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Sport Performance

Explorando la Intensidad de la Música en la Frecuencia Cardiaca, Esfuerzo Percibido y Rendimiento Físico Durante el Ejercicio Sub-Máximo

Exploring Music Intensity on Heart Rate, Perceived Exertion and Physical Performance During Sub-Maximal Exercise

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RESUMEN

El objetivo de este estudio fue determinar si la frecuencia cardiaca (FC), el esfuerzo percibido (EP) y el trabajo realizado (TR) están influenciados por la intensidad de la música, de acuerdo a la hipótesis de que a mayor volumen de música mejor es el rendimiento físico. Se comprobó la influencia que tiene la música en 11 personas que se ejercitaron por 30 minutos en cicloergómetro bajo tres condiciones aleatorias: música a 65 decibeles (65 dB), música a 95 dB (95 dB) y una condición control sin música (SM). Se encontraron diferencias entre condiciones en la FC (SM < M95; p=0.047) y en mediciones en EP (p=0.001), más no se hallaron efectos simples en TR para condiciones (p=0.085) y mediciones (p=0.138). Estos datos muestran que las personas realizan la misma cantidad de trabajo en condiciones de música a volumen moderado (65 dB), muy alto (95 dB) y una condición control sin música (SM), sin embargo, los sujetos mantuvieron una mayor FC durante la condición 95 dB (162.8 ± 5.0 lpm) comparado con SM (154.3 ± 4.3 lpm). La música a volumen alto no mejora el rendimiento físico.

Palabras Clave: cicloergómetro, decibeles, tempo, volumen

ABSTRACT

The purpose of the study was to determinate if the heart rate (HR), the rating of perceived exertion (RPE) and the physical performance (PP) are influenced by the music intensity, according to the hypothesis of some fitness instructors that the higher volume on the music, the better the performance or effort. The study proved the influence that had the music in 11 volunteers working out for 30 minutes on a cycloergometer by 3 random conditions: 65 decibels music (65 dB), 95 decibels music (95 dB) and a non-music (NM) control condition. The study found differences between the HR conditions (NM < 95 dB; p=0.047) and in RPE measurements (p=0.001), but it weren't found mean effect in PP for conditions (p=0.085) and in measurements (p=0.138). These data tell us that people do the same quantity of work out with medium intensity music (65 dB), with high intensity music (95 dB) and without any music. Certainly, the volunteers maintained a higher HR during the 95 dB condition (162.8 ± 5.0 bpm) comparing with NM condition (154.3 ± 4.3 bpm). Music at high volume does not improve physical performance.

Keywords: cycloergometer, decibels, tempo, volume

INTRODUCTION

Since the antiquity, the music has been a very important part in our history in different cultures. It surged for the communication and expression need to the gods (rain, fire, food, heal, etc.). Now, this combination of harmonic sounds has been studied in relation with the human body, with the intention of knowing how does the brain understands and organize the music and, through that, determinate the effects caused in the exercise performance.

The music has been so common in the people daily life that using it for exercising it won't be something new. This happens because the fatigue feeling that can be recognize by the brain gets detour by the music, been the music classified as a motivational factor and of ergogenic influence during the sport practice or any exercise activity (Brooks & Brooks, 2010).

Some studies proved that listening preferred music helps the sports practice, decreasing the perceived exertion and increasing motivation, becoming this an improvement for performance (Karageorghis, Jones, & Stuart, 2008). Other authors mention that the music perception comes in an intrinsic way, becoming this in an intern rhythm of the body (Montero-Herrera, & Aburto-Corona, 2015; Karageorghis, Jones, & Low, 2006). Therefore, if the music can be perceived it also can be performed, what gives by results an interaction between the psychological (emotions) and the physical (sports performance) (Soria-Urios, Duque, & García-Moreno, 2011).

A very important aspect of music that has not been deep investigated, it is the intensity, using decibel (dB). As already mentioned, the music in the physical performance has multiply benefits, however, high sound volumes can generate ear damages, that acquire losing this sense (in a temporary or permanent way) (Alessio, & Hutchinson, 1991; Aragón-Vargas, & Marín-Hernández, 2000).

In agreement with Eileen (2007), starting the 85 dB and up, the music may affect the hearing if this is heard for a prolonged time. An intensity equal to or greater than 110 dB starts to cause instant pain and damage. However, there is a high population of adult people that like listening music above 85 dB for long periods of time (Levey, Levey, & Fligor 2011).

