

Research article

A motivational music and video intervention improves high-intensity exercise performance

Martin J. Barwood , Neil J.V. Weston, Richard Thelwell and Jennifer Page

Department of Sport and Exercise Science, University of Portsmouth, Portsmouth, UK

Abstract

Music and video are utilised by recreational gym users to enhance their exercise experience. Music and video have not been investigated for their combined ergogenic effect during high intensity exercise. To induce fatigue, this study was performed in warm (~26°C), moist conditions (~50%RH). Six, non-acclimated, male participants took part in the study. Each participant completed three 30-minute exercise bouts on a motorised treadmill under three counterbalanced conditions on separate days: control (CON), motivational music plus video intervention (M), non-motivational intervention (NM). They completed a warm-up (5 km·h⁻¹ [5 minutes], 9km·h⁻¹ [10 minutes]) followed by a maximal effort run (15 minutes). Participants did not receive any feedback of time elapsed, distance run or speed. Measures: Distance covered (metres), heart rate, blood lactate accumulation (B_{lac}) and ratings of perceived exertion (RPE). Participants in the M condition ran significantly further than in the NM (M: 3524 [388]metres; NM: 3110 [561]metres; CON: 3273 [458]metres) and CON conditions, accumulated more B_{lac}, but did not increase their peak RPE rating ($p < 0.05$). The M intervention improved tolerance of high intensity exercise in warm conditions. It was proposed that a change in attentional processing from internal (physical sensations) to external perspective (music and video) may have facilitated this improvement. These findings have strong implications for improving health, fitness and engagement in gym-based exercise programs.

Key words: Running, distraction, attention, lactate threshold.

Introduction

Music and video have separately been used to enhance sports performance as part of preparatory routines (Szabo et al., 1999; Templin and Vernacchia, 1995), skill acquisition (Onestak, 1997) or during the intervals between games, halves or sequences (Bishop et al., 2007; Hall and Erffmeyer, 1983). Considering the applied significance of separate music and video interventions prior to and during sports performance it is surprising that no studies have examined the ergogenic effect of motivational music and video interventions in combination. The applied efficacy of combining music and video to influence sports performance is appealing because, with the advancement of communication technologies, both of these interventions can easily be implemented at sporting venues and are already utilised by recreational gym users to supplement their exercise routines (Karageorghis et al., 2006a). In the latter context it is likely that this type of intervention could influence adherence and work intensity in an exercise program culminating in health benefits as has already

been suggested with music alone (Karageorghis and Terry, 1997).

The theoretical underpinning for the use of music in this setting is more established than that of video (see Bishop et al., 2007, Karageorghis et al., 2006a, Priest et al., 2004). A greater number of studies have examined the ergogenic effect of music, particularly prior to or during high intensity exercise, during which, the synchronising of physiological and motor responses during exercise with music may be one means by which music is influential (Brownley et al., 1995; Karageorghis, 2000; Simpson and Karageorghis, 2006). The ergogenic effect of music on high intensity exercise also extends to elite sports persons. Elite runner, Heile Gebreselassie, used a high-tempo popular music song to synchronise his strides in order to optimise his pacing in winning a 5000m race in 2003 (Simpson and Karageorghis, 2006). Asynchronous music, defined as not consisting of any conscious effort to synchronise movements with music tempo, is also suggested to carry this performance enhancing effect (Karageorghis, 2000).

The Brunel Music Rating Inventory-2 (BMRI-2; Karageorghis et al, 2006a) and recently updated version BMRI-3 (Karageorghis, 2008) have allowed researchers to specifically identify music tracks that induce a motivational impact upon an athlete during sports performance. Motivational tracks are thought to include a high tempo beat (>120bpm), a strong rhythm, and to enhance energy and induce bodily action (Karageorghis et al., 2006b). Further influential characteristics of music have been suggested to include the rhythm response, musicality, cultural impact and association with the tracks (Karageorghis et al., 1999). Therefore music tracks that encompass all of these aspects would optimise moderate intensity exercise performance. Bishop et al (2007) have recently extended the study of music and performance providing a rationale for the manipulation of emotional responses to music in junior tennis players. Here it was suggested that the right music can be used as a tool to 'psych up' in preparation for performance (arousal regulation), shift attentional focus (association/dissociation), boost self-efficacy and encourage psychological skills usage (e.g. mental imagery). Presumably during high intensity exercise participants would aim to be psyched up, may wish to dissociate from unpleasant exertion induced sensations (untrained participants only; Brownley et al., 1995), feel confident and employ appropriate psychological coping strategies. Clearly the use of appropriately selected music could induce an ergogenic effect.

