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EFFECT OF EXTREME CONDITIONING TRAINING ON BODY PERCEPTION

EFEITO DO TREINAMENTO DE CONDICIONAMENTO EXTREMO SOBRE A PERCEPÇÃO CORPORAL

EFECTO DEL ENTRENAMIENTO DE ACONDICIONAMIENTO EXTREMO SOBRE LA PERCEPCIÓN CORPORAL

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ABSTRACT

Introduction: Extreme conditioning training (ECT) has become a popular method, characterized by a wide variety of exercises. For good technical performance, practitioners must have good perception of the different parts of the body; however, it is not known whether this perception differs between practitioners and non-practitioners of ECT. Objective: To analyze the perception of body dimensions among subjects submitted to an ECT session. Methods: Adult men were divided into TRAINED (n = 10) and UNTRAINED (n = 10). All subjects were submitted to a combination of high-effort multiarticular exercises for a set period of nine minutes ("the largest possible number of repetitions" [AMRAP]). For the procedure of marking the body pattern, the subjects were scored in terms of acromioclavicular joints, waist and trochanter. Results: Regarding the general perception of body size, the TRAINED and UNTRAINED groups were classified as adequate for each stage. In the dimension of body segments, there was an overestimation of the shoulder region in both groups (TRAINED Pre = 105.2 ± 8.37; Post = 117.23 ± 22.11 [ES = 0.79]; 30 min = 101.34 ± 14.21 [ES = 0.34] and UNTRAINED Pre = 96.72 ± 12.79; Post = 99.47 ± 12.17 [ES = 0.22]; 30 min = 111.05 ± 11.06 [ES = 1.27]). The perception of the waist region improved significantly after training (TRAINED Pre = 114.11 ± 16.4; Post = 117.7 ± 20.16 [ES = 0.20]; 30 min = 104.59 ± 11.46 [ES = 0.68] and UNTRAINED Pre = 114.66 ± 9.88; Post = 104.64 ± 12.87; [ES = 0.88]; 30 min = 108.36 ± 12.32 [ES = 0.57]). Conclusion: ECT can promote better perception of body dimensions. In addition, the assessment of body size in active, but untrained individuals showed a better body perception, albeit a transitory effect. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Body image; Circuit-based exercise; Physical fitness; Cardiorespiratory fitness.

RESUMO

Introdução: O treinamento de condicionamento extremo (TCE) tornou-se um método popular, caracterizado pela ampla variedade de exercícios. Para um bom desempenho técnico, os praticantes devem ter boa percepção das diferentes partes do corpo. No entanto, não se sabe se essa percepção difere entre praticantes e não praticantes de TCE. Objetivo: Analisar a percepção das dimensões corporais de sujeitos submetidos a uma sessão de TCE. Métodos: Homens adultos foram divididos em TREINADOS (n = 10) e NÃO TREINADOS (n = 10). Todos os sujeitos foram submetidos a uma combinação de exercícios multiarticulares de alto esforço por um período predeterminado de 9 minutos ("o maior número possível de repetições" [AMRAP]). Para o procedimento de marcação do padrão corporal, os sujeitos foram pontuados quanto às articulações acromioclaviculares, cintura e ao trocanter. Resultados: Com relação à percepção geral do tamanho corporal, os grupos TREINADO e NÃO TREINADO foram classificados como adequados para cada estágio. Na dimensão dos segmentos corporais, houve superestimação da região do ombro para ambos os grupos (TREINADO Pré = 105,2 ± 8,37; Pós = 117,23 ± 22,11 [ES = 0,79]; 30 min. = 101,34 ± 14,21 [ES = 0,34] e NÃO TREINADO Pré = 96,72 ± 12,79; Pós = 99,47 ± 12,17 [ES = 0,22]; 30 min. = 111,05 ± 11,06 [ES = 1,27]). A percepção da região da cintura melhorou significativamente depois do treinamento (TREINADO Pré = 114,11 ± 16,4; Pós = 117,7 ± 20,16 [ES = 0,20]; 30 min. = 104,59 ± 11,46 [ES = 0,68] e NÃO TREINADO Pré = 114,66 ± 9,88; Pós = 104,64 ± 12,87; [ES = 0,88]; 30 min. = 108,36 ± 12,32 [ES = 0,57]). Conclusões: O TCE pode promover melhor percepção das dimensões corporais. Além disso, a avaliação do tamanho corporal em indivíduos ativos, mas não treinados, mostrou percepção corporal melhor, mas com efeito transitório. ***Nível de evidência II; Estudos terapêuticos – Investigação dos resultados do tratamento.***