Once the music travels by the human earing, it is directly processed at the auditory cortex. The sound, in dependence of the volume, it may generate stress that brings out mental fatigue (Soria-Urios, Duque, & García-Moreno, 2011). At that time, how does the music intensity affect the physical performance? Taking into consideration that the mental fatigue may lead also a muscle fatigue.

The objective of this investigation is to determine if there is an influence between the heart rate (HR), the rating of perceived exertion (RPE) and the physical performance (PP) with the music intensity. With this, the investigation wants to prove if the better performance at higher intensity theory of the gym trainers it's true, mentioned by Aburto and Aragón (2013).

METHODS

Subjects

Eleven students (males and females) physically actives from the Sports Faculty, of the Autonomous University of Baja California, Tijuana campus (table 1) participated in the study . It was requested to sign (once read) a physical activity ability questionnaire and an informed consent application.

Table 1. *Subjects characteristics (mean ± SD).*

	N	Age (years)	Height (cm)	Weight (kg)
Males	8	21.3 ± 2.1	171.2 ± 5.7	75.9 ± 15.0
Females	3	20.7 ± 0.6	155.6 ± 7.0	55.6 ± 9.3
Total	11	21.1 ± 1.8	166.5 ± 9.4	69.9 ± 16.3

Material

- Cycloergometer (LODE Sport Excalibur, Groningen, Netherlands).
- Heart rate monitor (Polar FT1, Kempele, Finland).
- Music player (QFX SBX-1201BT).
- Music software (Virtual DJ 8).
- Sound level meter (Mastech MS6700, Guangdong, China).
- Tympanic thermometer (Braun ThermoScan Pro 4000, Kronberg, Germany).
- Perceived exertion table (CR10 scale) (Borg, 1998).
- Music. It was requested to the subjects their preferred music to play while exercising. It was standardized a 128 ± 5 beats per minute tempo (using the Virtual DJ 8 software). Mentioning also that every subject had their own playlist, listened at the same order during the random conditions.

Protocol

Through an experimental design of repeated measures (conditions and 3 measurements), the subjects were invited to assist 4 sessions to the Faculty of Sports Biosciences of human motricity laboratory . All sessions in every subject were separated by at least 48 hours in a room of 23.4 ± 0.8 °C degrees and a 49.5 ± 3.1% relative humidity.

The first session was to familiarized and adapt the subject to the test. For this, measurements of the sit and the handle were taken (according with the physic characteristics and the subject comfort) for the future sessions. Also, the subject exercised on the cycloergometer experimenting different power (potency) during 15 minutes.

The next 3 sessions were tested and assigned in a random way: 65 dB music condition (65 dB), 95 dB music condition (95 dB) and non-music condition (NM). Before beginning every session, the subject warmed up on the cycloergometer for 3 minutes (with a 70 watts potency and *ad libitum* cadence). After that, the test started initiating with a power outpot of 70 watts, and every 3 minutes subjects were asked if they wanted to change the power (increase, decrease or maintain). This was made with the purpose of facilitating as they were changing speed on a regular condition of a common bicycle or a stationary. They realized 30 minutes of continuous exercising, where every 10 minutes HR, RPE and PP were tested (it were given indications that the effort was ad libitum). At the end of the session, there was a cool down until the normalization.

The tympanic temperature (TT) and the initial heart rate (iHR) were taken before every session, with the objective of determining if every subject came in the same condition during the experiment.

To distract the attention of the music they were given 100 ml of an artificial colorant drink (blue and red dye), however, they were mention of our purpose with evaluating the physical performance through the cycloergometer.

All the subjects were evaluated throw out the day at the same time in different conditions. They were asked to not ingest any food or drinks considered diuretics, also, they were given indications to at least drink 1lt of water the night before (to prevent hypohydration) (Nuccio, Barnes, Carter & Baker, 2017).

Statistical analysis

Means and standard deviation were first computed for age, height and weight (table 1). They were made 2 ANOVA of one-way of repeated measurements (3 treatments) for TT and iHR, also, 3 ANOVA of two-ways with repeated measurements (3 treatments - 3 measurements) for the HR, RPE and PP. To determinate difference, between tests, a post hoc tuckey was realized, using the SPSS version 21,0 software taking a value of significance same or less to 0.05.

