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ORIGINAL

INFLUENCE OF MUSIC ON PHYSICAL PERFORMANCE, PERCEIVED EXERTION AND MOTIVATION

INFLUENCIA DE LA MÚSICA EN EL RENDIMIENTO FÍSICO, ESFUERZO PERCIBIDO Y MOTIVACIÓN

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ABSTRACT

The purpose of this study was to assess the extent to which different types of music (classical or techno), or the absence of music, may affect motivation, performance and perceived effort. 24 triathletes were divided into three groups, one of which served as a control group. Each group underwent three exercise sessions of twenty minutes on the static bicycle. No music was played in any of the control group's sessions. In the first session for Group 1 no music was played. In the first session for Group 2 no music was played. In the second session, classical music was played for the participants of Group 1 and techno music was played for the participants of Group 2. In the third and final session, techno music was played for the participants of Group 1 and classical music was played for the participants of Group 2. Results indicate that the choice of music has little effect on performance. It appears that a song's popularity or its association with a famous film is the most motivational factor and that this affects the participants' levels of perceived effort, however this effect is less noticeable with classical music.

KEY WORDS: Music, effort perceived, physical performance, motivation

RESUMEN

El propósito de este estudio fue evaluar la influencia motivacional del estilo de música (clásica y tecno) frente a su no utilización sobre el rendimiento y el esfuerzo percibido. Se administró a 24 triatleta que hicieron tres sesiones de 20 minutos, en bicicleta estática. Se establecieron dos grupos experimentales y un grupo control. El grupo control realizó todas las pruebas sin música, el grupo experimental 1 realizó una primera sesión sin música, una segunda con música clásica y una tercera con tecno y, el grupo experimental 2, realizó una primera sesión sin música, una segunda con tecno y una tercera con clásica. Los resultados indicaron que la música seleccionada no influye significativamente en el rendimiento. El éxito atribuido a una melodía y la asociación de la música con una película es una de las cualidades más motivacionales e influye sobre el esfuerzo percibido, siendo menor con música clásica.

PALABRAS CLAVE: Música, esfuerzo percibido, rendimiento físico, motivación.

INTRODUCTION

The use of music as an aid for the acquisition and improvement of motor abilities, including the capacity to exclude irrelevant information and to focus on the task at hand, has been an area of study in recent years. Nearly all of the studies that have investigated the influence of music in sport performance have concluded that music can be beneficial in increasing the capacity of the person to minimize sensations of fatigue and effort and to focus on the task at hand in the presence of external stimuli and distraction. It should be highlighted that the rhythm of the music also can have an influence given the innate human predisposition to synchronize movements at a rhythm of greater than 100 beats per minute in which case motor movements become more efficacious and are associated with an improved physical performance (Yanguas, 2006).

In the pioneering study on this topic at the beginning of the last century MacDougal (1902) found that rhythm was the primary characteristic of music that influenced the execution of movement due to the innate tendency of humans to synchronize their movements with the rhythm of the music. For five subsequent decades no one examined this topic again until Dillon (1952) and Beisman (1967) conducted research which found that music has a role in helping to learn new motoric abilities although it wasn't until the decade of the seventies that the ergogenic effects of music were found (Lucaccini & Kreit, 1972) with the accompanying realization that the nervous systems can attend only to one stimulus at a time which could result in the delay of fatigue through the central nervous system.

In the decade of the eighties, different studies (Dowling & Harwood, 1986; Fraisse, 1982; Rosenfeld, 1985; Wilson, 1986) identified cardiac frequency as an indicator of the intrinsic rhythm of the person with the tendency for humans to prefer rhythms of 70 to 100 bpm. This line of research concluded that preference for musical rhythm is conditioned by the basal rhythm of the person given that individuals' preferred rhythm is positively correlated with their cardiac frequency (Iwanaga, 1995).

Copeland and Franks (1991) studied the effects of different types of music on the physical performance of individuals. To accomplish this study, they selected 24 healthy young and randomly placed them in three groups in which they performed a test of treadmill endurance until fatigue. The first group had musical accompaniment of high volume (75-85 dB) and a rapid rhythm, the second group had a lower volume (60-70 dB) and a slower rhythm (100 bpm) whereas the third group was the control group that performed the task without music. The investigators examined cardiac frequency, the extent of perceived exertion using Borg's scale and time elapsed until the appearance of fatigue. The researchers found that in the condition with slower rhythm that the cardiac frequency and perceived exertion were less than in the remaining conditions and the distance covered was greater in the pursuit rotor task when music accompanied the performance.

