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Redesign and initial validation of an instrument to assess the motivational qualities of music in exercise: The Brunel Music Rating Inventory-2

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Abstract

In the present study a measure to assess the motivational qualities of music in exercise was redesigned, extending previous research efforts (Karageorghis *et al.*, 1999). The original measure, the Brunel Music Rating Inventory (BMRI), had shown limitations in its factor structure and its applicability to non-experts in music selection. Redesign of the BMRI used in-depth interviews with eight participants (mean age 31.9, s = 8.9 years) to establish the initial item pool, which was examined using a series of confirmatory factor analyses. A single-factor model provided a good fit across three musical selections with different motivational qualities (CFI: 0.95 – 0.98; SRMR: 0.03 – 0.05). The single-factor model also demonstrated acceptable fit across two independent samples and both sexes using one piece of music (CFI: 0.86 – 1.00; SRMR: 0.04 – 0.07). The BMRI was designed for experts in selecting music for exercise (e.g. dance aerobic instructors), whereas the BMRI-2 can be used both by exercise instructors and participants. The psychometric properties of the BMRI-2 are stronger than those of the BMRI and it is easier to use. The BMRI-2 provides a valid and internally consistent tool by which music can be selected to accompany a bout of exercise or a training session. Furthermore, the BMRI-2 enables researchers to standardise music in experimental protocols involving exercise-related tasks.

Introduction

The scope of research into the psychology of music has broadened in the past decade to include research into the effects of music in a wide variety of social contexts (for a review, see Hargreaves and North, 1999). In the context of physical training, it has been suggested that music may significantly affect the exercise experience and influence patterns of exercise adoption and adherence (Karageorghis *et al*., 1999; Schwartz *et al*., 1990). Research into the psychophysical effects of music in physical activity settings has been characterised by methodological limitations and uncertain theoretical bases (Karageorghis and Terry, 1997). As a possible consequence of this issue, research findings have been largely equivocal.

One of the main methodological limitations reported by Karageorghis and Terry (1997) was the haphazard selection of music for experimental conditions, with little regard for the socio-cultural upbringing of participants or the nature of the experimental task. To address this limitation, Karageorghis *et al*. (1999) developed and validated a psychometric measure to assess the motivational qualities of music in exercise and sport settings; the Brunel Music Rating Inventory (BMRI; see Appendix A). This inventory provided exercise leaders, sports coaches and researchers with a standardised method by which to select music that is intended to have a motivational effect. In the context of their study, Karageorghis *et al*. defined motivational music as that which stimulates or inspires physical activity. Moreover, they postulated that listening to motivational music would engender measurable psychophysical consequences such as improved mood, reduced perceptions of exertion and changes in arousal.

A four-factor structure for the BMRI derived from exploratory and confirmatory factor analyses was depicted in a conceptual model (see Karageorghis *et al*., 1999), which predicts the effects of *asynchronous* or background motivational music in the context of exercise and sport.

When exercise participants consciously synchronize their movements with the beat of the music, the music is said to be *synchronous*. Conversely, the background music played in most gymnasia would typify the use of *asynchronous* music (i.e. no conscious synchronization occurs between movement and music tempo).

Factors that determine the motivational qualities of a piece of music are proposed to be rhythm response, musicality, cultural impact and association (Karageorghis *et al*., 1999). Rhythm response refers to the rhythmical elements of music, whereas musicality refers to the response to pitch-related elements of music such as harmony (how the notes are combined) and melody (the tune). Cultural impact refers to the pervasiveness of the music in the context of the cultural experiences of the individual, while association refers to extra-musical thoughts, feelings and images that the music may evoke. The four factors in Karageorghis *et al.'s* (1999) conceptual model (which also comprised the four factors of the BMRI) showed a hierarchical structure; that is, rhythm response was the most important contributor to motivational qualities of a piece of music whereas association was the least important.

The implications of the conceptual model are that the motivational impact of music might influence exercise enjoyment and adherence and, by extension, public health. Against a backdrop of the high importance that exercise participants attach to ambient music (Priest *et al.*, 2004), there is increasing evidence to suggest that the *right music* (however this might be defined) can lead to greater frequency, intensity and duration of exercise behaviour (Atkinson *et al.*, 2004; Copeland and Franks, 1991; Hall and Erickson, 1995; Karageorghis *et al.*, 1996; Schwartz *et al*., 1990; Szabo *et al.*, 1999; Tenenbaum *et al*., 2004). The impact of music on these components is likely to confer significant health benefits. Thus, appropriate music selection may result in the reduction of one of the main “consumer resistances” associated with exercise in public gymnasia (Priest *et al*., 2004).

