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Musical stimuli and performance of university students in a deep pool running protocol

Estímulos musicais e desempenho de estudantes universitários em protocolo de corrida em piscina profunda

Estímulos musicales y rendimiento de estudiantes universitarios en un protocol de Carrera en piscina profunda

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Abstract

This study aimed to analyze the effects of musical stimuli on university performance through heart rate and Rate of Perceived Exertion as a function of a running protocol in deep water. The sample consisted of 18 women aged between 18 and 30 years (23.44 ± 3.42) from Mossoró/RN. Participants were assessed on two separate days, one day with musical stimulation and the other without the stimulus. At the end of each stage reached within the test, the Heart Rate and Rate of Perceived Exertion of each participant were measured before the beginning of the next stage. To compare the performance variables with and without musical stimuli, the paired "t" test. $p<0.05$. The results showed that they do not present relevant differences in Heart Rate and Rate of Perceived Exertion with and without music, except in stage 1 ($p=0.045$) and stage 3 ($p=0.048$) for Heart Rate. It is concluded that the use of music as a stimulus in the performance of university students through a running protocol in a deep pool is a valid strategy for reaching maximum effort or continuity at a moderate/high intensity in the aquatic environment.
Keywords: Musical stimuli; Performance; Water actives; Health.

Resumo

Este estudo teve como objetivo analisar os efeitos de estímulos musicais no desempenho universitário por meio da frequência cardíaca e da taxa de percepção de esforço em função de um protocolo de corrida em águas profundas. A amostra foi composta por 18 mulheres com idade entre 18 e 30 anos (23,44 ± 3,42) de Mossoró/RN. Os participantes foram avaliados em dois dias separados, um dia com estimulação musical e outro sem o estímulo. Ao final de cada etapa alcançada dentro do teste, a Frequência Cardíaca e a Frequência Percebida de Esforço de cada participante foram medidas antes do início da próxima etapa. Para comparar as variáveis de desempenho com e sem estímulos musicais, o teste "t" pareado. $p<0,05$. Os resultados mostraram que não apresentam diferenças relevantes na Frequência Cardíaca e Frequência Percebida de Esforço com e sem música, exceto no estágio 1 ($p=0,045$) e estágio 3 ($p=0,048$) para Frequência Cardíaca. Conclui-se que o uso da música como estímulo no desempenho de estudantes universitários por meio de um protocolo de corrida em piscina profunda é uma estratégia válida para atingir o máximo esforço ou continuidade em intensidade moderada/alta no meio aquático.
Palavras-chave: Estímulos musicais; Performance; Atividades aquáticas; Saúde.

Resumen
Este estudio tuvo como objetivo analizar los efectos de los estímulos musicales sobre el rendimiento universitario a través de la frecuencia cardíaca y la Tasa de Esfuerzo Percibido en función de un protocolo de carrera en aguas profundas. La muestra estuvo compuesta por 18 mujeres con edad entre 18 y 30 años (23,44 ± 3,42) de Mossoró/RN. Los participantes fueron evaluados en dos días separados, un día con estimulación musical y el otro sin estímulo. Al final de cada etapa alcanzada dentro del test, se midió la Frecuencia Cardíaca y la Tasa de Esfuerzo Percibido de cada participante antes del inicio de la siguiente etapa. Para comparar las variables de ejecución con y sin estímulos musicales se utilizó la prueba de la "t" pareada. p<0,05. Los resultados mostraron que no presentan diferencias relevantes en Frecuencia Cardíaca y Frecuencia de Esfuerzo Percibido con y sin música, excepto en el estadio 1 (p=0,045) y estadio 3 (p=0,048) para Frecuencia Cardíaca. Se concluye que el uso de la música como estímulo en el rendimiento de los universitarios a través de un protocolo de carrera en piscina profunda es una estrategia válida para alcanzar el máximo esfuerzo o la continuidad a una intensidad moderada/alta en el medio acuático.
Palabras clave: Estímulos musicales; Actuación; Actividades acuáticas; Salud.

