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ANALYSIS OF THE ANTICIPATORY RESPONSE OF BICEPS BRACHII MUSCLE ACTIVATION WITH AND WITHOUT VISUAL FEEDBACK IN UNTRAINED INDIVIDUALS

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ABSTRACT

The study evaluated the anticipatory activation of the biceps brachii in 24 participants (12 women and 12 men, aged 18-24) using surface electromyography. Four conditions were applied: no visual deprivation and no weight (SPV_0Kg), no visual deprivation with 5kg (SPV_5Kg), visual deprivation and no weight (CPV_0Kg), and visual deprivation with 5kg (CPV_5Kg). Participants performed elbow flexions under each condition. Anthropometric data were collected: for men, the average body mass was 77.15±15.91Kg and height 1.79±0.08m; for women, the average body mass was 62.51±9.37Kg and height 1.62±0.07m. Electromyographic (EMG) activity was recorded with a Miotool 400 electromyograph, with electrode placement based on the Atlas of Muscle Innervation Biceps brachii activation variables (RMS, FM, FMED) were analyzed for each condition. The results indicated no statistically significant difference in biceps activation across the four conditions, nor when comparing data between sexes. For both women and men, differences in muscle activation responses were insignificant, regardless of load or visual deprivation. It was concluded that, whether with or without weight or visual deprivation, anticipatory activation of the biceps brach.

Key words: Biofeedback. Electromyography. Muscle strength. Visual deprivation.

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RESUMO

Análise da resposta antecipatória da ativação muscular do bíceps braquial com e sem feedback visual em indivíduos destreinados

O estudo avaliou a ativação antecipatória do bíceps braquial em 24 participantes (12 mulheres e 12 homens, entre 18 e 24 anos) usando eletromiografia de superfície. Foram aplicadas quatro condições: sem privação visual e sem peso (SPV_0Kg), sem privação visual com 5kg (SPV_5Kg), com privação visual e sem peso (CPV_0Kg) e com privação visual com 5kg (CPV_5Kg). Os participantes realizaram flexões de cotovelo para cada uma das condições. Foram coletados dados antropométricos: para homens, a massa corporal média foi de 77,15±15,91Kg e estatura de 1,79±0,08m; para mulheres, a massa média foi de 62,51±9,37Kg e estatura de 1,62±0,07m. A atividade eletromiográfica (EMG) foi registrada com um eletromiógrafo Miotool 400, com a colocação dos eletrodos baseada no Atlas de Zonas de Inervação Muscular. As variáveis de ativação do bíceps braquial (RMS, FM, FMED) foram analisadas para cada condição. Os resultados indicaram que não houve diferença estatisticamente significativa na ativação do bíceps entre as quatro condições, nem ao comparar os dados entre os sexos. Para mulheres e homens, as diferenças nas respostas de ativação muscular não foram significantes, independentemente da carga ou da privação visual. Conclui-se que, tanto com quanto sem peso ou privação visual, a ativação antecipatória do bíceps braquial manteve-se similar para ambos os sexos.

Palavras-chave: Biofeedback. Eletromiografia. Força muscular. Privação ocular.

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INTRODUCTION

Resistance Training (RT), recognized for promoting health, stands out as a safe and effective conditioning method for individuals with diverse needs, ranging from rehabilitation to performance optimization (Silveira et al., 2020).

Muscle strength generation results from the interaction of morphological and neural mechanisms (Paz et al., 2013), where skeletal muscle converts chemical energy into mechanical energy by transforming electrical impulses into motor action (Bruniera, Bruniera, 2000).

Various factors can influence RT performance improvements, including volume, intensity, active muscle mass, type of muscle action, rest intervals between sets, exercise order, time under tension, and others (Salles et al., 2009; Machado et al., 2022). However, other variables may also affect execution and performance in students or athletes.

Studies suggest that visual deprivation can impact strength training performance. Jesus and Triani (2021) observed a significant increase in total training volume (total load x number of repetitions) during a front pulldown exercise when participants performed the movement with visual deprivation.