At present, it appears that in exercise environments, practitioners select music somewhat arbitrarily without due consideration of its motivational qualities (see Priest *et al*., 2004). Consequently, there is a need for a standardised means of selecting music according to its motivational properties that will enable practitioners to fully harness the purported benefits of motivational music such as increased exercise intensity and duration. The primary rationale for the present study therefore was to provide a means by which to facilitate the selection of motivational music in exercise settings.

A serious limitation of music research in sport and exercise contexts has been the haphazard selection of music conditions (Karageorghis and Terry, 1997). The equivocal findings associated with such research may stem from the non-standardised selection of music conditions. Therefore, a secondary rationale underlying the present study was to provide researchers with a means by which to select motivational music according to established standards. Greater consistency in the selection of music for experimental conditions may considerably strengthen the coherence of research into the effects of motivational music in exercise settings. In summary, the redesign of the BMRI will guide both researchers and practitioners in the effective application of music in exercise contexts.

In the development of the original BMRI, a number of limitations were apparent despite acceptable fit of the four-factor model (rhythm response [four items], musicality [two items], cultural impact [four items] and association [three items]) to the data (according to the criteria proposed by Bentler and Wu, 1995). Some of these limitations were reported in the original publication, whereas Karageorghis and his associates noted others following the application of the BMRI in exercise, sport and research contexts. First, Karageorghis *et al*. (1999) reported a degree of instability in the rhythm response factor across the two samples used in their multisample CFA (aerobic dance exercise instructors vs. exercise participants). Second, the items in the cultural impact factor yielded low internal consistency (α = .57). Third, the variance of the melody item was entirely accounted for by the musicality factor in which it sat (measurement error = 0.00). Fourth, the familiarity item demonstrated a relatively weak relationship with the cultural impact factor that it was intended to reflect (factor loading = .35; measurement error = .94) but was retained because it was theoretically meaningful. Fifth, similar limitations were observed from the responses of exercise participants for items assessing the stimulative qualities and danceability as part of the rhythm response factor among exercise participants. Although Karageorghis *et al*. offered theoretically grounded justifications in retaining weak items, reservations about the psychometric integrity of the BMRI remain. The authors concluded that further development and validation should be an imperative.

A further concern we have regarding the validation process of the BMRI was that a panel of aerobics instructors assessed content validity but not exercise participants. Thus, the BMRI was developed explicitly for use by experts in musical selection rather than by exercise participants. The exercise leaders who responded to the inventory *inferred* that the music being rated would motivate exercise participants. Such inferences are unlikely to be as valid as the responses of a representative sample of exercise participants. Gluch (1993) asserted the importance of an individual’s interpretation of music in determining psychophysical responses. Despite the acknowledged limitations of the instrument, the BMRI did provide researchers and practitioners with a valuable resource that enabled motivational music to be selected in a time-efficient and standardised manner.

The rationale underlying the present study was to provide a means by which to facilitate the effective selection of motivational music in exercise settings. Furthermore, the revised BMRI will permit the selection of motivational music conditions in exercise-related research. It has been suggested that the biggest limitation pertaining to such research is the haphazard selection of experimental music conditions (Karageorghis and Terry, 1997). Therefore, the purpose of the present study was to redesign the BMRI to account for the acknowledged limitations of the instrument. The authors intended to use the BMRI and accompanying conceptual framework as a starting point but *not* a blueprint in the redesign and initial validation process.

Method and Results

Ethical approval was obtained from the institutional ethics committee of the first author for all procedures employed in the present study and all participants were required to provide written informed consent.

Stage 1: Qualitative appraisal of the BMRI

To comprehensively redesign the instrument and establish an item pool, it was deemed necessary to appraise the content of the BMRI from the perspectives of exercise participants. A sample of eight exercise participants with at least 2 years' experience of exercising to music was purposively selected (see Mason, 2002) from health clubs in London, UK. The sample ranged in age from 20 to 46 years (mean age 31.9, s = 8.9 years) and comprised four males and four females. Participants were recruited by a member of the research team from among a sample used in prior qualitative research undertaken by the first and second authors. The researchers had the opportunity to cultivate trusting relationships with the participants (see Patton, 1990). They were interviewed regarding the BMRI response process to highlight any issues relating to the comprehension and interpretation of the items, instructions and response set.

A researcher interviewed participants, either at their place of study (*n* = 1), their health club (*n* = 3), or their home (*n* = 4). Interviews lasted 45-60 minutes and were recorded for transcription. The researcher initiated each interview by presenting the BMRI to the participants, who were given an opportunity to peruse its items and instructions. During the course of each interview, three musical pieces chosen by the participant were delivered using a portable compact disc player. Participants were asked to select music that they considered appropriate as an accompaniment for the type of exercise performed in a gymnasium context (i.e. submaximal exercise utilizing cardio-vascular and resistance machines). This music was typically fast (> 120 beats$\cdot$min^{-1} [beats per minute]), with a pronounced rhythmical component; described by participants as either “dance” or “pop” music.