A similar study was conducted by Szabo, Small, and Leigh (1999) in which 24

participations did a cycle ergometer test in which they listened to different types of music including slower music, music with a more rapid rhythm, and music that progressed from slower to more rapid rhythms and vice versa. The results indicated that the participants attained greater pedaling force when the activity was accompanied by more rapid music. In addition, the more rapid music and music that progressed from slower to faster rhythms were preferred by the participants in doing the exercise.

In their research, Atkinson, Wilson and Eubank (2004) conducted a study with 16 male subjects who had to pedal a stationary bicycle with the goal of completing 10 kilometers of distance in the least amount of time possible. The participants were divided into two groups and performed under a condition without music during one week and a condition with music during the other week with the conditions alternated between the groups. Results revealed that the velocity, pedaling force, and cardiac frequency as well as the perception of fatigue were significantly greater in the conditions in which the participants were accompanied by music.

As Karageorghis and Priest (2012) have noted, it is possible to find numerous studies that have identified benefits of music with exercise although the majority of these studies were conducted prior to 1995 and resulted in doubts about the benefits of music principally due to methodological and theoretical limitations. In their review of the topic, Karageorghis and Terry (1997) noted that the number of studies that have examined the relationship between music and physical exercise have grown considerably in recent years.

The first conceptual framework relating the effects of music on exercise was developed by Karageorghis, Terry and Lane (1999) in which four factors were considered to affect the motivational qualities of the music: the rhythm (velocity as expressed in beats per minute), the musicality, including harmony and melody; and the cultural impact and association of the music. These characteristics are classified as internal factors (rhythm and musicality) and external factors (association and cultural impact) related to the music. According to Karageorghis and Priest (2012), of these factors the most important is considered to be the rhythm whereas cultural impact is least important. Through investigations by Crust (2008) and Priest and Karageorghis (2008), a hierarchical relationship has been established among these four factors (Figure 1) in which the motivational capacity of the music is what influences arousal level, perceptions of effort and changes in mood state. Nonetheless, there exists criticism of this model because the motivational characteristics were defined in a way that was directly comparable to the definition of Hevner (1937) of stimulating movement that is associated with a rapid tempo and throbbing pulse. An additional function of this type of music, according to Karageorghis y Priest (2012), is an increase in exercise adherence and more effective preparation routines for athletes.

These principles in which the model are based were tested through the creation of the “Brunel Music Rating Inventory” (BMRI), which was designed by Karageorghis et al. (1999) to measure the effects of music on performance.