Theoretically, the supplementation of appropriately chosen music with video footage has the potential to enhance the beneficial effect of such interventions prior to and during sports performance. Video footage of sports-persons demonstrating mastery could manipulate the self-efficacy of an individual as part of a combined music and video intervention. This suggestion has already been supported with the use of personal motivational videos (PMVs) in competitive tennis players following a relatively short intervention period (2 weeks; Bishop and Forzoni, 2006). Self-efficacy is an individual's belief about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives (Bandura, 1977). In relation to Bandura's (1977; 1997) self-efficacy theory, video footage of competent sports performance may improve the performance accomplishment (via self-reflection on previous successful performances) and vicarious experience components that are thought to comprise this construct thereby facilitating emotional control. It has already been suggested that the combination of music with video can stimulate positive images and help recreate feelings of confidence and memories of previous performances (Forzoni, 2006). The additive effect of music with images is further supported by evidence of stimulation of areas of the brain with music and images that are thought to complete emotional processing (Baumgartner et al., 2006). This evidence appears to suggest that music and video combined has the potential to stimulate self-efficacy and emotional engagement and may therefore enhance motivation during exercise.

Watching a video also has the potential to shift attentional focus from internal stimuli to external cues. Music researchers hypothesise this effect with asynchronous music whereby attention is shifted from salient physiological cues to the external components of music particularly the rhythm and musicality components of a given track (Karageorghis and Terry, 1997). Rejeski's (1985) parallel processing model explains this facilitative change in attentional processing. The attentional field of an individual is thought to narrow increasingly with elevations in work intensity. During low and moderate exercise external musical cues can prevail thereby reducing RPE (Borg, 1982). However, this is only hypothesised to the case at low/moderate intensities below the anaerobic threshold above which salient physiological cues are thought to dominate (Boutcher and Trenske, 1990). It is possible that increasing the strength of external cues through combining music and video may be sufficient to influence RPE above the anaerobic threshold. If supported, this suggestion could have implications for trained runners who are suggested to favour internal associative perspectives whilst performing exercise (Morgan, 1977).

Evidence has been presented for the potential ergogenic effect of music and video on sports performance which, if supported could have a more powerful influence on attentional focus than video or no intervention alone. This could have implications for those who exercise whilst watching videos and listening to music. Recent evidence has been presented demonstrating the efficacy of other interventions, namely psychological skills training (PST), in dealing with significant exertion induced physi-

cal sensations in hot conditions (Barwood, Thelwell and Tipton, 2008). The aerobically trained participants in this study showed an 8% (1.15km) improvement in distance covered during a 90 minute time-trial run in hot (30°C), moist conditions (50% relative humidity; RH) by suppressing their temptation to reduce their work intensity using a range of psychological skills. The authors suggested that aspects of the PST (mental imagery, positive self-talk) may have facilitated performance by distracting the participant from unpleasant sensations elicited by hyperthermia). Theoretically both music and video interventions may function in part in a similar way, that is by distracting the individual from unpleasant sensations elicited during high intensity exercise. This has yet to be assessed under environmentally demanding temperature conditions in which tolerance to unpleasant sensations from exercise and heat will force performance to deteriorate at a faster rate (Tucker et al., 2004). This will provide an improved backdrop for distinguishing the effects of music and video interventions on performance.

Given the recent research and theoretical developments the aim of this study was to examine the beneficial effect that a motivational music and video intervention could have on high intensity exercise performance under moderate environmental stress. The experiment hypothesis was that a motivational music and video intervention would significantly increase distance covered during a time-trial running task and help participants tolerate warm (~26°C), moist ambient conditions (~50%RH). If the content of the video portion of the intervention proved important, participants in a non-motivational video condition would complete the shortest distance.

Methods

Participants

The study protocol was approved in advance by the institutional ethics committee and the participants gave their written informed consent to participate. Following medical checks, six healthy male, non-acclimated volunteers acted as participants for the experiment (mean [s.d]; Age 20 [1] yrs; height 1.81 [0.04] m; mass 77 [10] kg). Participants were non-smokers recruited from university rugby and football teams, completed a minimum of four hours of physical activity a week and were familiar with treadmill running. Each participant refrained from strenuous exercise, alcohol and caffeine consumption 24 hours prior to participating in the study. The experimental procedures were conducted in accordance with the Declaration of Helsinki, as adopted at the 52nd World Medical Association general assembly, 2000.

Experimental design

Each participant performed three 30-minute (15 minute warm-up, 15 minute self paced) maximal effort runs on a treadmill in a climatic chamber held at a constant temperature of ~26°C and ~50% relative humidity (RH). During each run the participant underwent one of three experiment manipulations comprising either a control (CON) condition, motivational (M) or non-motivational (NM) music and video intervention. To minimise any

order effects, the order of interventions were delivered in a balanced crossover design. Prior to each run the participants were instructed to exert a maximal effort. Trials were conducted at the same time of day on separate days for each participant to minimise any circadian effects, with a minimum of three days between each laboratory visit. Following the completion of the study each participant completed a Social Validation Questionnaire (SVQ) to measure his responses to each treatment intervention delivered.

Procedure

The participants were required to visit the laboratory on 3 occasions. On arrival each participant changed into running clothes including shorts, socks, a running vest and trainers; the same clothing was worn in each trial. Each participant then attached a heart rate monitor (Team Polar, UK) recording data every 6 seconds, to measure work intensity during each run. Resting blood lactate (B_{lac}) concentration was measured (Biosen, C-line Sport, Germany) via a finger prick blood sample taken by a qualified phlebotomist. The difference between pre and post exercise B_{lac} (ΔB_{lac}) was used as an index of aerobic or anaerobic metabolism during the maximal effort run. To avoid the potential distraction by measurement equipment (Karageorghis and Terry, 1997), no further measurement devices were attached.