1. Introduction

Sedentary behavior results in a negative impact on the population's life, causing an increase in mortality, obesity, cardiovascular diseases, cancer, type 2 diabetes and damage to human development. In addition, the highest levels of physical inactivity have a deleterious correlation with frailty, the longer the individual has inactivity, the greater his physical frailty. In contrast to this, individuals who practice physical activity from the lightest levels already show a lower rate of diseases and health harm. (Kehler & Theou, 2019; Sousa et al., 2021)

A sedentary lifestyle has been one of the main causes of worsening global health, accompanied by several physical and mental problems, thus making the practice of physical activity an important instrument for reducing a sedentary lifestyle (Laclaustra et al., 2014; Peng & Zhao, 2000; Silva Junior et al., 2021). The practice of physical exercise associated with healthy habits provides improvements for people's lives, especially disease prevention (Gomes et al., 2020; Panter et al., 2018; Sadeh, 1988).

It started at the beginning of time because primitive man ran to hunt and not to be hunted. Due to this way of life, humans must have fallen into water many times, intentionally or not, to develop in an aquatic environment. Water sports have been continuously developed according to human needs, given the large number of people who like to exercise in a liquid environment, water sports are one of the most used sports in gyms and clubs (Kargarfard et al., 2018).

The physics of water, the physiological effects of immersion on the body, and the physiological response to exercise in an aquatic environment are important resources. As for its properties, water has density, it is understood as the quantification of the mass occupied within a given volume, as far as it is concerned, the fluctuation is based on an Archimedes principle that says that a body immersed completely or part of it in liquid, undergoes an upward thrust, equal to the weight of the displaced liquid, hydrostatic pressure is conceptualized as a force applied to a certain area of the body and can be given in Newtons, viscosity meets a principle called surface tension exerted on water and other liquid media and temperature (Silva et al., 2019).

As for its physiological effects, various patterns have been identified in aquatic activities that promote health and well-being, it is essential to understand how the human body responds to a liquid environment. The two main reasons that differentiate the physiological responses of air and aquatic environments are the hydrostatic effects on the cardiovascular system and the increased heat loss from water, which is approximately 25 times greater than air (Adsett et al., 2015; Bloedow et al., 2021; Thon et al., 2022)

Aquatic training is an activity well tolerated by sedentary adults, where physical capacity can be increased, as well as the health-related quality of life of these individuals. Since this training category can be applied to reduce pain and disability in sedentary individuals, presenting positive changes with regard to body composition and physical performance, an improvement in cardiorespiratory fitness and a significant increase in VO2MAX can be seen. (Baena-Beato et al., 2014).

An important tool for increasing exercise adepts is physical activity in an aquatic environment, which allows for metabolic improvements as well as cardiorespiratory improvement and less impact on joints (Azevêdo et al., 2008; Kanitz et al., 2014; Medeiros et al., 2016; Nagle et al., 2015; Tsitkanou et al., 2017). Research shows that the aquatic environment, compared to the terrestrial, decrease the maximum heart rate and the average heart rate obtained in exercise concerning the positioning of the body in the water, the depth, and temperature of the water, thus making it very advantageous in cases of pathologies, considering that the use of the aquatic environment brings a hydrostatic pressure which lowers blood pressure and improves venous return (Graef & Kruel, 2006; Nakanishi et al., 2004; Ritchie & Hopkins, 1991), relevant features in rehabilitation (Carregaro, 2008). Findings also concluded that running training in a deep pool causes a decrease in heart rate during activity, making it usual in special groups with heart problems (Graef & Kruel, 2006; Nakanishi et al., 2004; Ritchie & Hopkins, 1991).

Running in deep pools has been the most popular aquatic practice among runners during periods of injury due to less physical stress caused by this environment (Ritchie & Hopkins, 1991). The reduced impact on joints is of great value to the population obese, considering that continuous or interval training, such as running in deep pools, shows satisfactory results in the weight loss of this population (Pasetti et al., 2012).