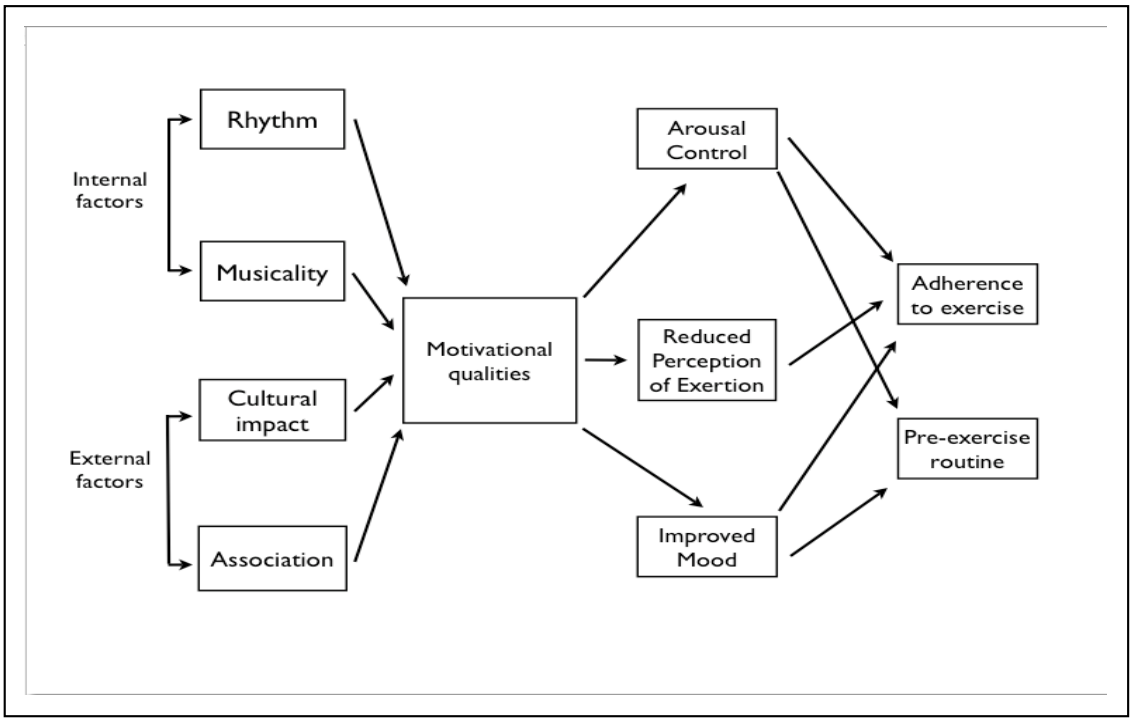
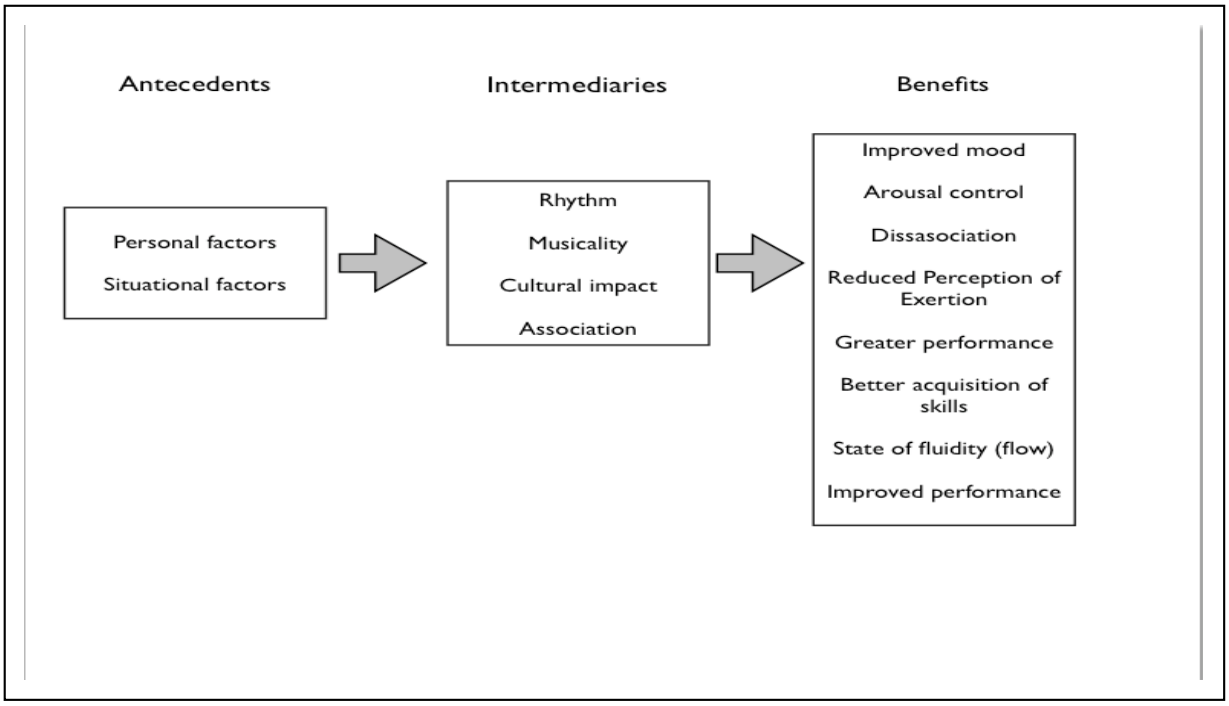


Figure 1*: Conceptual framework to explain the influence of motivational music on the performance and adherence to exercise* (Karageorghis, Terry & Lane, 1999)

This conceptual framework was revised by Terry and Karageorghis (2006) who simplified the structure of the model and augmented the potential benefits (Figure 2). This model shows incremental benefits when physical activity is accompanied by appropriate music given that the ergogenic effect of the music is greater when the physical activities demand a high level of resistance, force or output (Karageorghis, 2008).