***Descritores**: Imagem corporal; Exercícios em circuitos; Aptidão física; Aptidão cardiorrespiratória.*

RESUMEN

Introducción: El entrenamiento de acondicionamiento extremo (EAE) se ha convertido en un método popular, caracterizado por una amplia variedad de ejercicios. Para un buen desempeño técnico, los practicantes deben tener una buena percepción de las diferentes partes del cuerpo. Sin embargo, no se sabe si esa percepción difiere entre practicantes y no practicantes de EAE. Objetivo: Analizar la percepción de las dimensiones corporales de sujetos sometidos a una sesión de EAE. Métodos: Hombres adultos fueron divididos en ENTRENADOS (n = 10) y NO ENTRENADOS (n = 10). Todos los sujetos fueron sometidos a una combinación de ejercicios multiarticulares de alto esfuerzo por un período predeterminado de 9 minutos ("el mayor número posible de repeticiones" [AMRAP]). Para el procedimiento de marcado del patrón corporal, los sujetos fueron calificados con respecto a las articulaciones acromioclaviculares, cintura y el trocánter. Resultados: Con relación a la percepción general del tamaño corporal, los grupos ENTRENADO y NO ENTRENADO fueron clasificados como *adecuados para cada etapa. En la dimensión de los segmentos corporales, hubo sobreestimación de la región del hombro para ambos grupos (ENTRENADO Pre = 105,2±8,37; Post = 117,23±22,11 [ES = 0,79]; 30 min = 101,34±14,21 [ES = 0,34] y NO ENTRENADO Pre = 96,72±12,79; Post = 99,47±12,17 [ES = 0,22]; 30 min = 111,05±11,06 [ES = 1,27]). La percepción de la región de la cintura mejoró significativamente después del entrenamiento (ENTRENADO Pre = 114,11±16,4; Post = 117,7±20,16 [ES = 0,20]; 30 min = 104,59±11,46 [ES = 0,68] y NO ENTRENADO Pre = 114,66±9,88; Post = 104,64±12,87; [ES = 0,88]; 30 min = 108,36±12,32 [ES = 0,57]). Conclusiones: El EAE puede promover mejor percepción de las dimensiones corporales. Además, la evaluación del tamaño corporal en individuos activos, pero no entrenados, mostró mejor percepción corporal, pero con un efecto transitorio.* ***Nivel de evidencia II; Estudios terapéuticos - Investigación de los resultados del tratamiento.***

Descriptores: *Imagen corporal; Ejercicio en circuitos; Aptitud física; Aptitud cardiorrespiratoria.*

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INTRODUCTION

Extreme conditioning training (ECT), such as CrossFit@, are recognized as one of the fastest-growing training modes in the world. This fitness program is composed of cardiovascular, strength, power, balance, and coordination exercises. To perform the exercises with quality, it is necessary to have the ability to place yourself in space to minimize the risk of injury and improve the performance of skills.[1]

The perception of body dimensions is fundamental for technical improvement and motor learning. However, it is not clear to what extent the understanding of body dimensions can affect the locomotor performance of well-trained individuals.[2] Indeed, body schema develops based on the sensory information used by the moving body and by its interactions with the environment.[3] As a postural model that monitors limb position, it involves aspects of the brain, sensory, and proprioceptive processes. The body schema can be considered the non-conscious set of processes that records the location of the body parts in space, which includes the length of limb segments, their arrangement, the shape of the segments in space, and the shape of the body surface. To that end, we expect that for the optimal accomplishment of complex motor tasks, such as those required in ECT protocols, trained individuals present better body dimensional perception than those without prior experience in the modality.[4]