After listening to each piece of music, participants rated its motivational qualities using the original BMRI. The target construct (motivational qualities of music) was presented with reference to the definition of Karageorghis *et al*. (1999). With the application of a simple schedule to provide structure (see Ĉoté *et al*., 1995), participants were then questioned about their responses. The schedule consisted of four themes: the relevance of each item to the motivational qualities of music; the degree to which the participant felt that he or she was able to comprehend the meaning of each item; the extent to which the participant’s interpretation of each item corresponded with its intended meaning; and fourth, the elicitation of additional items that might contribute to the new item pool.

Participants were invited to describe their thoughts and responses during the rating procedure to help elucidate their interpretation of the wording of each item. Such a procedure resembles protocol analysis (Ericsson and Simon, 1980), a technique used to infer thought processes based on concurrent verbal reports (see Green, 1995). Protocol analysis has been used to qualify test-based quantitative data and highlight inconsistencies and erroneous reasoning on the part of respondents (for example, see Barber and Wesson, 1998). Verbatim transcripts of the interviews were made. Data pertaining to each of the 13 items of the BMRI (see Appendix 1) were content analysed (see Marshall and Rossman, 1999) in accordance with the four themes of the interview schedule. For example, responses pertaining to the comprehensibility of items were grouped under a single theme.

The first theme of the content analysis concerned the relevance of items to the motivational qualities of music. Participants expressed concerns about several items. In particular, Items 6 (“chart success”) and 13 (“date of release”) were felt to be irrelevant. Moreover, the scope of Items 4 (“lyrics related to physical activity”), 5 (“association of music with sport”) and 7 (“association of music with a film or video”), which related to association, was perceived to be very narrow. Results of the protocol analysis indicated that only a tiny percentage of the pieces of music used in exercise contexts would carry associations that related specifically to sport or physical activity. Participants indicated that the essential nature of music is extra-verbal (cf. Demorest, 1995): the non-verbal devices employed through the meshing of sounds that engender thoughts, feelings and reactions. Consequently, the research team decided that a wider frame of reference should be used.

With regard to Item 5 (“association of music with sport”), one participant suggested that many who participate in recreational exercise feel intimidated by the notion of competitive sport. In addition to the aforementioned concerns regarding the items that leant on musical terminology, the participants encountered difficulties in responding to other items. Some participants found that the chart success (Item 6) of the music they selected was difficult to recall. Furthermore, several participants stated that they were unaware of the identity of the artist(s) (item 8) who performed the majority of the musical pieces that they heard during exercise. The response to item 8 was determined by the style of music that the artist in question was thought to represent. Two participants asserted that attitudes towards dancing might bias the response to item 12 (“danceability”). Item 13 (“date of release”) proved the most difficult for the participants to interpret. It was unclear whether the item implied that current music is motivational and older music is not.

The second theme of the content analysis was the degree to which participants were able to comprehend the meaning of each item. They reported satisfactory comprehension of items except those related to musical terms. Results of the protocol analysis revealed that participants had trouble differentiating between tempo and rhythm without further qualification from the interviewer. Moreover, the only participant who was able to distinguish between harmony and melody was a music student. With the exception of this individual, none of the participants claimed to understand the term harmony.

The third theme of the content analysis concerned the extent to which the participant’s interpretation of each item corresponded with its intended meaning. Results of the protocol analysis revealed certain erroneous response trends that were actually not specific to individual items. First, participants typically failed to rate the music for a pre-specified group (e.g. British pop music listeners in the age range 20-25 years) as instructed (see Appendix A). Rather, participants rated the motivational qualities of music from their own perspectives. Second, responses were impaired by the apparent complexity of the rating process. For example, in order to respond to item 9 (“harmony”), participants were required to assess the type of harmony evident in the segment of music to which they had listened, decide to what extent that harmony contributed to the motivational qualities of the piece and infer that this contribution would still be applicable from the perspective of a third party. Lastly, the respondents demonstrated a tendency to ignore the piece of music that they were listening to and report generic responses that related their estimations of the contribution of certain items (e.g. “rhythm”) to the motivational qualities of music.

The fourth theme of the content analysis concerned the elicitation of additional items. Participants elicited relevant content for a number of items that related to the motivational qualities of music. Examples of item content mentioned by a number of participants included the impact of the style of the music, the vocal performance, the sound of instruments and the beat. The latter was a term commonly used to describe the rhythmic quality of a piece of music; however, its use deviated considerably from its musicological meaning. Musicians use the term *beat* synonymously with tempo, whereas laypersons use it with reference to the general rhythmic *feel* of a piece of music.