Also included in the newer model are precursors that relate to the athlete (sex, age, personality type) and the context (situational factors that pertain to the environment in which the exercise is performed).

Figure 2. *Conceptual framework of the benefits of music on exercise and sport* (Terry & Karageorghis, 2006; Karageorghis & Priest, 2012)



In relation to these antecedents identified by Terry and Karageorghis (2006), Sloboda remarked that the influence of the music depends completely on the individual's preferences and experiences as well as on the context. On the other hand, Karageorghis and Priest (2012) mentioned that one of the current limitations to knowledge about the effects of music on exercise is due to current disagreement about the utilization of appropriate measurement instruments (e.g., electroencephalograms, magnetic resonance imaging equipment, etc.) In this regard they stated that "at times music in a social context is lived in a way that is not easy to create in experimental situations" (Karageorghis & Priest, 2012).

With regard to attentional processes, Rejeski (1985) stated that the capacity of the central nervous system is limited and can only attend to one stimulus and "when a physical activity is accompanied by music, those stimuli that are produced by physical activity can avoid the feedback processes related with physical exertion" (Karageorghis & Priest, 2012). Similarly, Hernández-Peón (1961) mentioned that music can produce pleasant feelings that can inhibit electrical activity and stimuli.

Rejeski (1985) explained that the intensity of exercise performed by the person will be related to the capacity of the music to inhibit the processing of other sensory stimuli. In those activities that demand a high level of intensity, these are the physiological signals that require processing whereas in activities of a moderate level both signals (the person's own exertion and the musical input)

can be processed in parallel. Thus, even though the music cannot alter the fatigue that is produced when engaged in activities of high intensity, it can change the perception of the person in relation to this effort.

As has been previously mentioned, humans have the innate capacity to synchronize movements with the rhythm of the music as demonstrated by Schneider, Askew, Abel and Strüder (2010). More recently studies that have used magnetic resonance techniques have shed additional light on the topic in relation to the effect of music on the brain. One of these recent studies was conducted by Korkysheva, von Cramon, Jacobsen and Schubotz (2010) who found that the activation of certain parts of the brain while listening to music (in accordance with the listener's preferences) indicates that listening to preferred music strengthens the activity in the premotor ventral cortex.

In reference to the emotional response to the music, Scherer and Zentner (2001) recognized three ways in which music can evoke emotion. First, through memory, in which the individual recalls emotional experiences associated with the music through subcortical mechanisms. The second way is through empathy which refers to the capacity of the individual to identify with the emotions of the singer and the personal meaning of the music represents the third source of emotion and relates to the person own well-being.

Karageorhis et al (1999) identified three aspects to keep in mind: the synchronization of the rhythm of the music with the rhythm of the work performed; the variations within the music in terms of maintaining interest and the volume of the music which must be adequate to ensure that the effects of the music are not minimized by other ambient sounds. In this regard, Sloboda (2008) emphasized that personal selection of music by the participant is essential since each type of music has associated personal experiences that have unique meanings to participants.

The general purpose of the present study was to examine the effects of music on physical performance, motivation and perceived exercise in relation to two different types of music: techno music and classical music. For this purpose we a) compared both styles of music to find out whether greater physical performance was associated with a constant rhythm or, to the contrary, whether results would be better through more complex forms of music; and b) to analyze the motivational components of each style of music. As such, this purpose was to determine which type of music resulted in greater stimulation during exercise. And c) to understand the relationships among musical type, performance as assessed through distance covered and perceived effort in accordance with each type of music.

METHOD

Participants

The participants in this study were Spanish athletes (n = 24) between the ages

of 15 and 50 years (*M* = 30.7; *SD* = 10.26) of whom 6 were women (29.2%) and 17 were men (70.8%). In terms of competitive level, the majority were amateurs in the sport of triathlon who had a mean power output of 495.08 W (*SD* = 150.47) on the Wingate test.