In this field, most are linked to the understanding of the formation and development of the perception of the body dimension at the neurological level, which includes the associations of the regions of the cerebral cortex with the perception of the body in space, and the understanding of the processing of this information originated from visuomotor, tactile, proprioceptive, and exteroceptive stimuli.[5-20] According to Ramsey, body perception reflects a working alliance between the ventral visual stream and extended neural systems associated with action perception, executive functions, and theory of mind.[6] In this way, body perception becomes an essential and complex tool, actively associated with the quality of the motor task pattern included in the ECT modality. Therefore, we have the following hypotheses: First, due to the higher muscular density, individuals trained in ECT will perceive themselves larger than those not trained in the modality; Second, we expect the ECT session to normalize this effect; and third, untrained individuals will exhibit more hyper schematic changes compared to trained individuals due to acute increase in muscle size induced by the ECT session.

Thus, this study aimed to analyze the perception of body dimensions in subjects with different levels of trainability submitted to an acute session of ECT.

MATERIALS AND METHODS

The Ethics Committee approved this study of the São Judas Tadeu University (protocol 37330614.7.0000.0089) under Resolution 466/12 of the National Health Council, which regulates all methodological procedures in research with Human Beings.

Participants

Twenty adult men (20-40 years of age) were equally divided into groups: TRAINED, volunteers with experience in the ECP (age 31±5 years, height 1.75±0.04 m, weight 83.9±3.72 kg and training experience 22±9 months) and UNTRAINED, active volunteers that never participated of ECP (age 31±7 years, height 1.76±0.08 m, weight 83.2±6.61 kg). Volunteers participating in two or more concurrent training programs or making regular use (last four weeks) of substances such as anabolic steroids, psychotropics, antibiotics, and corticosteroids were excluded.

Initially, individuals received all the information regarding the study and all the evaluations that would be developed. The informed consent form (ICF) was read for all, and doubts clarified. After reading and agreeing to participate in the study, they signed all the routes of the ICF. After that, all volunteers answered the International Physical Activity Questionnaire (IPAQ), the Physical Activity Readiness Questionnaire (PAR-Q), and general anamnesis.

Experimental procedures

Training session

Volunteers were evaluated on three different conditions. For data collection, both groups were initially assessed at baseline. Then, they trained a single ECP session, which consisted of a combination of high-intensity multi-joint exercises with a predetermined time of 9 minutes.[21] Being re-evaluated in the moments immediately and 30 minutes after the end of the session.

The overall warm-up was composed of 3 sets of 10 movements of jump air squat and kettlebell swing. Afterward, the volunteers trained the high-intensity session composed of the following exercises: WOD (Workout of the day) - AMRAP method (as many reps as possible) in 9 minutes - 5 reps of Cleans, 10 Wall Ball reps and 20 Double-Unders or Single-Unders reps.

After each successful round, an extra movement was added to each exercise, except for the double-unders or single-unders exercise, making the training session more exhaustive.[21]

Perception of body dimensions (PBD)

For the Body Pattern Marking procedure (BPM), which was initially described by Askevold,[22] subjects were scored in the following body regions: right and left acromioclavicular joints, right and left waist curves, and right and left trochanter major (hip). This procedure aimed to ensure that all subjects are located in the same places. The subjects remained orthostatic in front of the wall, at a distance determined by the semi-flexed upper limb, and through the verbal orientations, they were instructed to conduct the blindfold test, imagining that the wall was a mirror.

The first anatomical point evaluated was the top of the head. At this moment, the subjects were instructed to perform an inspiratory apnea and projected this point on the wall; then, the subjects were touched at the marked locations and pointed at the wall with the forefinger projection of that point. At that point, the evaluators identified this point on the wall by placing a tag. This procedure was performed three consecutive times[23] without the aid of vision. (Figure 1) Next, the subject was placed close to the wall to mark the real points by fixing a larger label.