After instrumentation each participant entered a climatic chamber. The environmental conditions were recorded each minute during the 30 minute trials by a WBGT weather station (Grant Instruments, Cambridge, U.K.). Environmental conditions in the CON trial were 26.50 [1.20]°C and 45 [9]%, in the NM trial 26.60 [0.30]°C and 49 [4]%, and the M trial 25.90 [0.70]°C and 45 [7]%, RH and were not different from each other ($P > 0.05$). Such conditions are mild at rest but are sufficient to provide a moderate thermal stimulus during high intensity exercise producing a moderate risk of heat illness (Armstrong et al., 1996). The participant mounted a treadmill (Powerjog GX200, Powerjog, U.K.) and completed a standardised warm-up over a 15 minute period. The warm-up comprised 5 minutes of exercise at 5 km·h⁻¹ and a further 10 minutes at 9km·h⁻¹ following which the participant began his 15-minute maximal effort run. During this time the participant controlled his speed and did not receive any feedback of time elapsed, distance covered or current running speed. Throughout the warm-up and maximal effort run the treadmill incline was set to 1% to reflect the metabolic energy demands of outdoor running (Jones and Doust, 1996). RPE (Borg, 1982) was recorded at a minimum of 2-minute intervals; the frequency of RPE measurement was limited to minimise any temporal cues to the participant. Every effort was made by the experimental team to eliminate temporal cues from the immediate environment around the participant to avoid anticipatory changes in work intensity toward the end of the run. No verbal encouragement was given at any stage. Following the cessation of the run the participant slowed the treadmill to walking speed for 3 minutes and exited the climatic chamber. A post exercise sample of blood was drawn from the fingertip after 4 minutes for blood lactate analysis. Participants were allowed to con-

sume normal tap water (19°C) ad libitum during each trial. The distance covered in each trial was noted and used as a performance indicator. In two of the three trials the participants received the M video and music intervention or NM video intervention projected (Sony SVGA, VPL-DS100, Japan) onto the wall of the climatic chamber ~2 metres in front of the participant and through two audio speakers (Goodmans 40W speakers, U.K) mounted adjacent and above (1.80m), and below (0.40m) and behind the treadmill respectively. The M and NM interventions were controlled by a laptop computer (Toshiba Tecra M5, Japan) and were reproduced in each trial at the same intensity (Goodmans MS 355, U.K) as measured by a handheld sound level meter (Lutron SL-4001, Lutron Electronic Enterprise Co, Taiwan); volume was 75db adjacent to the ear of the participant; ≥ 75 db is classified as loud music according to Karageorghis and Terry, 1997).

Development of Materials

Motivational Intervention

The music was selected by the experimenters on the basis of tempo (e.g. Pendulum, 'Slam' 139 bpm), potential affective content (e.g. Survivor, 'Eye of the Tiger' 109bpm) or the inclusion of inspirational lyrics (e.g. Lock, Stock and Barrel 'Rise above it'). To avoid previous research criticisms for the arbitrary selection of music in experiments using music interventions (Karageorghis and Terry, 1997), participants rated the music portion of the M intervention using the Brunel Music Rating Inventory-3 (Karageorghis, 2008); this was undertaken following completion of the study. Within the BMRI-3, the motivational properties of each piece of music are rated on a 7-point scale whereby the sum of the ratings indicate the extent of the motivational properties (highly motivational rating 36-42; moderately motivating 24-35; <24 low/oudeterous). The warm-up section of the M intervention was rated as 27 [4] (0-15 minutes) and the self-paced exercise section of the M intervention was rated 36 [3] (15-30 minutes). It has previously been noted that the term 'motivational music' may oversimplify the effects that music can have on exercise performance because of the lack of distinction between the affective components that music may include (Karageorghis et al., 2006a). Considering the exercise type (high intensity) high tempo music (> 120 to 140bpm) was selected for the study with tracks consistent with Gaston (1951) and Karageorghis et al.'s (1999) suggestions of motivational music.

Controls were also implemented to account for potential differences in the influence of the music portion of the intervention between different age groups (participant ages: 20 [1]), gender (male participants) and socio-cultural background (Caucasians raised in the UK) (Karageorghis et al, 2006a; Priest et al., 2004). Lastly, although the music was of high tempo in nature it was not designed to be synchronised with strides whilst participants were running. Asynchronous music has previously been identified as background music similar to that present in most gymnasias (Karageorghis et al., 2006b).

In order to stimulate the vicarious experience component of self-efficacy (Bandura, 1997) the video and picture portions of the M intervention included pictures

and videos of influential World and British sporting feats that the participants were likely to have seen in the media previously. (e.g. Kelly Holmes' 2004 Olympic 1500m and 800m gold-medal winning races; Sir Steve Redgrave's coxless fours 2000 Olympic gold medal win). The videos included moving pictures of further inspirational sporting moments including England's 2003 Rugby Union World cup winning drop goal (Jonny Wilkinson) and Michael Owen's 2001 FIFA World Cup qualifying hat-trick versus Germany.