Design

An experimental design was utilized and, as such, the 24 participants that participated in the activity were divided into three groups of eight individuals who were randomly selected for the first session and then subsequently placed in following conditions based upon their results in the first trial. Each of the three groups performed the three tests by pedaling a bike with smaller wheels throughout the twenty minutes with the goal of achieving the best result possible in terms of kilometers of distance covered in the permitted time. The control group performed the three sessions without musical accompaniment; the experimental group (G1) performed the first session without music, the second with classical music and a third session with techno music; the other experimental group (G2) performed the first test without music, the second with techno music and the third with classical music. The table is provided to explain the three conditions.

Table 1. Organization of the groups and conditions

	Session 1	Session 2	Session 3
Experimental Group (G1)	No music	Music 1	Music 2
Experimental Group (G2)	No music	Music 2	Music 1
Control Group (GC)	No music	No music	No music

Apparatus and Measures

The apparatus utilized in the investigation included 10 bicycles with small wheels and distance output and were equipped with musical systems through which the music was presented over the speaker systems.

Rating of Perceived Effort (RPE; Borg, 1970). In the original version of the scale, perceived effort was analyzed through 15 items that ranged from 6-20 on the scale with “6” corresponding to “no effort” and “20” corresponding to “maximal effort”. The participants answer the stem, “How do you perceive the effort that you just completed?” and the respondents identify the number that corresponds to the effort. The RPE scale is a reliable measure of perceived physical effort and possesses very good psychometric properties and correlates well with other measures of physical exertion (Borg, 1982).

Brunel Music Rating Inventory (BMRI; Karageorghis et al., 1999) is a questionnaire with 13 items comprising four factors: rhythm, musicality, cultural impact and cultural association. These items are responded to on a scale of 1-10 (“1” = “weak motivator” and “10” = “strong motivator”. The scale was designed to assess the motivational qualities of songs. The reliability of the instrument has exceed .70 in various studies (Castellanos & Pulido, 2009;

Karageorghis et al., 1999)

Procedure

In order to recruit participants for the study, a triathlon club was contacted. Authorization was requested from the director of the club with the idea of conducting the study in one of their facilities. In the same way, informed consent was requested from each of the participants, assuring them that data of a personal nature would only be known to the investigators. Individuals who participated in the study maintained the same time schedule across the different conditions and, in this way, only the music was altered. At the time of the first session, the general purpose of the study was explained to the participants and their involvement was invited.

In relation to the characteristics of the music utilized in the present study, varied musical styles were selected in relation to the melody, the harmony, changes in intensity and rhythm, the style, instrumentation, the era of music and which would be reflected in the two styles: classical music and techno music. Nonetheless, a similar tempo was established throughout (around 150 bpm) with both the classical and the techno music with the purpose of determining whether a constant rhythm, simple and with the same melody (techno) or whether variations, including changes in intensity and harmonic composition and with more complex melodies (classical music) would have different effects. Two recordings were developed; each one designed according to the mentioned criteria, with duration of 20 minutes each and which represented a combination of musical contributions from various composers.

Statistical Analyses

Descriptive statistics (means and standards deviations) for the distances covered by each of the groups during the sessions were calculated. A repeated measures ANOVA was conducted to determine if significant differences were found in the distances covered under the different conditions and/or whether differences existed in RPE. At the same time, repeated measures analysis was conducted to determine whether the musical preferences influenced scores relative to scores the BMRI. Finally, a Pearson correlation analysis was conducted to determine whether distance covered and perceived effort were significantly correlated in these sessions in relation to the musical accompaniment. All analyses were conducted through the SPSS 19.0 statistical program for Windows.

RESULTS

Descriptive statistics and ANOVA for physical performance

Table 2 provides the means obtained for the distances covered by the participants in each of the three sessions. It can be noted that no significant differences were found between any of the groups. The control group

performed the trial without music and barely experienced a change across the tests. To the contrary, experimental group 1 improved directly on the test of the second day when they were accompanied by classical music and the third session, techno music, resulted in worse results than in the first session.

Experimental group 2 bettered their performance in each session with an improvement from the no music condition to the techno music condition and the classical music condition. These results indicate that the best results were obtained under the classical music condition although these differences were small and nonsignificant.