To avoid errors in the markings, the cervical region was stabilized with the support of the hand, preventing the postural balance. These points marked on the wall and the identification of the subject were photographed with a digital camera for later analysis. The measures evaluated were the distances of the locations marked by the subject and the evaluator in the coronal plane that represents the body width (distance between the right side and the left side), and on the vertical axis that represents the height (distance from the ground to the indication of the point) between the real and the perceived. Thus, this test allows us to evaluate the relationship between the perceived dimension (PD) and the real dimension (RD). Based on these values, the Body Perception Index (BPI) was calculated using the following formula: BPI = PD / RD x 100 (%).

According to Fisher,[24] employing this calculation, a value was determined that was expressed in percentage that differentiated the BPI from each subject. In addition to calculating the BPI for each body region, the calculation of the general BPI (BPIg) was also performed, as determined by the BPI average head height, shoulder width, waist, and trochanter, which are the parameters for quantitative analysis of this research.

To categorize the BPI, we used the mean distribution in percentiles, with the values between the 1st quartile (25th percentile) and the third quartile (75th percentile), being adopted as the appropriate interval, thus delimiting the parameters for classification of the values of the corporal perception of young adults.[25]

Thus, those with a BPI lower than the 25th percentile were classified as hypo schematic, while those with a higher BPI score were considered to be hyper schematic, and finally, those with BPI with a value between the 25th percentile and the 75th percentile were classified as a normal schematic.[25] (Table 1)

For a qualitative analysis of the perception of the body dimensions, we used the images that emerged from the union of the perceived points and the real size, as shown in Figure 2.

Statistical analysis

All the results were presented through descriptive statistics (mean ± standard deviation). The Shapiro-Wilk test assessed data normality. For comparison between the three moments, two-way ANOVA analysis (Tukey post hoc) was used. For baseline comparison between groups, an *independent t-test* was applied. The Hedges´g effect size calculation (ES = difference between pre- and post-intervention divided by pooled and weighted standard deviation) was used to evaluate the magnitude of training effects on the body perception indexes. ES values were determined from small (0.20), median (0.50) and large (0.80). For the calculation of the data, we used SPSS software version 21.0, and the level of significance was set at $p \leq 0.05$.

Table 1. Categorization of general body perception index based on the criteria of Segheto et al. (2012).

Classification	Percentage of classification
Hypo schematic	<99.4
Normal schematic	99.4-112,3
Hiper schematic	>112.3