Non-Motivational Intervention

The NM intervention consisted of 30 minutes of public speaking from a recent political trial in the USA. The footage included verbal communication of evidence from the prosecution, defence interspersed with passages of speech from a judge. At no point did this footage include motivational slogans or any music or synchronous activity. This intervention did not include any of the components that have previously been noted to have an ergogenic effect during exercise, therefore the term non-motivational was used. The NM footage was selected on this basis.

Control condition

Participants in the control condition completed their warm-up and maximal effort run undergoing the same physiological and psychological measurements but did not watch or listen to any video or music whilst running.

Social validation questionnaire (SVQ)

To improve external validity, following completion of the study each participant was informed of the distance they covered in each trial and completed an SVQ asking for a rating on a 7 point Likert scale (1 – not at all important/significant/satisfied/useful to 7 extremely important/significant/satisfied/useful) whether they rated an

improvement in performance as important to them, whether they rated this improvement as significant, how satisfied they were with the intervention programme and whether the intervention proved useful. Consistent with the recommendations of Tenenbaum et al. (2004), the participants were invited to provide any subjective comments on the perceived influences of the interventions received.

Data analysis

The following variables were analysed: Distance covered in each trial (m) and ΔB_{lac} , from each maximal effort run. Data sets were analysed for differences between trial using a Multivariate analysis of variance (MANOVA) with repeated measures; significant effects were detected using a *post-hoc* pairwise comparisons test with Bonferroni adjustment for multiple comparisons. Statistical findings are reported with their observed power (β) where the chance of type II error is equal to $1 - \beta$. Where appropriate data sets were adjusted using a Greenhouse-Geisser adjustment. For all statistical tests α level was set at 0.05.

Results

Performance indicators

Data are presented as mean [SD] where appropriate. Distances covered for each participant are presented in Figure 1. MANOVA indicated a significant difference between the CON, NM and M conditions ($F = 3.68$, $p = 0.023$, $\beta = 0.77$). The univariate statistic ($F_{(2,10)} = 11.29$, $p = 0.003$, $\beta = 0.96$) indicated that participants ran significantly further in one trial with the post-hoc analysis showing that participants covered a greater distance in the M condition than both the NM ($p = 0.049$) and the CON ($p = 0.019$) condition. There were no differences between the CON and NM condition in distance covered ($p > 0.05$). On average the participants ran 415 m (13%) and 251 m (8%) further in the M than NM and CON respectively.

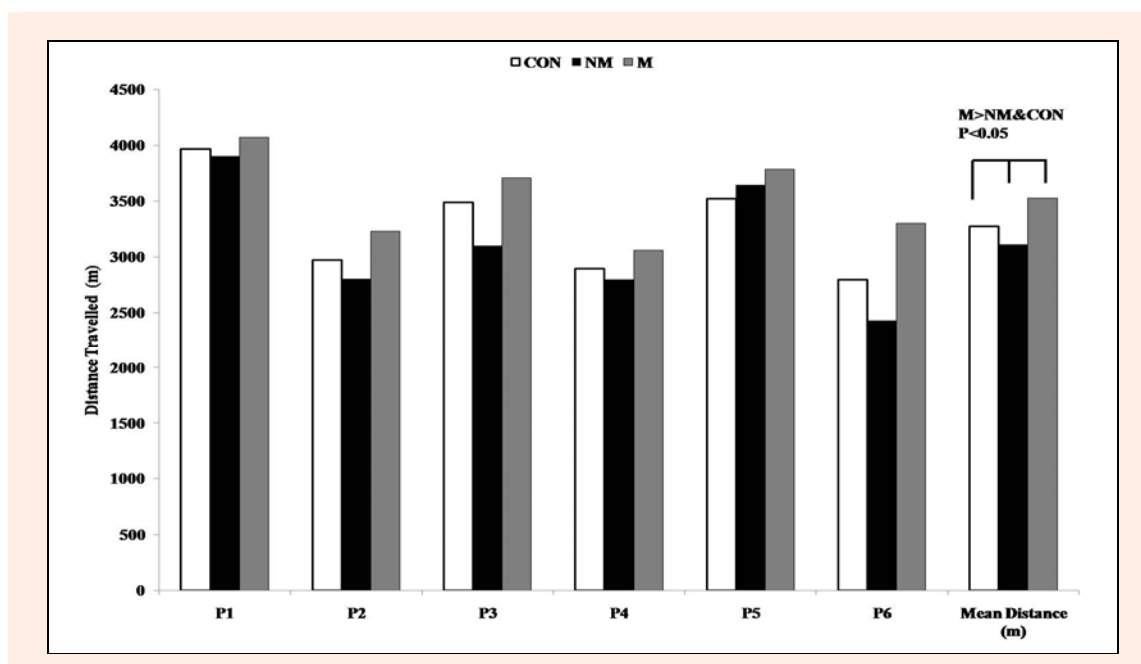


Figure 1. Individual and mean distance covered (m) during each 15 minute maximal effort run in participants 1-6.