In addition to the existing potential of physical exercise, intrinsic and extrinsic stimuli during its practice improved the performance and the level of motivation and affectivity of practitioners (de Oliveira et al., 2018; Jones et al., 2017; Stork et al., 2015). The use of music stimuli is of great relevance because it contributes to the adhesion and permanence of the population that practices some type of physical exercise in this habit (Stork et al., 2015) , also causes the feeling of involvement and intrinsic motivation in practitioners so they can bear more of the effort and achieve better results (Carneiro & Bigliassi, 2010; Ortín et al., 2018; Souza & Silva, 2010).

However, it is believed that exercising in aquatic environments still needs better strategies to involve the population. Thus, the use of auditory music stimuli would allow greater motivation, acceptance, continuity in the modality, and consequently, an increase in performance.

Therefore, this study aims to analyze the effects of musical stimuli on the performance of university students submitted to a deep pool running protocol.

2. Methodology

Participants

This research characterizes as descriptive, because it explores relations between two or more variables with the same subjects, having in view that the problems here found can be solved through observation, analysis and objective description made by the evaluator (Peaira et al, 2018;J. R. Thomas et al, 2009).

The sample consisted of 18 female students (23.44 ± 3.42) from the Mossoró/RN, Brazil. The university students were supposed to be active, had favorable health conditions based on the risk factors verified by the Physical Activity Readiness Questionnaire (PAR-Q), not participated in a training program in the last four months, and had experience in the aquatic que environment (S. Thomas et al., 1992).

The research was approved by The Human Research Ethics Committee from Rio Grande do Norte State University, Mossoró, RN, Brazil, approved the study protocol n. 3.932.429. All the participants signed an informed consent form to participate in this study, confirming their participation as a volunteer. The study was conducted in accordance with the ethical guidelines outlined in the Declaration of Helsinki and the ethical standards of The Journal Of Sports Medicine And Physical Fitness (Harriss et al., 2019).

Study design

A heart rate monitor (FT1, Polar, Finland) with a waterproof coded transmitter belt was used to measure the heart rate before (HRpre) and after (HRpost) each test.

For measuring the rating of perceived exertion (RPE), we used the Modified Borg Scale for swimmers, which corresponds to the monitoring of the training intensity performed by the individual, who was already known and familiar with the individuals evaluated. (Maglischo & do Nascimento, 1999). The evaluator, at the end of the test, presented an illustrative table graduated from 1 to 10 where each number corresponded to the intensity of the exercise and the effects of training. The participants listed the level of effort performed in that task using this scale, where 1 corresponds to very low intensity, usually used in the warm-up, and 10 corresponds to the extremely difficult effort.

A Figura 1 mostra o cronograma de coleta do batimento cadíaco e PSE dentro do teste em relação oos estágios que a parcipante alcançava durante a coleta.

Figure 1. Mesurement of HR and RPE.

Source: Own authorship.

The tests were performed in a 25-meter pool, at a scheduled time, according to the availability of the participants so the test would not interrupt the course of classes/training considering that these would already be within their daily routine at the university. The meetings occurred in two different days for each participant with 48 h of resting.

On the first day, the university students received explanations about the procedures and started by keeping the body submerged only with the head above the water for 5 minutes to stabilize their heart rate. The participants who had experience in the aquatic environment, were familiarized with the running test with a 2-minute warm-up at 80 cycles per minute (CPM) (Silva et al., 2010), a measure referring to the steps performed in the water by the evaluated person. A metronome with visual signals that flash at the speed proposed by the protocol helped in the cadence of the rhythm of each stage. A float vest was attached to the subject's waistline and tied to the edge of the pool using a rope tied to the vest, preventing horizontal displacement. The protocol begins with an intensity of 100 CPM, where at each stage 4 CPM is added, continuing this way until the individual becomes fatigued or fails to perform the movement. Each stage lasts for 1 minute according to the protocol applied. On that test day, the student had a musical auditory stimulus. The songs used in the test were chosen by each evaluated, where they had a playlist they needed. As the intention was to use music as an ergogenic effect during exercise, we allowed those evaluated to bring music that would increase their level of physical performance (Carneiro & Bigliassi, 2010). After the end of each step performed by the participant, the HR and the PSE seen at the end were collected. At the end of the test, the maximum stage she reached in the protocol was noted and a 5 min cooldown lap at 40 CPM was performed

On the second day, the participants once again performed the deep pool running protocol, following the same parameters as the first day, except for musical stimuli.