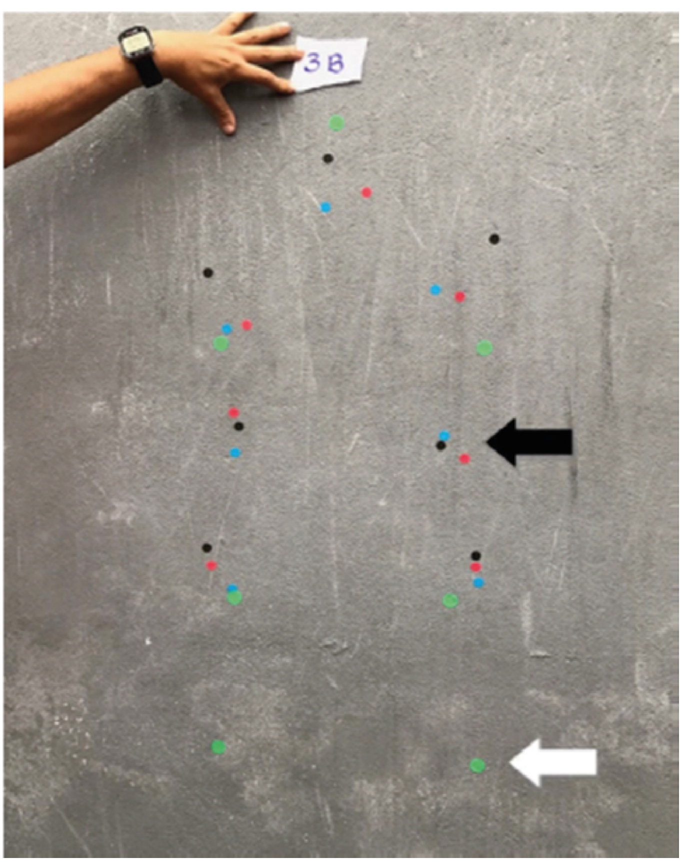

Figure 1. Wall used in the Body Pattern Marking procedure in which the test result can be identified: the smaller colored labels (blue, red and black) indicate the projection of the perceived points pointed by the subject (black arrow) and the larger label (green) shows the actual points evaluated by the examiner (white arrow). The number "3B" represents the identification and the moment of the evaluated one.

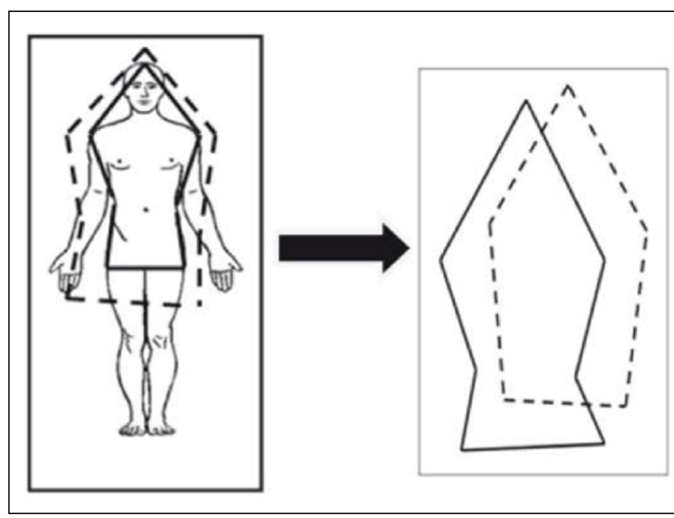

Figure 2. Drawing obtained at the end of the procedure of marking the perception of the body dimensions. Perceived dimension (dotted line) and real body dimension (solid line).

RESULTS

General Body Perception Dimension

At baseline, the groups were different from each other ($p < 0.05$). However, both were classified as a normal schematic. At 30 minutes post-training, the TRAINED group strongly reduced (ES= 0.83) the general body perception index compared to the post-workout value ($p < 0.05$). UNTRAINED did not alter any parameter ($p > 0.05$). Data are shown in Table 2.

Perception of Body Segments Dimension

The TRAINED group increased the shoulder width perception index significantly compared to the UNTRAINED group at the post-training time ($p < 0.05$). However, these values decreased significantly after 30 minutes ($p < 0.05$). On the other hand, the UNTRAINED group sharply increased the perception of this segment after 30 minutes ($p < 0.05$, ES = 1.27).

Regarding waist width, the UNTRAINED group sharply reduced (ES = 0.88) the perception index of this segment (p <0.05). For the body height index, both groups were statistically different at baseline (p <0.05). In the issue of effect size, there was a moderate reduction of this parameter up to 30 minutes after training in the TRAINED group (ES = 0.53), while in UNTRAINED, there was a moderate increase in this parameter (ES = 0.69). Data are shown in Table 3.

Body Perception Symmetry

In the TRAINED group, there was a significant increase in the body perception index of the right (0.94) and left (1.51) waist symmetry at the 30 minutes post-training compared to the baseline (p <0.05). As for the other body segments, we did not find significant differences in time or between groups. (Table 4)

Table 2. Comparison of mean values and standard deviation (mean ± SD) and effect size (ES) of the General Body Perception Index (BPIg) for moments baseline, posttraining, and 30 minutes posttraining between TRAINED (n=10) and UNTRAINED (n=10) groups.