Table 1. B_{lac} accumulation, heart rate and RPE_{peak} in the CON, NM and M conditions.

Participant	ΔB_{lac} (mmol·L ⁻¹)			Mean HR (bt·min ⁻¹)			RPE _{peak}		
	CON	NM	M [‡]	CON	NM	M	CON	NM	M
1	11.34	7.67	8.66	181	182	170	19	18	19
2	1.50	4.36	8.62	197	192	190	19	19	19
3	3.85	1.55	6.91	168	160	177	16	12	19
4	7.96	5.43	6.81	188	182	192	20	19	19
5	3.01	1.81	5.28	180	170	185	17	19	18
6	3.70	-0.09	8.42	171	161	183	17	19	16
Mean	5.23	3.46	7.45	181	174	183	18	18	18

† denotes M > CON and NM condition, ‡ denotes M > NM only.

Indicators of exercise intensity

Indicators of exercise intensity are presented in Table 1. Univariate analysis indicated differences in B_{lac} accumulation between trials ($F_{(2,10)} = 5.33$, $p = 0.026$, $\beta = 0.70$). Post-hoc analysis indicated B_{lac} accumulated to a significantly greater extent ($p = 0.05$) in the M compared to the NM condition. There were no further differences between the other conditions ($p > 0.05$). On average, participants produced an additional 4 mmol·L⁻¹ of B_{lac} in the M condition. Mean heart rate during maximal effort running is displayed in Figure 2. Four of the six participants displayed elevated heart rates in the M compared to the NM condition. Heart rate during treadmill running had a tendency to be higher throughout the maximal effort run in the M condition (Figure 2). RPE peak was similar during each of the experimental manipulations and averaged 18 in each condition.

Social validation data, rated on a 7-point Likert scale, indicated that the participants rated the improvements in performance during the M intervention as important (6 [0]), rated their improvement in performance as significant (6 [1]), were satisfied with the intervention (6 [1]) and found the intervention useful (6 [2]).

Discussion

This study examined the effect a motivational music and

video intervention on high intensity exercise performance in warm conditions. It was hypothesised that, since the combination of music and video included more external stimuli to induce a dissociative attentional strategy and increase tolerance, that these interventions combined would increase distance covered during a 15 minute treadmill maximal effort run trial. The first hypothesis was supported. The video content clearly played a role in determining participants' effort as they covered the least distance in the NM conditions in which stimulating cues were minimised. We also suggested that the magnitude and number of external distractions caused by the combination of music with video would lead to a lowered RPE rating despite running further. This is partially supported by the unchanged RPE, having run 13% further, in the motivational music and video intervention. In the NM condition RPE was also not different raising the possibility of a change in perception.

Previous studies using only music as an intervention have indicated that music is most efficacious during low and moderate work intensities or in untrained participants (Boutcher and Trenske, 1990; Brownley et al., 1995). The current study demonstrated that music with video extended the beneficial effects of audiovisual interventions to include high intensity exercise. Participants receiving the M intervention worked at a higher heart rate and accumulated more B_{lac} post-exercise. Boutcher and