Stage 2: Development of a new item pool

Following detailed consideration of the qualitative data presented above by the first and second authors, during which problematic items were removed or amended and additional facets of the motivational qualities of music were incorporated, a new item pool comprising of 24 items was developed by the same authors and attached to a 7-point Likert-type scale. The scale was anchored by 1 (*strongly disagree*) and 7 (*strongly agree*). The development of the item pool was based upon recommendations in the psychometric test literature (e.g. Anastasi and Urbina, 1997; Mulaik and Millsap, 2000). Several pertinent issues were identified that bore consideration when forming the initial pool of items. First, efforts were made to ensure that the items were worded in a uniform fashion. Specifically, it has been suggested that an item should refer to an action, a time, a context and a target (Azjen and Fishbein, 1977). Also, each item should refer to these four parameters at the same level of generality. Items were reworded so that they conformed to the following specification. The action would concern motivation; the time reference would be *during* exercise; the context would be exercise and the target would be a property of the musical stimulus such as rhythm or tempo. Thus, the generic form of each item-statement would be: “A property [e.g. melody] of this music would motivate me during exercise.”

The second issue for consideration was the operationalization of the term motivation, which was judged to be insufficiently precise. Specifically, the instruction to participants using the original BMRI implied that music motivates individuals to *initiate* exercise. Although research evidence supports the conclusion that musical accompaniment precipitates increased exercise intensity or endurance (e.g. Atkinson *et al*., 2004; Szabo *et al*., 1999), there is no evidence to support the contention that music affects the initiation and persistence components of motivation. Thus, the instructions of the BMRI-2 specified that participants should rate the extent to which music motivated them to exercise harder and/or longer (see Appendix 2). This amendment was deemed sufficient given that no theoretical work or research findings exist to suggest that music exerts differential effects on exercise intensity and duration. Examples of items included: “the vocal style of this piece of music would motivate me during exercise”, “the familiarity of this piece of music to me would motivate me during exercise” and “the images created by this piece of music would motivate me during exercise”.

Stage 3: Content and face validity of the item pool

The degree to which items represent the construct that they are purported to measure is referred to as content validity, whereas face validity refers to the extent to which the items appear to be valid (American Psychological Association, 1999). In order to assess content and face validity, the first version of the redesigned BMRI (henceforth referred to as the BMRI-2) comprising 24 items was distributed to a sample of 78 fitness instructors (not exercise-to-music instructors) who were employed in 31 health clubs across the UK (mean age 24.9, s = 5.9 years). Participants evaluated the relevance of each item in relation to the assessment of the motivational qualities of music in exercise. Responses were given on a 7-point Likert-type scale anchored by 1 (*not at all important*) and 7 (*very important*). Participants were asked to rewrite any items they did not understand and provide any feedback they deemed relevant.

In terms of additional items, two participants suggested an item relating to the volume of the music. However, the music volume is a contextual variable – that is, it would vary between a music-rating session and the actual gymnasium environment owing to a variety of factors, including differences in music delivery equipment, ambient noise and the acoustic properties of the interior spaces concerned. All other suggested items diverged from the format established for the item stems or extended beyond the scope of the instrument (e.g. “What sort of music would you listen to at home?”). Six items yielded a mean response above four on the 7-point scale, which represented an endorsement of their inclusion and these were retained for the final version of the BMRI-2 that was subsequently tested using confirmatory factor analyses (CFA).

Stage 4: Music selection for test of factorial validity

To validate the six-item BMRI-2, music was required that could be used during subsequent rating sessions. For the purpose of providing a comprehensive test of the factorial validity of the BMRI-2, it was deemed necessary to select three pieces that varied according to their motivational impact (highly motivational, moderately motivational and oudeterous [neutral]). This procedure enabled the researchers to test the tenability of the factor structure across three different pieces of music. Prior to the copying and delivery of the music selections, permission was gained from the record companies concerned. A compilation of fast (> 120 bpm) musical selections (k = 24) from the dance and rock idioms was edited onto a compact disc. A motivational quotient for each musical piece was determined using the original BMRI. Psychomusicology researchers working in the field of exercise and sport (n = 6; mean age 23.8, s = 6.2 years) attended a music listening and rating session administered by the researchers. Researchers were chosen to rate the music as they were deemed to be more likely to comprehend the inventory than exercise participants.

Prior to the rating, participants were introduced to the original BMRI and afforded an opportunity to question the researcher and clarify its meaning and the procedure of responding. Although the ratings were not being used to form experimental conditions, the instructions of the BMRI required participants to envisage a group for whom they were selecting music. Thus, participants were asked to select music for a group of students in their late teens and early twenties, mixed in terms of gender and mostly White UK or Irish in terms of their ethnic background. Such characteristics closely approximated those of the samples subsequently used to validate the BMRI-2. At this juncture, the researcher asked the participants whether there were any ambiguities for which they would require further elaboration. All participants indicated that the instructions were clear.

