg pain or shortness of breath, but try to focus on your total feeling of exertion.

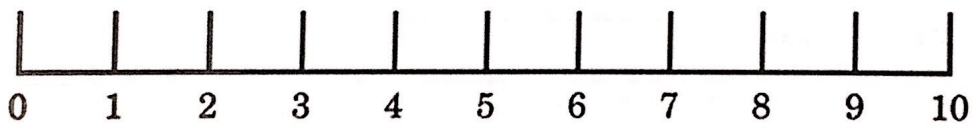
Circle the number from below that best describes your level of exertion. Try to appraise your feeling of exertion as honestly as possible, without thinking about what the actual physical load is. Your own feeling of effort and exertion is important, not how it compares to other people's. Look at the scales and the expressions and then give a number.

#	Level of Exertion
6	No exertion
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

Emotional Attachment Questionnaire

Emotional Attachment to Music

The purpose of the Emotional Attachment to Music Scale is to assess the extent to which the piece of music you heard elicited an emotional response during circuit training. As you heard music during your circuit, indicate the extent of your emotional response by circling one of the numbers on the scale below. Provide an honest response to each statement. Give the response that best describes your opinion, and avoid dwelling for too long.



No
Attachment
to Music

Complete
Attachment
to Music

Motivational Scale Instruction

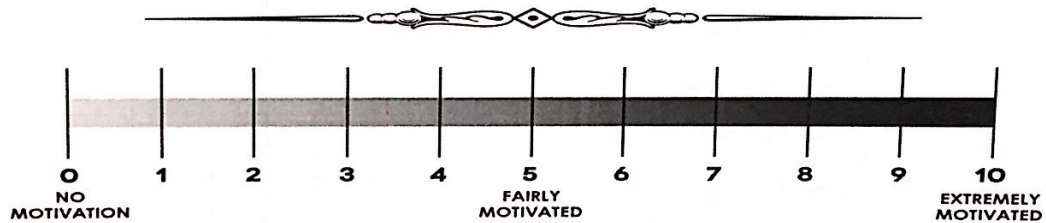
Motivational Scale Instructions

Motivation refers to how much you want to keep going (persistence) and the extent to which you want to push yourself to work harder (effort)

Use this scale from 0 to 10, in which 0 means not motivated at all (i.e., you are not at all motivated to keep going or to work hard) and 10 means Extremely motivated (i.e., you are extremely motivated to keep going or to work hard) please rate how you felt during the session when the music was being played.

Try to appraise your feelings of motivation as honestly as possible. Don't underestimate them, but don't overestimate them either. It is your own feelings of motivation that are important, not how they compare to other people's. What other people think is not important either. Look at the scale and the expressions, and then choose a number.

0-10 NUMERICAL RATING SCALE



Pre-Circuit Training

PANAS

Below is a list of words that describe feelings people have. Please read each one carefully, then tick the one that best describes **how you currently feel at this present time**

	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
1. Interested	1	2	3	4	5
2. Excited	1	2	3	4	5
3. Strong	1	2	3	4	5
4. Hostile	1	2	3	4	5
5. Enthusiastic	1	2	3	4	5
6. Irritable	1	2	3	4	5
7. Alert	1	2	3	4	5
8. Inspired	1	2	3	4	5
9. Determined	1	2	3	4	5