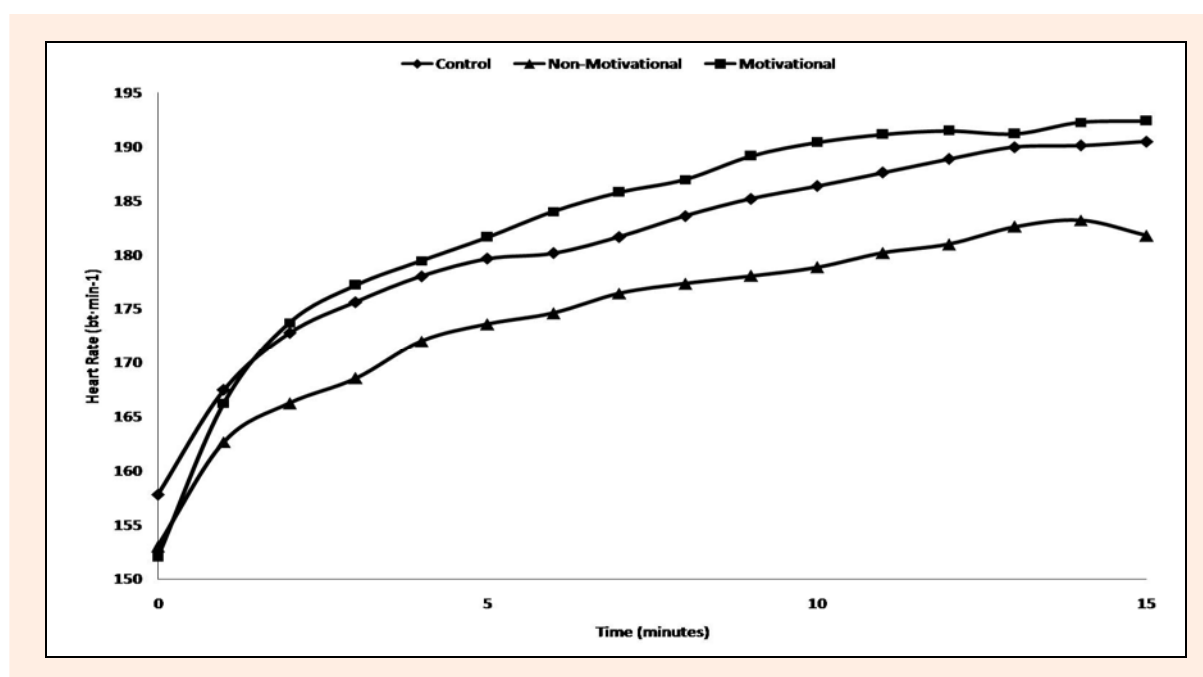


Figure 2. Mean heart rate during each 15 minute maximal effort run in participants ($n = 6$).

Trenske (1990) suggested that the physiological cues at high exercise intensities (~170bpm), similar to those observed in our study (~180 to 190bpm), were too strong for their participants to ignore thereby restoring RPE to the levels observed in a control condition. The current study provides some tentative support for a change in perception and consequent benefit to exercise performance when many stimulating distractions were present in the exercise environment.

Rejeski's (1985) parallel information processing theory has consistently been used to interpret the ergogenic influence of music on performance at a range of intensities (e.g. Simpson and Karageorghis, 2006; Carr et al., 2006; Tenenbaum et al., 2004). This model could also provide insight into the findings of the current study. Rejeski (1985) suggests that both physiological and psychological afferent inputs are processed preconsciously and in parallel. During high intensity exercise, the bandwidth for attentional processing narrows and only the most salient cues are processed which are often, because of their overwhelming strength, physiological in nature (e.g. high heart rate, respiratory rate and raised B_{lac}). The inclusion of video may have provided some competition for preconscious processing. In untrained runners this could have a beneficial impact on exercise intensity and adherence to exercise programmes potentially constituting a health benefit. However, this could ultimately be damaging for trained participants who favour an internal attentional perspective, particularly during high intensity exercise, because such cues carry important details of pacing strategy for training or competition (Morgan, 1977). Music and video may force trained participants to miss important pacing cues. The cohort of participants in the current study were physically active but were not trained runners per se. Further studies using trained runners would elucidate the relationship between training status and music and video interventions.

Conversely, the NM intervention may have induced fewer stimulating distractions culminating in the poorest maximal effort performance but interestingly it did not differ in RPE rating. The subjective comments made following the NM trial suggest that the exercise intensity was perceived as harder because of the boredom experienced. This emphasises the specificity of the content of the motivational music and video intervention in the current study. Where possible the appropriate research tools were used to create the music in the M intervention (BMRI-2; Karageorghis et al, 2006a; BMRI-3; Karageorghis, 2008) and an equivalent tool to develop the video interventions may have proved useful. Some tentative suggestions have been made in developing this personal motivational videos (Forzoni, 2006), although these suggestions have not been assessed empirically.

Indeed, the combination of music with video may have functioned in other ways to facilitate high intensity exercise performance. Rendi et al. (2008) suggested that high-tempo music may only facilitate arousal during high intensity exercise performance with no change in attentional processing. Rendi et al. also reported unchanged RPE ratings during rowing exercise but linked the facilitative effect of music to a greater stroke frequency aug-

mented by elevations in arousal. As already noted, music in combination with images stimulates many brain structures involved in emotional processing (Baumgartner et al., 2006) and it appears feasible that the M intervention facilitated arousal in the this manner. Some support for this suggestion can be found in the post-trial comments made in the current study where some participants felt that they "wanted to run faster in the warm-up because of the music and video" in the M condition whereas they "wanted to slow the speed down because the trial felt harder" in the NM condition. Interestingly, heart rate appeared higher at the start of exercise (Figure 2) in the M condition despite completing the same warm-up as in other conditions suggesting some impact upon arousal. Risk-taking images (e.g. climbing, surfing, parachuting) have also been noted to carry an affective component (at rest) and may also have contributed to the elevated heart rate in the M condition (Gomez et al., 2005). Conversely heart rate was lowest prior to the start of the maximal effort run in the NM condition (Figure 2).

We can only assume that the video portion of the M intervention boosted self-efficacy and future studies should measure this possibility. It was proposed that vicarious experience and performance accomplishment may be augmented by watching video footage including mastery of skill in elite and sub-elite sports persons. This could be further enhanced by the creation of personal motivational videos which can be tailored to carry information specific to the performer providing behavioural reinforcement, augmenting psychological skills usage and optimising the emotive response prior to or during exercise (Forzoni, 2006). This represents an important future direction for research in this area as a study using PMVs in this setting will help develop a rationale for the use of effective tools for sport psychology practitioners.