A 90 sec excerpt of each track was selected that included at least one chorus and one verse (Gluch, 1993). The music was delivered using a portable compact disc player situated on a table equidistant from the seven raters, who were seated in a semi-circular formation. Following each track, participants were given a 30 sec period to rate the piece of music using the BMRI. The next track was delivered once all participants had completed their ratings and were ready to attend to the following piece of music.

The motivational quotients assigned to each piece using the BMRI ranged from 11.99 to 26.18. The possible range of scores for the BMRI reported by Karageorghis *et al*. (1999) was 3.33 – 33.33. Scores below the middle range (18.33) are considered to represent *oudeterous* (neutral) rather than demotivational music. Three pieces were selected to reflect the desired motivational qualities. The first piece, *Out of Space* by *The Prodigy*, was rated as oudeterous (Motivational Quotient = 16.95). The second piece, *Back In My Life* by *Alice Deejay*, was rated as moderately motivational (Motivational Quotient = 22.15). The third piece, *Set You Free* by *N-Trance*, was considered to be highly motivational (Motivational Quotient = 26.18). Hereafter, these three tracks will be referred to by number (1, 2 and 3) in the order presented above. There were significant differences between each of the three pieces in terms of their motivational quotients ($F_{2,248} = 72.50$, $P < 0.001$, $\eta^2 = .37$; Track 1 < 2 < 3).

Stage 5: Factor validity of the BMRI-2

The six-item BMRI-2 was administered to 151 sport and exercise science undergraduates (mean age 19.4, $s = 2.8$ years), which henceforth will be referred to as Sample 1. The sample comprised of 48 females and 74 males although 29 participants did not disclose their gender. Sport and exercise science undergraduates were chosen owing to their broad experience of physical activity with musical accompaniment. Asynchronous music was present in all of the student training facilities on the test site.

Subsequent to the first administration of the BMRI-2, data were collected from a second sample (Sample 2) that consisted of a different group of 99 sport and exercise science undergraduates (mean age 19.9, $s = 1.4$ years) that comprised of 30 females, 58 males and 11 participants who did not report their gender. The purpose of the second sample was to provide data for a multisample CFA in which sample and gender invariance was tested. Hereafter, the samples will be referred to as Samples 1 and 2, respectively. The same data collection procedure was adhered to for both samples.

Prior to a lecture, participants were given three copies of the BMRI-2 and directed to read the instructions and address any queries regarding the instrument to the first author. Participants were then instructed to listen to the three pieces of music that had been selected for the validation (see Stage 4). Each selection was delivered for 90 sec using a portable compact disc player and at least one verse and chorus of each selection was heard (Gluch, 1993). Following the delivery of each piece, participants were given adequate time to complete their responses.

Participants were requested to complete the "concentration grid" (Harris and Harris, 1984) for 1 min before the rating each track. The purpose of using the concentration grid was to distract participants from cognitions induced by the music that they had just heard, and to induce cognitive fatigue so that responses to one track would not impact upon responses to the following track; a procedure known as a *filler* (Bargh and Chartrand, 2000).

A single univariate outlier was identified and deleted from Sample 1 ($z > \pm 3.29$; Tabachnick and Fidell, 2001). A single multivariate outlier was identified and deleted using the Mahalanobis distance method ($P < 0.001$). There were no outliers identified in Sample 2. Thereafter, the distributional properties of each item were examined separately for each sample. None of the items exhibited a leptokurtic (Standard Kurtosis [Std. Kurt.] > 1.96), platykurtic

(Std. Kurt. < -1.96), positively skewed (Standard Skewness [Std. Skew.] < -1.96), or negatively skewed (Std. Skew. > 1.96) distribution for any of the three tracks. A check was made on the mean scores for the three tracks rated using the BMRI-2 to ensure that the instrument discriminated between pieces of music with different motivational qualities. A repeated-measures ANOVA with Greenhouse-Geisser adjustment revealed significant differences between the three tracks ($F_{1.56,230.59} = 58.48$, $P < 0.001$, $\eta^2 = .28$; Track 1 < 2 < 3), indicating that 28% of the overall variance was attributable to the music manipulation. This mirrored the results obtained in Stage 4 using the original BMRI with expert raters.

Because only two of the items ("the melody [tune] of this music would motivate me during exercise" and "the sound of the instruments used (i.e. guitar, synthesizer, saxophone, etc.) would motivate me during exercise"; see Appendix 2) related specifically to musicality as opposed to rhythm response, there was no conceptual justification to test multiple-factor models as the items were directly related to the music factors component of Karageorghis and colleagues' (1999) conceptual model. The recommendation of psychometricians is that, preferably, a factor should consist of at least six items (see Loewenthal, 2001). Consequently, the fit of a single-factor model was tested on the data pertaining to each musical track from Sample 1 using CFA (EQS v. 5.7).