In a study by Souza, Andrade, and Santos (2023), which examined the influence of visual deprivation and belief in verbal information on performance during a bicep curl to concentric failure, results indicated that visual deprivation combined with the belief that the load was increased (without any real load change) significantly reduced the number of repetitions performed. Lastly, Lopes and Silva (2017) research demonstrated a significant increase in repetitions during a flat barbell bench press when participants were subjected to visual deprivation.

The literature reveals that studies correlating RT with visual deprivation are scarce. A promising strategy would involve isolating an individual's effort perception through visual deprivation, encouraging them to generate more force than they might anticipate. This could lead to greater neural activation of the neuromuscular system, thereby optimizing training outcomes.

Considering the above, the present study aimed to analyze the anticipatory response in biceps brachii muscle activation, measured via surface electromyography (EMG), with and without visual feedback in individuals with no prior RT experience.

Our hypothesis was that visual feedback would influence the anticipatory response in biceps brachii muscle activation, promoting earlier motor unit recruitment based on prior information provided, even when the actual weight to be lifted was lower than initially indicated.

MATERIALS AND METHODS

This experimental and prospective study was conducted entirely at the Human Morphophysiology Analysis Laboratory (HUMAN LAB) of the Physical Education program at the Federal University of Viçosa, Florestal Campus.

The project was submitted to the Ethics Committee for Research on Human Subjects of UFV for evaluation and was approved under CAAE number 93793118.1.0000.5153, with opinion number 2.919.591. All procedures adhered to the ethical guidelines for research in Exercise and Sports Science and complied with the Declaration of Helsinki (Williams, 2008).

Sample

The study population comprised students aged 18 to 24 years residing in the city of Florestal.

The inclusion criteria were: being between 18 and 24 years old; being clinically fit to engage in regular physical exercise; not having any acute or chronic illness that could be affected by exercise; not presenting musculoskeletal problems in the shoulder or elbow joints that could interfere with the tests; having no prior experience with strength training; and voluntarily consenting to participate in all study procedures.

The exclusion criteria included the presence of bone or joint limitations that prevented the execution of exercises in the training program and the use of hormonal or anti-inflammatory drugs that could influence the results of morphological and functional evaluations.

Volunteers who met all inclusion criteria and did not present any exclusion criteria were admitted to the study, provided they completed the Physical Activity Readiness Questionnaire (PAR-Q) and signed the informed consent form for study participation.

Considering an alpha error (α) of 0.05 and a statistical power of approximately 0.95, the total sample size for the study was calculated to include a minimum of 20 participants, based on the G*Power software from the University of Düsseldorf.

Experimental procedures

In order to conduct the present study, electromyographic (EMG) activity of the biceps brachii muscle was measured using a surface electromyograph, model Miotool 400 (Miotec®, Porto Alegre, Brazil).

All channels of the electromyograph were calibrated prior to data collection. The SDS-500 sensor was used with a final gain of 1000 times, a sampling frequency of 2,000 Hz, and the signal was passed through a band-pass filter set between 20 Hz and 500 Hz. After signal rectification, analysis was performed using normalized root mean square (RMS) values, peak frequency (PF), and median frequency (MF).

Bipolar Ag/AgCl disc electrodes were employed. All procedures for electrode placement and the measurement of electromyographic activity in the designated muscles followed the protocol established by Moreira et al., (2022).

The electrode insertion sites were determined based on the Atlas of Muscle Innervation Zones (Barbero, Merletti, and Rainoldi, 2012). Before electrode application, the skin was shaved using razor blades, and local hygiene was performed with alcohol gel to eliminate any interference in the electromyographic signal capture.

EMG measurements were taken for ten seconds, prior to the execution of the exercises, starting from the moment the volunteer received the "prepare" command until they began the movement following the "go" command.