This study presents a number of interesting further questions to be answered with subsequent studies. It is difficult to separate out specifically how the video intervention improved performance and some measure of the participant reactions to the treatment interventions, over and above the SVQ used here, would clarify this issue. Similarly, further treatment conditions including only music and only video would help to separate the additive effect that these interventions combined may have but these have been studied in part elsewhere (e.g. Bishop and Forzoni, 2006; Brownley et al., 1995). The findings of the current study provide a strong rationale to test this hypothesis. This study does provide some ecological validity for the appeal of video and music in combination as an ergogenic aid to exercise of short duration. Testing these beneficial effects over longer duration may also prove interesting as there may be a greater number physiological inputs that comprise fatigue and compete for attentional processing over longer exercise of greater duration, particularly in warm conditions (Tucker et al., 2004; Davis and Bailey, 1997; Nybo and Nielsen, 2001). In relation to ecological validity, the conditions of the study may be similar to those experienced in non-air-conditioned cardiovascular exercise suites of recreational gyms. Likewise the intervention itself was highly rated according to the SVQ in participants similar to those who may comprise a

population of gym users. The SVQ showed that the participants in the current study were highly motivated, rated their improvements as significant, were satisfied with the intervention thereby indicating they would use this kind of intervention in future.

Conclusion

In conclusion, this study showed that a combined music and video intervention has a beneficial effect on exercise of high intensity in conditions that may induce premature fatigue. Video and music may primarily be of use to non-competitive, recreational gym users who are more likely to select dissociative attentional strategies to elongate or tolerate a high intensity exercise workload. Future studies should assess the efficacy of this intervention in trained runners. In order to establish suitably motivating video components to such interventions, research tools, similar to the BMRI-3 (Karageorghis, 2008) should be developed to aid practitioners and researchers in subsequent studies.

References

- Armstrong, L.E., Crago, A.E., Adams, R., Roberts, W.O. and Maresh, C.M. (1996) Whole-body cooling of hyperthermic runners: Comparison of two field therapies. *American Journal of Emergency Medicine* **14**, 355-358.
- Bandura, A. (1977) Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review* **84**, 191-215.
- Bandura, A. (1997) *Self-efficacy: The exercise of control*. New York: Freeman.
- Barwood, M.J., Thelwell, R.C. and Tipton, M.J. (2008) Psychological skills training improves exercise performance in the heat. *Medicine and Science in Sport and Exercise* **40**(2), 387-396.
- Baumgartner, T., Lutz, K., Schmidt, C.F. and Jancke, L. (2006) The emotional power of music: How music enhances the feeling of affective pictures. *Brain Research* **1075**, 151-164.
- Bishop, D. and Forzoni, R. (2006) The use of music video in sport psychology interventions: empirical and anecdotal considerations. In: *British Association of Sport and Exercise Sciences Annual Conference, September 11-13, University of Wolverhampton, England*. 4.
- Bishop, D.T., Karageorghis, C.I. and Loizou, G. (2007) A grounded theory of young tennis players' use of music to manipulate emotional state. *Journal of Sport and Exercise Psychology* **29**, 584-607.
- Borg, G.A.V. (1982) Psychophysical basis of perceived exertion. *Medicine and Science in Sports and Exercise* **14**, 377-381.
- Boutcher, S.H. and Trenske, M. (1990). The effects of sensory deprivation and music on perceived exertion and affect during exercise. *Journal of Sport and Exercise Psychology* **12**, 167-176.
- Brownley, K.A., McMurray, R.G. and Hackney, A.C. (1995) Effects of music on physiological and affective responses to graded treadmill exercise in trained and untrained runners. *International Journal of Psychophysiology* **19**, 193-201.
- Carr, S., Elliott, D. and Savage, D. (2006) The influence of rhythm and personality on the endurance response to motivational asynchronous music. *Journal of Sports Sciences* **24**, 187-195.
- Cervone, D., Kopp, D., Schaumann, L. and Scott, W. (1994) Mood, self-efficacy and performance standards: Lower moods induce higher standards for performance. *Journal of Personality and Social Psychology* **67**, 499-512.
- Davis, M. and Bailey, S.P. (1997) Possible mechanisms of central nervous system fatigue during exercise. *Medicine and Science in Sports and Exercise* **29**, 45-57.
- Easterbrook, J.A. (1959) The effect of emotion on the utilization and organization of behavior. *Psychological Review* **66**, 183-201.
- Forzoni, R. (2006) Personal motivational videos: So where's the downside? *The Sport and Exercise Scientist* **7**, 10-11.
- Gaston, E.T. (1951) Musical factors influencing social behaviour. *Kansas Welfare Digest* **10**, 2-4.
- Gomez, P., Zimmermann, P., Guttormson-Schär, S., and Danuser, B. (2005) Respiratory responses associated with affective processing of film stimuli. *Biological Psychology* **68**, 223-235.
- Hall, E.G. and Erffmeyer, E.S. (1983) The effect of visuo-motor behaviour rehearsal with videotape modelling on free throw accuracy of intercollegiate female basketball players. *Journal of Sport Psychology* **5**, 343-346.
- Jones, A.M. and Doust, J.M. (1996) A 1% treadmill incline most accurately reflects the energetic cost of outdoor running. *Journal of Sports Sciences* **14**, 321-327.
- Karageorghis, C.I. (2008) The scientific application of music in sport and exercise. In: *Sport and Exercise Psychology*. Ed: Lane, A. London: Hodder Education. 109-138
- Karageorghis, C.I. (2000) The effects of synchronous and asynchronous music in cycle ergometry. *Journal of Sports Sciences* **18**, 16.
- Karageorghis, C.I. and Terry, P.C. (1997) The psychophysical effects of music in sport and exercise: a review. *Journal of Sport Behavior* **20**, 54-68.
- Karageorghis, C.I., Jones, L. and Low, D.C. (2006b) Relationship between exercise heart rate and music tempo preference. *Research Quarterly for Exercise and Sport* **77**(2), 240-250.
- Karageorghis, C.I., Terry, P.C. and Lane, A.M. (1999) Development and initial validation of an instrument to assess the motivational qualities of music in exercise and sport - The Brunel Music Rating Inventory. *Journal of Sports Sciences* **17**, 713-724.
- Karageorghis, C.I., Priest, D.L., Terry, P.C., Chatzisarantis, N.L.D. and Lane, A.M. (2006a). Redesign and initial validation of an instrument to assess the motivational qualities of music in exercise: The Brunel Music Rating Inventory-2. *Journal of Sports Sciences* **24**, 899-909.
- Morgan, W.P. (1977) Psychological characterizations of the elite distance runner. *Annals of the New York Academy of Sciences* **301**, 383-403.
- Nybo, L. and Nielsen, B. (2001) Perceived exertion is associated with an altered brain activity during exercise with progressive hyperthermia. *Journal of Applied Physiology* **91**, 2017-2023.
- Onestak, D.M. (1997) The effect of visuo-motor behaviour rehearsal (VMBR) and videotape modelling (VM) on free throw performance of intercollegiate athletes. *Journal of Sport Behavior* **20**, 185-198.
- Priest, D.L., Karageorghis, C.I. and Sharp, N.C.C. (2004) The characteristics and effects of motivational music in exercise settings: the possible influence of gender, age frequency of attendance, and time of attendance. *Journal of Sports Medicine and Physical Fitness* **44**, 77-86.
- Rejeski, W.J. (1985) Perceived exertion: an inactive or passive process? *Journal of Sport Psychology* **7**, 371-378.
- Rendi, M., Szabo, A. and Szabo, T. (2008) Performance enhancement with music in rowing sprint. *The Sport Psychologist* **22**, 175-182.
- Simpson, S.D. and Karageorghis, C.I. (2006) The effects of synchronous music on 400-m sprint performance. *Journal of Sports Sciences* **24**, 1095-1102.
- Szabo, A., Small, A. and Leigh, M (1999) The effects of slow and fast rhythm classical music on progressive cycling to voluntary physical exhaustion. *Journal of Sports Medicine and Physical Fitness* **39**, 220-225.
- Templin, D.P. and Vernacchia, R.A. (1995) The effect of highlight music videotapes upon the game performance of intercollegiate basketball players. *The Sport Psychologist* **9**, 41-50.
- Tenenbaum, G., Lidor, R., Lavyan, N., Morrow, K., Tonnel, S., Gershgoren, A., Meis, J. and Johnson, M (2004) The effect of music type on running perseverance and coping with effort sensations. *Psychology of Sport and Exercise* **5**, 89-109.
- Tucker, R., Rauch, L., Harley, Y.X.R. and Noakes, T.D. (2004) Anticipatory regulation of skeletal muscle recruitment and reduced exercise in the heat. *Pflugers Archive* **448**, 442-430.