According to Hu and Bentler (1999), the cutoff value required before one can assert a relatively good fit between the hypothesised and observed models should be close to 0.95 for the robust comparative fit index (CFI), and close to 0.08 for the standardised root mean residual (SRMR). These indices were used to evaluate the adequacy of model fit. In order to assess the extent to which the derived factor structure was invariant across different samples, a multisample CFA was computed with data from both samples using the maximum likelihood estimation method. The invariance of the factor structure across gender was tested by dividing the two samples to yield four separate groups (sample x gender). Although this procedure created relatively small sub-samples for CFA with fewer than 10 participants per parameter to be estimated, the factor loadings were consistently high and the items were all normally distributed (see Tabachnick and Fidell, 2001).

A multisample CFA with factor loadings constrained to be equal across all four groups, was undertaken. In the interests of simplicity and brevity, only the data pertaining to Track 1 were used. This delimitation was deemed acceptable because the single-factor solution that was tested on the first sample met the specified goodness-of-fit criterion (CFI > 0.95) in the case of each of the three tracks. No Monte Carlo simulations have been performed using multisample CFA (see Marcoulides and Hershberger, 1997) and consequently, the CFI criterion of 0.90 is applicable in this instance (see Bentler and Wu, 1995).

The single-factor model produced an acceptable fit to the data (CFI > 0.95) in the case of each of the three tracks and for both genders (see Table 1) with the exception of females in Sample 1, who yielded a CFI slightly below the criterion value (CFI = 0.86). Multisample CFA indicated a CFI of 0.96 for the sample-by-gender analysis, which is well in excess of the accepted cutoff value of 0.90. The SRMR was close to the accepted criterion (SRMR = 0.11), although this index is particularly sensitive to simple model misspecification (Hu and Bentler, 1999). The marginally low CFI of 0.86 in respect of the females in Sample 1 is attributable to the limited sample size ($n = 48$); such fit indices are highly sensitive to sample size (Tabachnick and Fidell, 2001). However, the SRMR was inside the 0.08 cut-off, which indicated an adequate fit between the observed and hypothesised (single-factor) models. The internal consistency estimates for the single factor of the BMRI-2 across the four multisample groups using

Cronbach's (1951) alpha coefficient were as follows: Sample 1 (male) = 0.86, Sample 1 (female) = 0.92, Sample 2 (male) = 0.88, and Sample 2 (female) = 0.90. These figures exceed the criterion value of 0.70 specified by Nunnally (1978).

****Table 1 near here****

The standardised solutions for each item were examined in order to assess the amount of unique variance accounted for by the single factor (see Table II). Only in the case of the males in Sample 2 was the measurement error for Item 3 ("the melody [tune] of this music would motivate me during exercise") marginally high (0.91). However, the factor loadings for item 3 in all of the samples were in excess of the 0.40 criterion (Ford *et al.*, 1986). In summary, each item demonstrated a sufficiently strong relationship with the single factor of the BMRI-2.

****Table 2 near here****

Discussion and Conclusions

The present study offers some initial support for the factorial validity of an instrument with which to rate the motivational qualities of music in exercise settings. The single-factor model attained an adequate level of fit with the data in the case of all three tracks. Furthermore, the factor structure generalised well across two independent samples and both sexes. The standardised solutions indicated that each item bears a distinct relationship to the single factor. The prevailing single-factor model demonstrated higher psychometric integrity than the factor structure of the original BMRI. Indeed, the residual concerns relating to the structure and items of the BMRI have been almost entirely resolved.

The limitations of psychometric instruments in the field of motivational music research have also been exemplified. For example, despite the acceptable fit indices that the original BMRI demonstrated, participants experienced notable difficulties in comprehending the items.

Specifically, the personal response to motivating music proved an inappropriate subject for objective measurement. The interview data revealed that the subjective bias evident in the scoring of such items rendered them unsuitable for inclusion in the BMRI-2. Hence, the single factor of the BMRI-2 consists of items that relate to the musical stimulus itself and not one's personal interpretation of the music. This outcome is concurrent with the revised conceptual model (Karageorghis *et al*., 1999), to the extent that music factors were regarded as more salient than personal factors.

Notably, the BMRI-2 is less than half the length of its predecessor (6 items as opposed to 13). This characteristic renders the newer instrument particularly suitable for rating a large number of musical selections, a purpose for which it was specifically designed. The relative importance of the rhythmic qualities of music over melodic qualities (see Karageorghis *et al*., 1999) has been underlined; the rhythm, tempo and beat items demonstrated a stronger relationship with the single factor of the BMRI-2 than the melody item (see Table II). Atkinson *et al*. (2004) asked those who participated in a simulated cycle time-trial to rate the motivational qualities of the music that had accompanied the trial. The rhythmical components of the music were reported to have made a greater contribution to its motivational qualities than the melodic or harmonic components.