Groups	Baseline	Posttraining	ES	30 minutes	ES
TRAINED	106.29±6.21	109.83±11.9	0.39	100.28±8.25*	-0.83
UNTRAINED	100.92±4.74**	101.24±8.1	0.05	103.3±2.76	0.63

*represents a statistical difference from the TRAINED posttraining moment (p<0.05); **represents a statistical difference from the TRAINED group at baseline (p<0.05).

Table 3. Mean values and standard deviation (mean ± SD) and effect size (ES) of the Body Perception Index (%) for shoulder width (SW), waist width (WW), hips-width (HW) and height of the TRAINED and UNTRAINED groups during moments baseline, posttraining (Post) and 30 minutes posttraining (30 min).

Body Segment	Groups	Baseline	Post	ES	30 min	ES
SW	TRAINED	105.2±8.37	117.23±22.11**	0.79	101.34±14.21*	-0.34
	UNTRAINED	96.72±12.79	99.47±12.17	0.22	111.05±11.06#	1.27
WW	TRAINED	114.11±16.41	117.7±20.16	0.20	104.59±11.46	-0.68
	UNTRAINED	114.66±9.88	104.64±12.87$	-0.88	108.36±12.32	-0.57
HW	TRAINED	112.61±11.77	112.76±15.64	0.01	104.26±14.92	-0.63
	UNTRAINED	105.26±8.06	110.01±17.66	0.37	101.81±9.15	-0.40
Height	TRAINED	93.41±4.68	91.62±3.32	-0.45	90.93±4.64	-0.53
	UNTRAINED	87.04±6.02***	90.86±8.01	0.54	91.98±8.26	0.69

*represents statistical difference from TRAINED Posttraining (p<0.05); **represents statistical difference from UNTRAINED (p<0.05); *** represents statistical difference from TRAINED group at the baseline (p<0.05); #represents statistical difference from UNTRAINED baseline and posttraining moments (p<0.05); $represents statistical difference from UNTRAINED baseline (p<0.05).

Table 4. Mean values and standard deviation (mean ± SD) and effect size (ES) of the Body Perception Index (%) of the body segments: right (RS) and left (LS) shoulder, right (RW) and left (LW) waist, right (RH) and left (LH) hip of the TRAINED and UNTRAINED groups at baseline, posttraining (Post) and 30 minutes post-training (30 min).

Body Segment	Groups	Baseline	Post	ES	30 min	ES
RS	TRAINED	105.55±3.74	106.02±4.18	0.12	106.02±5.48	0.10
	UNTRAINED	101.8±10.37	103.95±6.74	0.25	105.71±10.53	0.37
LS	TRAINED	104.46±4.19	103.79±4.62	-0.15	104.41±3.9	-0.05
	UNTRAINED	97.19±10.79	102.89±3.84	0.78	101.61±3.47	0.62
RW	TRAINED	115.92±16.56	120.38±15.75	0.28	128.93±11.07*	0.94
	UNTRAINED	118.57±10.6	133.51±14.16	1.21	125.67±17.18	0.51
LW	TRAINED	110.98±13.1	118.5±17.24	0.50	129.3±10.92*	1.51
	UNTRAINED	118.98±12.1	132.76±18.7	0.89	121.04±20.39	0.13
RH	TRAINED	145.93±29.31	151.56±59.95	0.12	164.13±27.41	0.64
	UNTRAINED	204.82±50.63	164.3±48.24	-0.82	191.6±50.64	-0.26
LH	TRAINED	144.09±50.58	148.37±46.39	0.09	161.73±27.29	0.45
	UNTRAINED	226.07±63.04	174.32±45.08	-0.96	189.83±79.12	-0.51

*represents a statistical difference from the TRAINED baseline (p<0.05).

DISCUSSION

The results presented in this study partially confirmed our hypotheses: first, at the beginning, the TRAINED group was perceived to be greater than the UNTRAINED group, but only for the general body perception index; and second, the ECT session induced relative changes in the way the two groups perceived themselves. For the analysis of the BPIg of the groups, we used the standard of normality of the sample of the study by Segheto et al[25] as a reference. Therefore, although a statistically significant difference was observed between groups in the pre-training assessment, BPIg was classified as adequate. However, it is worth mentioning that in the TRAINED group, immediately after training, there was a 3% increase in the perception of body size and, after 30 minutes of training, these values came from what we call "ideal dimensional perception." In the UNTRAINED group, the participants presented adequate patterns of perception of body dimensions at the three moments of the evaluation, showing only small variations.