RESULTS

No significant differences were found in TT between the conditions (65 dB, 95 dB and NM), same way, it weren't found significant differences at the iHR (table 2). Thus , the subjects that volunteered the study came in the same physiological way in every different experimental condition.

Table 2. *Mean and standard deviation (±) of tympanic temperature (TT) and initial heart rate (iHR).*

	65 dB	95 dB	NM	F	p =
TT (°C)	36.6 ± 0.6	36.7 ± 0.3	36.4 ± 0.3	1.596	0.219
iHR (bpm)	80.5 ± 19.7	76.3 ± 12.7	71.0 ± 13.1	1.044	0.365

It were found an absence at the interaction between HR measure and condition (p= 0.317), however, it was found differences in the condition (NM < 95 dB; p=0.047) and measure (minute 10 and 30; p=0.017 and 20 and 30; p=0.039) variables (figure 1).

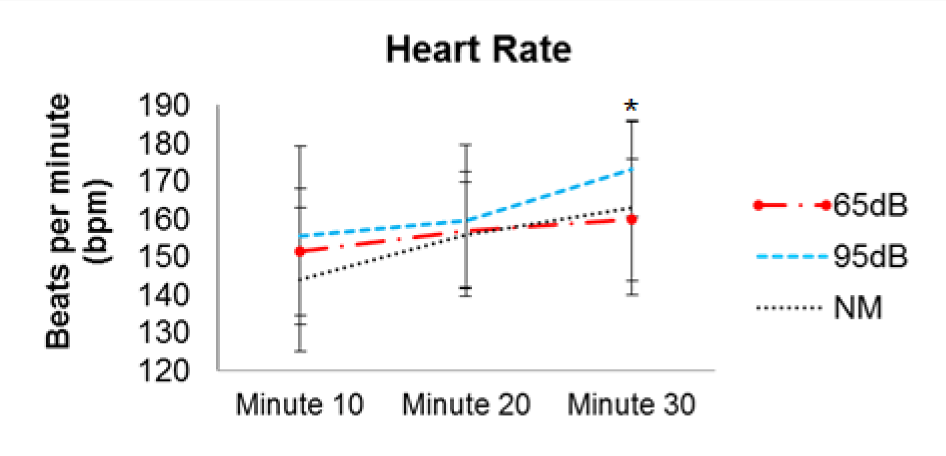

Figure 1. *HR between conditions and measurement: NM < 95 dB (p=0.047*), minute 10 < 30 (p=0.017) and minute 20 < 30 (p=0.039).*

Statistic significant differences ere found in the RPE variable between the measurements (minutes 10, 20 and 30) (p=0.001), but not between conditions (p=0.644). The interaction was shown absent (p=0.937) (figure 2).

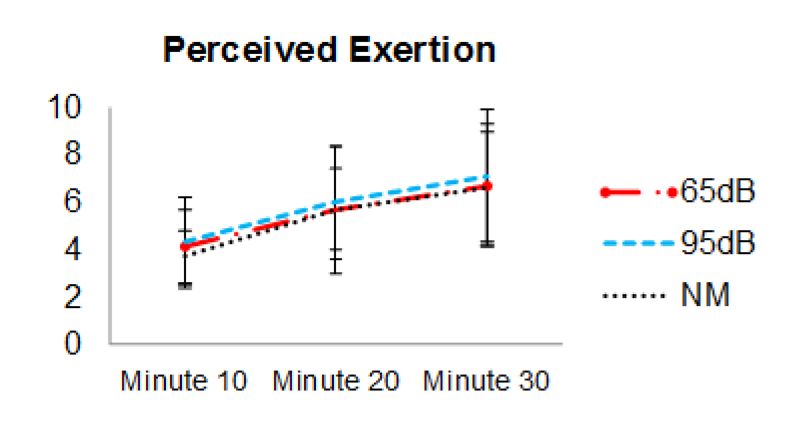

Figure 2 *Perceived exertion CR10 between conditions and measurements:*

minute 10 < 20 (p=0.001), minute 20 < 30 (p=0.019) and minute 30 > 10 (p=0.001).