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Statistical analysis

After data collection and tabulation, a descriptive analysis was performed using measures of central tendency and dispersion (mean and standard deviation) after normality and homogeneity identification using Shapiro-Wilk and Levene's tests, respectively. To compare the performance variables with and without musical stimuli, the paired "t" test was used. Data were analyzed using the SPSS statistical package for Windows (v 20; IBM Corporation, Armonk, NY). All variables were considered for a significance level of $p < 0.05$.

3. Results

Table 1 presents the data regarding the Heart Rate of university women submitted to a running protocol in a deep pool, with and without musical stimuli.

Table 1. Heart Rate with and without musical stimuli correlated with the stages reached in the test.

Stages	HR with music			HR without music			Sig.
	n	x	s	n	x	s	
Resting	18	81	7,2	18	81,06	7,0	0,974
Warm up	18	111,22	13,0	18	106,11	8,73	0,063
1	18	144,33	15,3	18	136,28	16,88	0,045*
2	18	155,18	17,1	18	149,83	18,04	0,128
3	17	163,47	15,824	16	155,06	17,88	0,048*
4	12	164,08	15,072	12	158,58	18,44	0,249
5	10	167,40	18,56	8	157,38	18,84	0,378
6	6	166,17	14,14	4	159,75	14,9	0,922
7	5	172,60	15,630	1	157	-	-
8	-	-	-	1	165	-	-

X: mean; s: Standard deviation. * statistically significant p<0,05. Source: Own authorship.

Nota-se que em apenas dois estágios a frequência cardíaca mostrou diferença significante que foram o 1 e o 3, porém o momento 2 onde não houve música como estímulo externo os resultados obtidos foram menores que o momento 1.

Table 2 highlights the RPE answered at the end of the stages of the deep pool running protocol applied to university women.

Table 2. RPE with and without musical stimuli correlated with the stages reached in the test.

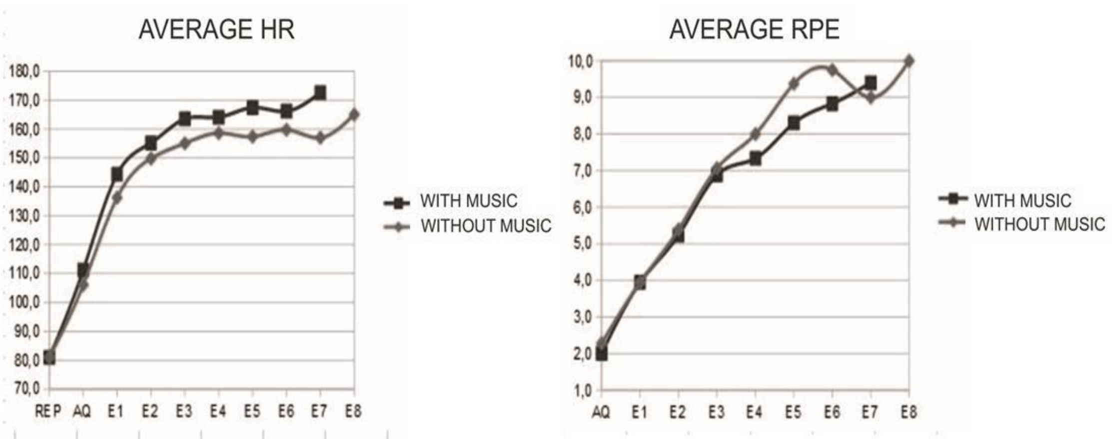
Stage	RPE with music			RPE without musica			Sig
	n	x	s	n	x	s	
Warm up	18	2	1,02	12	2,28	1,36	0,384
1	18	3,94	1,69	18	3,94	1,39	1,000
2	18	5,24	1,64	18	5,39	2,3	0,903
3	17	6,88	1,53	16	7,06	1,61	0,493
4	12	7,33	1,15	12	8	1,8	0,510
5	10	8,30	1,25	8	9,38	0,74	0,172
6	6	8,83	0,5	4	9,75	0,50	0,667
7	5	9,4	0,55	1	9	-	-
8	-	-	-	1	10	-	-

X: mean; s: Standard deviation. * statistically significant p<0,05. Source: Own authorship.