There are two principal reasons that explain the absence of the distinction between rhythm response and musicality that was reported by Karageorghis *et al*. (1999). First, the BMRI was developed for expert respondents (qualified exercise-to-music instructors), whereas the BMRI-2 was developed for the use of non-expert respondents who may not have been able to distinguish between the rhythm- and pitch-related qualities of music. Second, the results of the interviews undertaken during the present study support the conclusion that musical terms such as "harmony" are poorly understood by those lacking a music education (see Stage 1). It would be misleading to cite the present results as evidence that the pitch- and rhythm-based components of music do not exert different psychophysical effects. Specifically, the pitch-related elements of music are thought to determine affective responses whereas the rhythm-related components of music elicit a physical response (Lucaccini and Kreit, 1972).

Unlike the original BMRI, which was developed with reference to exercise and sport contexts, the BMRI-2 has been developed to enable the selection of music for exercise settings. However, practitioners may wish to amend the instructions of the instrument so that music can be selected for a physical training context that relates to sport, such as weight training or circuit training. Although such a minor amendment is unlikely to compromise the psychometric integrity of the instrument, further research in the sport context is warranted. Notably, the BMRI-2 was validated by samples of participants who engaged in a broad range of physical activity, including both sport training and exercise (see Stage 5), thus increasing the likelihood that the instrument will generalise well to sport settings. In addition to validation of the instrument in the sport context, given that the present study was delimited to an examination of initial validity, work to examine convergent, discriminant and predictive validities as well as temporal stability is warranted.

An issue raised during the course of the present study is the appropriateness of the term "motivational music". Such terminology has intuitive appeal and is favoured by exercise participants themselves (see Priest *et al*., 2004). However, it is conceivable that different musical properties may separately influence mood, attention and arousal. Mood-enhancing music may not necessarily prove to be arousing music. Thus, to subsume these different effects under the banner of "motivating music" may represent an over-simplification. The operational definition that Karageorghis *et al*. (1999) offered of motivational music is practically synonymous with Gaston's definition of stimulative music (1951): "Motivational music tends to have a fast tempo (>120 bpm) and a strong rhythm and is proposed to enhance energy and induce bodily action" (p. 2). The differentiation between motivating and stimulative music may be regarded as insufficient and the concept of stimulative music may prove to be more parsimonious. Although the psychophysical effects of music may invoke a state that contributes to an individual's decision to increase the intensity and/or the duration of a bout of exercise (see Priest *et al*., 2004), these effects are not easily reconciled with extant theoretical frameworks relating to motivation (e.g. Bandura, 1986; Vallerand, 1997).

The limitations of the psychometric measurement technique preclude the development of an inventory that censors for the multitudinous facets of musical response. There are aspects of aesthetic experience that transcend scientific evaluation; however, the brevity and simplicity of the BMRI-2 mean that large quantities of music can be rated on a scale that permits comparisons between the responses of different subgroups. In order to elicit the optimum selection of music in exercise settings, it may be necessary to use the BMRI-2 in tandem with qualitative methods that enable the subtler aspects of musical response to be assessed. For example, the BMRI-2 may be used as a wide filter to identify musical pieces that can then be considered on additional grounds. Subsequently, an exercise leader may wish to employ the following framework of criteria when selecting music:

- Music with clear associations to sport or physical activity may prove motivating (see Karageorghis and Terry, 1997). It should be noted that not all exercise participants are motivated by music that is associated with sport (Priest *et al*., 2004).

- Associations that are unrelated to sport or physical activity may also prove motivating. For example, the theme to a popular television adventure series may promote the desire to engage in physical activity. Moreover, lyrics that are related to determination and strength may also conceivably enhance motivation to exercise more intensely and/or for a longer duration.
- The musical idiom, date of release and artist of the music in question must be allied to the age and socio-cultural background of the exercise participants. When a very diverse group is being considered, a systematic attempt must be made to vary these factors (see Priest *et al*., 2004).
- When selecting music for a pre-determined exercise intensity, music tempo should be linked to exercise heart rate, particularly during high intensity exercise (see Karageorghis, Jones, & Low, 2006).
- When selecting music for an individual, the effects of personal associations should be considered. For example, a boxer may have conditioned him or herself by listening to a certain piece of music prior to fighting. Where possible, practitioners should attempt to encourage the formation of such personal associations and harness their power.

Although extra-musical associations are an important determinant of musical response, music with certain structural qualities can predispose listeners to form such associations (Trehub and Schellenberg, 1995). It is conceivable that music which is high in motivating qualities, as determined by the BMRI-2, may predispose exercise participants to form extra-musical associations that relate the music to physical activity.