When analyzing the drawings obtained in the BPM test, a physical perception very close to the ideal was observed in the TRAINED group. This result suggests that the chronicity of training may provide the neural stimuli needed to promote a more accurate understanding of body size. However, there was an imbalance right after the end of the exercise.

We also highlight a small distortion in the waist region. It is possible to justify this alteration by the anatomical characteristic of this region, which has no bone limits, that is, muscle tone can prevail as a reference for body limits. In the specific case of TBI practice, these muscles continuously act as stabilizers, and it is possible that this constant stimulus may cause changes in the dimensional perception of this region.

After analyzing the drawings obtained in the BPM test, we noticed that the UNTRAINED group noticed its shortened trunk at the first moment, but in the post-training moments and 30 minutes after the training, they presented an approximation between the perceived and the real dimension. We can infer, from the data obtained, that the realization of a ECT session, in volunteers previously not trained in the modality in question, had a beneficial effect on their perception.

In the analysis of the perception of body dimensions, referring to the body segments, we observed that in the TRAINED group, that in all parameters there was overestimation immediately after training and readjustment after 30 minutes recovery. Thus, better shoulder width accuracy was observed. On the other hand, in the UNTRAINED group, significant overestimation was observed, even after training.

When analyzing the BPI for the height of the head, we noticed that both groups showed a precise perception for the head region close to 100%, which is directly related to the preservation of the integrity of the organs responsible for the spatial senses, vision, hearing, tasting, olfaction.[23,25,26]

Studies conducted by our group corroborate the results found here, in which for the height of the head it is possible to find better indices of perception in different populations, such as high-performance athletes and active individuals,[23] dancers,[26] yoga practitioners and fighters,[27] and people with visual impairment.[28]

An adequate body perception allows the individual to know the location of his body, or parts of it, in the space around him, which can contribute to a more efficient motor response in the environment in which he lives.[29] The first studies in the area of body perception seemed to verify the changes that occurred in individuals with eating disorders. Thus, a relevant aspect of this study was the novelty of the proposal to assess the perception of body size after a single training session in trained and untrained individuals. When analyzing the BPIg of individuals in both groups, both were considered adequate in the three evaluated moments. We also pointed out that, in the TRAINED group, there was an improvement in accuracy, approaching the index of 100%, that is, close to what we consider an ideal dimensional perception at the end of the 30 minutes of recovery. In the consulted literature, we confirm our results, whose proprioceptive stimuli, that is, exercises and body activities, can stimulate the dimensional perception of the body and, thus, provide an improvement in movements.[30,31]

When analyzing the perception of the widths of the body segments, we observed that the TRAINED group showed an adjustment after training and readjustment after 30 minutes of recovery in all parameters (shoulder, waist and hip width). This fact shows that the high intensity stimulus can cause an increase in the excitation of sensory neurons and, consequently, a transient increase in the corresponding cortical area, as if the homunculus (motor and sensitive) changes its configuration and then is adjusted. Medina and Cosslett[32] argued that cortical representations are plastic and dynamic, changing in response to central and peripheral changes, as well as experiences. Thus, the area of perception of the body dimension is linked to the recognition of body parts and depends on the sensory afferents.

These stimuli come from the body, are designed for primary cortical areas and form a graphic representation, go to a secondary area in which they are interpreted and summarized with information from different parts of the body for a more complex tertiary area. On this website, all information is integrated and perception is scaled, changing its settings from moment to moment.[22,29,33,34]

CONCLUSION

Regarding the perception of body size before and after ECT, it was observed that high intensity acute exercise can generate a better perception of body dimensions. In addition, the assessment of body size in active, but untrained individuals in the modality in question, showed better body perception, but with a transitory effect.

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