Key points

- The study examined the ergogenic effect of a motivational (M) video and music intervention on high-intensity exercise performance in comparison to a non-motivational (NM) condition and a control (CON).
- Participants in the M condition ran significantly further than in the NM (M: 3524 [388]metres; NM: 3110 [561]metres; CON: 3273 [458]metres) and CON conditions, accumulated more B_{lac} , but did not increase their peak RPE rating ($p < 0.05$).
- It was proposed that a change in attentional processing from internal (physical sensations) to external perspective (music and video) may have facilitated this improvement.
- These findings have strong implications for improving health, fitness and engagement in gym-based exercise programs.

AUTHORS BIOGRAPHY



Martin BARWOOD

Employment

Senior Lecturer, Department of Sport and Exercise Science, University of Portsmouth

Degree

BSc, PhD

Research interest

Human and applied physiology.

E-mail: martin.barwood@port.ac.uk



Neil WESTON

Employment

Principal lecturer Department of Sport and Exercise Science, University of Portsmouth

Degree

BSc, PhD

Research interest

Sport and exercise psychology.

E-mail: neil.weston@port.ac.uk



Richard THELWELL

Employment

Principal lecturer Department of Sport and Exercise Science, University of Portsmouth

Degree

BSc, PhD

Research interest

Sport and exercise psychology.

E-mail: richard.thelwell@port.ac.uk



Jennifer PAGE

Employment

Senior lecturer Department of Sport and Exercise Science, University of Portsmouth

Degree

BSc, MSc

Research interest

Sport and exercise psychology.

E-mail: jenny.page@port.ac.uk

✉ Martin J. Barwood

Department of Sport and Exercise Science, University of Portsmouth, Portsmouth, UK