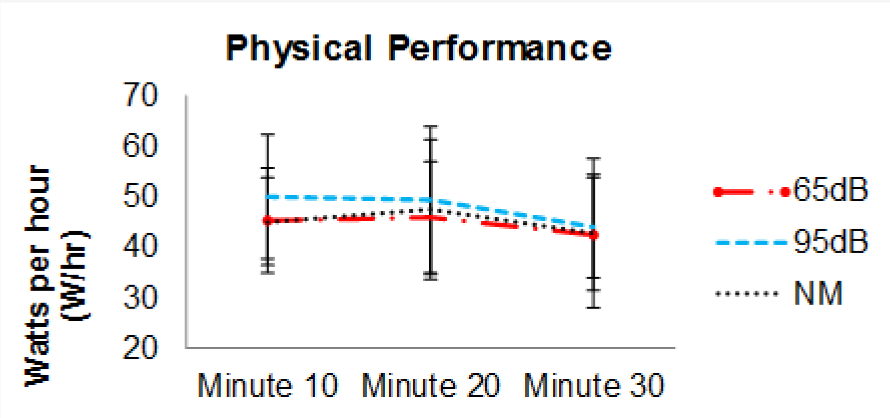

Figure 3. *PP between conditions and measurements.*

It was found an absent with the interaction in the PP variable (p=0.888). In the same way, there wasn't a difference in measurements (minute 10, 20 and 30) (p=0.138) either in conditions (65 dB, 95 dB and NM) (p=0.085; d=0.16) (figure 3).

DISCUSSION

The condition 65dB was used due to the intensity recommended by the OMS, on the other hand, 95 dB is an extreme intensity to do physical activity and one of the most used in the gyms, knowing that the sound, for long periods of times, can cause damages in the auditory channel (Gutiérrez, Sandoval & Aburto-Corona, 2015; Levey, Levey & Fligor, 2011).

The most important result was that in 95 dB an increased heart rate was found comparing with 65 dB and NM. According to Menon and Levitin (2005), music activates the brain hypothalamic area generating an autonomic nervous system response, inducing an increased heart rate.

This heart rate increment may be directly caused by the music intensity and not the tempo, genre or music letter (Atan, 2013; Knight, & Rickard 2001).

Similarly, the study expected a higher PP in the 95 dB condition compared to 65 dB and NM, the results showed that people exercises the same within the different conditions. Same as the actual study, Marín & Aragón (2001), and Aburto & Aragón (2013), they made a 3 condition study (high music volume, moderate music volume and a without music condition), founding that listening different music intensities is not a factor that improves performance.

Despite certain fitness instructors theory that higher music intensity brings a higher performance, our data suggest that music volume has no impact on physical performance improvement. However, fitness instructors like using music above 95 dB (Gutiérrez, Sandoval, & Aburto-Corona, 2015).

Hutchinson and Sherman (2014), found that people who prefer exercising with loud music are those who exercise recreationally. However, athletes prefer a lower volume while exercise. Regarding music intensity, Brownley, McMurray and Hackney (1995), found that untrained people have grater physiological benefits when exercising with faster music compared to those who usually train.

The present study, recruited physically active subjects (which occasionally compete) and athletes.

Possibly this may be the reason why we did not find significant differences, because previous studies in sedentary subjects found improvement in physical performance associated with higher music volume (Hutchinson & Sherman 2014; Brownley, McMurray & Hackney 1995).

Regarding to RPE, it was found that people have a higher perception of effort in the last measurement. This result is logical because the subjects are performing submaximal continuous exercise. For this reason, as time elapses greater the accumulated energy expenditure, which this means that subjects think they are having a greater performance.

Practical application

Nowadays, there is enough scientific evidence that proves that the liked music improves physical performance. However, according the data shown in the present study, it is recommended to exercise with a moderate music intensity. In this manner, physical performance will be the same, will generate lower cardiac output and it will cause less damage in the auditory system.

We recommend to exercise at a music intensity of 65 dB. Furthermore, hearing music at intensity equal or higher than 95 dB for a long time (more than an hour), leads to a light hearing loss. There is no reason to expose our audition to volumes passing 95 dB since there is no evidence of improved performance.

Future studies recommendations

One of the biggest debilities in music intensity investigations is that hearing capacity of the participants is not evaluated. We believe that it is necessary to apply audiometry examinations and, through that, determinate if the volunteers are perceiving the music as the planned sound intensity. Also, it is recommended to level up the exercise duration, as well as vary the type of exercise (cycling, running, etc).

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