Future research should aim to validate the inventory for use with different age groups and with recreational exercise participants. A methodological limitation of this study was that the sample sizes were relatively small for the multisample analysis given that there were 12 parameters to be estimated (Tabachnick and Fidell, 2001). This did not present a statistical problem, but does limit the generalisability of the findings. Furthermore, there were insufficient data to enable the establishment of norms that will, in time, be necessary to compare the responses of different subgroups of the population.

The present findings offered support for content and factorial validities as well as internal consistency of the BMRI-2. Construct validity is an ongoing process and there are multiple sources of construct validity evidence. The predictive validity of the BMRI-2 may be assessed by relating the motivational quotient of music to the affective and psychophysical responses to such music in physical activity settings using measures such as the Brunel University Mood Scale (Terry *et al.*, 1999), or the Flow State Scale-2 (Jackson and Eklund, 2002).

The discriminant validity of the BMRI-2 may be demonstrated by testing the effects of music with different motivational quotients on physical performance. In particular, there is a need for quasi-experimental designs that test the effects of motivational music in an externally valid setting. For example, researchers may wish to investigate the effects of motivating and oudeterous music on exercise behaviour in a health club environment. There is also a need for future research to address the test-retest reliability of the BMRI-2. Qualitative research paradigms may also be used to elaborate the precise contingencies and temporal flow of the effects that music exerts on physical performance and the experience of that performance.

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Table I. BMRI-2 fit indices following confirmatory factor analysis (CFA) and multisample CFA

Model and sample	$\chi^{2\ (d.f.)}$	CFI	SRMR
Single-factor, 6-item version (Sample 1)			
Track 1	22.70* $^{(9)}$	0.98	0.03
Track 2	22.35* $^{(9)}$	0.97	0.03
Track 3	30.19* $^{(9)}$	0.95	0.05
Multisample CFA with data from Track 1			
Sample 1 (Male)	22.86* $^{(9)}$	0.96	0.04
Sample 1 (Female)	33.98* $^{(9)}$	0.86	0.07
Sample 2 (Male)	9.85* $^{(9)}$	1.00	0.03
Sample 2 (Female)	12.67* $^{(9)}$	0.98	0.05
Constrained multisample	90.67* $^{(54)}$	0.96	0.11

Abbreviations: CFI = comparative fit index; SRMR = standardised root mean residual; d.f. = degrees of freedom.

*$P < 0.001$.

Table II. Standardised factor loadings and measurement errors resulting from the confirmatory factor analysis of the responses to the 6-item BMRI-2

	Sample 1				Sample 2			
	Male		Female		Male		Female	
Item	FL	ME	FL	ME	FL	ME	FL	ME
Rhythm	0.88	0.48	0.87	0.49	0.81	.058	0.78	0.62
Style	0.90	0.44	0.88	0.48	0.82	0.58	0.91	0.42
Melody	0.76	0.65	0.64	0.77	0.41	0.91	0.71	0.71
Tempo	0.85	0.52	0.86	0.51	0.88	0.48	0.69	0.72
Instruments	0.79	0.62	0.80	0.60	0.76	0.65	0.69	0.72
Beat	0.76	0.65	0.78	0.62	0.84	0.55	0.80	0.61

Abbreviations: FL = factor loading; ME = measurement error.

Appendix A

Directions: Very soon you will hear a series of musical selections. Imagine that you are selecting music for ………… (state activity; e.g. treadmill running) and the participants will be .... (state musical background; e.g. British pop music listeners) in the age range.......... (e.g. 20-25 years). [*Play the music now*]. Rate the piece of music you have just heard by indicating the extent each of the items below contributes to its motivational qualities. The term 'motivational qualities' refers to the extent to which the music inspires or stimulates physical activity. Rate each item on a scale from 1 (not at all motivating) to 10 (extremely motivating).

	Not at all motivating									*Extremely motivating*
1. Familiarity	1	2	3	4	5	6	7	8	9	10
2. Tempo (beat)	1	2	3	4	5	6	7	8	9	10
3. Rhythm	1	2	3	4	5	6	7	8	9	10
4. Lyrics related to physical activity	1	2	3	4	5	6	7	8	9	10
5. Association of music with sport	1	2	3	4	5	6	7	8	9	10
6. Chart success	1	2	3	4	5	6	7	8	9	10
7. Association of music with a film or video	1	2	3	4	5	6	7	8	9	10
8. The artist/s	1	2	3	4	5	6	7	8	9	10
9. Harmony	1	2	3	4	5	6	7	8	9	10
10. Melody	1	2	3	4	5	6	7	8	9	10
11. Stimulative qualities of music	1	2	3	4	5	6	7	8	9	10
12. Danceability	1	2	3	4	5	6	7	8	9	10
13. Date of release	1	2	3	4	5	6	7	8	9	10

Please use a separate sheet for each musical selection

Appendix B

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

Strongly disagree In-between Strongly agree

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