Table 2. Descriptive data and ANOVA analysis for distance covered in each type of music

	1ª SESSION	2ª SESSION	3ª SESSION	*F*
Control Group	NO MUSIC	NO MUSIC	NO MUSIC	
M (DT)	9.85 (1.66)	9.81 (1.58)	9.85 (1.69)	.187
G. Experimental 1	NO MUSIC	CLASSICAL MUSIC	MUSIC TECNO	
M (DT)	9.62 (2.33)	9.81 (2.33)	9.38 (1.86)	.137
G. Experimental 2	NO MUSIC	MUSIC TECNO	MUSICA CLÁSICA	
M (DT)	10.21 (1.74)	10.26 (1.97)	10.38 (1.67)	.655

ANOVA on the motivational variables

Motivation was also examined through the BMRI in relation to the qualities and characteristics of the music with the understanding different types of music can have greater or lesser stimulating effects. Table 3 shows the results obtained for the different items obtained with the BMRI in relation to the types of music. Statistically significant differences were found on nine of the thirteen items, specifically familiarity ($t = 2.76$, $p = .014$), tempo ($t = 2.34$, $p < .033$), rhythm ($t = 2.63$, $p < .019$), association of the music with the sport ($t = 2.83$, $p < .013$), success of the song ($t = 4.96$, $p < .000$), association of the music with a movie or video ($t = 6.95$, $p < .000$), harmony ($t = 2.51$, $p < .025$), melody ($t = 2.76$, $p < .015$) and stimulating quality of the music ($t = 2.55$, $p < .022$). It should be noted that greater values were obtained in each case for the classical music selections.

Table 3. Mean differences on BMRI according to type of music

	CLASSICAL MUSIC	TECHNO MUSIC	
	M (SD)	*M (SD)*	*t*
Familiarity	7.38 (1.92)	4.81 (2.19)	.2.76*
Tempo	7.75 (1.98)	5.75 (2.29)	2.34*
Rhythm	8.25 (1.73)	6.13 (2.15)	2.63*
Lyrics	1.73 (2.41)	2.00 (2.19)	-.25
Association with sport	7.50 (1.89)	4.81 (2.81)	2.83*
Success	7.81 (1.79)	3.88 (2.18)	4.96***
Association with a film	8.20 (2.00)	2.87 (2.13)	6.95***
Interpretation	1.36 (0.50)	2.18 (1.72)	-1.63
Harmony	4.27 (2.49)	2.13 (1.72)	2.51*
Melody	5.67 (3.08)	2.80 (2.36)	2.76*
Stimulating quality	7.88 (2.12)	5.06 (2.86)	2.55*
Danceability	6.56 (2.52)	4.38 (2.77)	1.72
Éra	4.88 (2.41)	4.25 (1.94)	.87

* $p < .05$; ** $p < .01$; *** $p < .001$

Correlational analysis between distance covered and perceived effort relative to the different types of music

Finally, a Pearson correlational analysis was conducted (Table 4) between the distance covered and the exertion perceived in each of the tests. A negative correlation was found in each of the tests conducted whereby a greater distance covered by the participants was associated with a lower perceived exertion. If we conduct separate analyses for each of these sessions in relation to musical accompaniment the obtained results were statistically significant in the session without music and with classical music with the strength of correlation notably greater in the latter condition. These data reveal that with classical music the perceived exertion was significantly lower in relation to distance covered.

Table 4: Correlations between distance covered and perceived effort according to music type

	PERCEIVED EFFORT WITHOUT MUSIC	PERCEIVED EFFORT CLASSICAL MUSIC	PERCEIVED EFFORT TECNO MUSIC
DISTANCE NO MUSIC	-.457***		
DISTANCE CLASSICAL		-.661******	
DISTANCE TECHNO			-.397***

* $p < .05$; ** $p < .01$; *** $p < .001$

DISCUSSION

The present investigation has intended to identify the effects that music can have on physical performance in a concrete situation with specific attention directed toward identifying differences in two types of music: classical music and techno music.

Influence of music on physical performance

To develop the study, a selection of music that is similar in tempo and pulse but different in type of music and in other characteristics such as melody, harmony, complexity of the work, intensity and variation was conducted. In this sense, the obtained findings revealed that there were not significant differences present in relation to type of music in terms of greater or lesser physical performance as has been found in previous studies (Molinari, Leggio, De Martin, Cerasa & Haut, 2003; Szabo, Small & Leigh, 1999). This finding could be due to the fact that many of the athletes examined, especially those whose physical performance results were the best, are accustomed to training without music such that they already have an established rhythm of work and knowledge about how to manage their effort. Given that the amount of distances covered were not significant we found that examining the more competent athletes yielded results that were less relevant.