There were no significant differences between the stages with and without musical stimuli in the applied protocol. Porém diferente da tabela 1, a PSE do momento 1 se manteve menor que a do momento 2 em todos os estágios do teste.

Figure 2 highlights the curve of mean values of HR and RPE in the stages of the deep pool running protocol in university women.

Figure 2. Comparison of HR and PRE values of groups with and without musical stimuli.



Source: Own authorship.

It was observed that musical stimuli allow a longer exercise execution time at high intensity, even with a higher heartbeat in the results without stimulus, the perceived exertion was decreased in relation to intensity, unlike the results obtained with no musical stimulus.

4. Discussion

There is a tendency for lower values of RPE with music, but the results are non significant. The existence of music in the activity allowed university women to reach the maximum of their performance with a RPE lower than when there was no music during the exercise. Thus, the results suggest that musical stimuli allow a lesser sensation of effort compared to the same level of intensity without stimuli.

As for the results presented in Table 1, we can observe linearity in the increase in heart rate according to the progression of stages in a deep pool running protocol (Silva et al., 2010). On the other hand, the significant differences verified in two of the HR stages, in Stage 1, possibly occurred due to the second day of tests, since participants would already be adapted to the protocol and thus performed the movement better (Coelho et al., 2007). In Stage 3, the bigger number of university students reached exhaustion, considering that with the help of music, the HR would be higher, as the effects of such stimuli enhance performance, minimizing the feeling of tiredness (Carneiro & Bigliassi, 2010). It was also possible to observe that those evaluated, even reaching maximum performance, their beats were not high if compared to tests performed outside the aquatic environment, probably because the activity is immersed and causes a significant decrease in the maximum heart rate (Graef & Kruel, 2006).

The RPE observed in Table 2 highlights that, with the increase in intensity, music becomes a factor in reducing the sensation of exerted effort (de Oliveira et al., 2018; Ortín et al., 2018). They also demonstrate that, even with the help of musical stimuli, a bigger number of women managed to reach higher stages of the test without the use of stimuli, noticing less effort imposed by the test when they listened to their favorite motivational music. Although there are no significant differences in the stages with and without music in RPE, it is possible to say that music was an influencing factor in the participants' performance (Souza & Silva, 2010).

The curve performed by the averages of HR and RPE of the participants observed in Figure 2, unlike the HR where from E3 the results stabilize, the findings regarding RPE continue to increase, and it is possible to see the difference in results between the test performed with the aid of musical stimuli and without them. Another finding to be considered is the inversion of the result of the graph referring to HR and RPE, wherein the HR graph the test without music obtained lower results than those in the existence of music. On the other hand, in the RPE graph, the result was the opposite: RPE values were higher in the absence of musical stimuli. Thus, by using music stimuli during the activity, it is possible to reach its maximum performance with a lower perception of effort when compared to the absence of music (Stork et al., 2015).

The following limitations of the study were considered: the difficulty in monitoring the participants performance due to water refraction; the method for controlling CPM elevation, as the visual signals were not so well understood in the test as the cadence could be within the chosen songs; control of the menstrual cycle to check the best period for carrying out the protocol; the application of other analysis variables, such as respiration and biochemical analysis, such as the measurement of lactate, for a better evaluation of performance in tests

5. Conclusion

The study concluded that the use of music as a stimulus in the performance of university students through a running protocol in a deep pool is a valid strategy for reaching maximum effort or continuity at a moderate/high intensity in the aquatic environment. Reminforcing the importance of the present study and continuity of future research, for the highest comprehension of the subject.

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