Influence of the music on motivation

On the other hand, motivation has been studied through the BMRI in relation to the motivational effects of the different types of music. These results reveal that it is the melody of classical or techno music as opposed to the absence of the same that has the motivational effect on the athletes. The BMRI findings also revealed that the athletes felt more motivated principally through the association of the music with classical works connected to a video or film. These characteristics follow the harmony, the melody, the stimulating quality of the music and the familiarity of the classical music piece as opposed to techno music, highlighting among the significant differences the rhythm and the danceability again in favor of the classical music. These results obtained are controversial given that one study (Hagen et al., 2013) in this line of research indicates that certain types of music are considered more motivational by athletes. Nonetheless, other studies (Bishop, Karageorghis y Loizou, 2007; Brooks y Brooks, 2010) have found contrary results relative to the effects of motivational music on performance. As such it is necessary to explore further about the motivational bases of different types of music.

Sensations perceived according to type of music

Various classical music pieces can be associated with feelings of accomplishment and vigor at moments of greater effort. The classical work included was selected specifically to test the level of acceptance of a piece that maintained constant rhythm (< 150 bpm). On the other hand, even though the techno music was more contemporary and in style, this type of music was not identified as being popularly successful or familiar to participants. This finding echoes Karageorghis, Terry and Lane (1999) in which not only the rhythm of the music has a motivational effect but also the musicality (harmony and melody) as well as the cultural association of the music and the evocation of images extraneous to the music. Nonetheless, it is necessary to report that the findings

of this study differ from those obtained by Karageorghis and Priest (2012) who found that rhythm is the most important determinant of the motivational process and extraneous musical images are the least important. As Sloboda (2008) commented, the listener's musical preference and the context of the music is essential to the experience.

CONCLUSIONS

The conclusion of this study was that music did not significantly affect the physical performance of the athletes who participated although the characteristics of the participants should be considered. Nonetheless, the influence of the music was reflected in the mood state of the participants as well as in the amount of exertion that they perceived. More concretely, the athletes whose training was accompanied by classical music covered a greater number of kilometers and perceived less exertion. Finally, the classical music resulted in being more motivational for the athletes as opposed to the techno music condition or the control condition.

Limitations

One major limitation of the study pertains to the sample used and the wide age range of the participants. Although age was not a primary consideration within the study, it would have been beneficial to have a more homogenous group in relation to age. The reason is that there might be possible differences in liking of particular types of music in accordance to age.

A second limitation has been that the participants had knowledge of their results from the previous training session(s) and could have attempted to surpass their performance on each occasion. A third limitation consisted of the difficulties that the participants had in understanding some of the terminology referred to in the BMRI.

Future investigations

Future investigators can consider including sports of different type of different types of physical activity in their research on the physical performance effects of music. It is suggested that studies with elite-level athletes might be beneficial. In this sense, there are alternative ways to examine training performance and intensity of the training. It would also be interesting to consider conducting these studies among individuals of particular ages (older individuals, younger children) to determine for which groups of people music can have a beneficial effect upon exercise adherence. Finally, it would be worthwhile to examine the effects of music not just on performance but also upon psychological variables such as mood state, psychological well-being, concentration, alertness and the like.

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ANEXO

Brunel Music Rating Inventory (BMRI)

	Weak Motivator									Strong Motivator
1. Familiarity	1	2	3	4	5	6	7	8	9	10
2. Tempo (pulse)	1	2	3	4	5	6	7	8	9	10
3. Rhythm	1	2	3	4	5	6	7	8	9	10
4. Lyrics associated with the music	1	2	3	4	5	6	7	8	9	10
5. Link between the music and sport	1	2	3	4	5	6	7	8	9	10
6. Popular success of the song	1	2	3	4	5	6	7	8	9	10
7. Link between the song and a movie	1	2	3	4	5	6	7	8	9	10
8. Singer	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. Stimulating quality of the song	1	2	3	4	5	6	7	8	9	10
12. Danceability	1	2	3	4	5	6	7	8	9	10
13. Era of the music	1	2	3	4	5	6	7	8	9	10

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Número de citas propias de la revista / Journal's own references: 0 (0%)