The participants were instructed to perform elbow flexion using the biceps curl machine (Strong Machine®, Patos de Minas, Brazil). Initially, a familiarization session with the exercises was conducted to ensure that the participants understood and correctly performed the tasks. Following this, the volunteers were randomly assigned (by drawing) to perform four experimental conditions: elbow flexion without visual deprivation and without weight (SPV_0Kg); elbow flexion without visual deprivation and with a 5 kg load (SPV_5Kg); elbow flexion with visual deprivation and without weight (CPV_0Kg); and elbow flexion with visual deprivation and with a 5 kg load (CPV_5Kg).

For all the conditions evaluated, the volunteers received the same instructions with the same commands, consisting of the "prepare" command followed by the "go" command after ten seconds. At this moment, the volunteers were required to lift the load during the elbow flexion exercise at least twice. Visual deprivation was achieved by placing a blindfold over the volunteers' eyes. Additionally, in the two conditions without visual feedback, the participants were not informed of the load they would be lifting during the exercise.

Statistical analysis

The data were analyzed descriptively as part of the statistical procedure. The Shapiro-Wilk test was then applied to verify the normality of the data, while the homogeneity of the variables was assessed using the Box M test. For within-group comparisons, a repeated measures analysis of variance (ANOVA) was used, considering a factor with four distinct conditions: no visual deprivation and no weight; no visual deprivation with 5 kg; with visual deprivation and no weight; and with visual deprivation with 5 kg. The significance level adopted was $p<0.05$. All statistical analyses were performed using SPSS (Statistical Package for the Social Sciences), version 21.0.

RESULTS

A total of 24 participants aged between 18 and 24 years took part in the study, with 12 females and 12 males. The characteristics of the sample are presented in Table 1.

Table 2 shows the descriptive analysis of muscle activation data in untrained individuals, segmented by gender across the four conditions analyzed. It is observed that in the gender-based analysis, there were no statistically significant differences in the biceps brachii muscle activation results across the four different conditions analyzed.

Table 3 presents the descriptive analysis of muscle activation data in untrained individuals across the four conditions, considering the total study sample. No statistically significant differences were observed in the biceps brachii muscle activation results across the four different conditions analyzed.

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Table 1 - Sample Characteristics.

Sex	Women (12)		Men (12)	
	Mean	SD	Mean	SD
Age (years)	21,00	3,06	21,00	3,09
Body mass (kg)	62,51	9,37	77,15	15,91
Height (m)	1,62	0,07	1,79	0,08
BMI (kg/m^2)	23,62	3,46	21,53	2,49

BMI: body mass index; SD: standard deviation.

Tabela 2 - Analysis of biceps brachii muscle activation data in untrained individuals across the four conditions, segmented by gender.

	Without deprivation				With deprivation			
	Women		Men		Women		Men	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
RMS_0Kg	1,56	0,80	0,67	0,31	1,44	0,72	0,56	0,26
MF_0Kg	111,01	21,59	116,13	15,43	124,45	33,62	108,57	16,75
MFED_0Kg	71,94	12,11	75,25	11,71	73,15	15,55	70,19	8,43
RMS_5kg	1,52	0,62	0,72	0,33	1,46	0,81	0,64	0,29
MF_5kg	110,27	19,19	111,77	23,02	108,03	17,31	108,96	23,81
MFED_5kg	69,17	11,26	75,05	10,09	70,82	13,66	74,69	10,25

SD: standard deviation; RMS: root mean square of the electromyographic activation frequency; MF: mean frequency; MFED: median frequency.

Table 3 - Analysis of biceps brachii muscle activation data in untrained individuals across the four conditions, comparing the total sample.

	Without deprivation		With deprivation	
	Mean	SD	Mean	SD
RMS_0Kg	1,11	0,75	1,00	0,69
MF_0Kg	113,57	18,54	116,51	27,21
MFED_0Kg	73,59	11,77	71,67	12,33
RMS_5kg	1,12	0,64	1,05	0,73
MF_5kg	111,02	20,74	108,50	20,36
MFED_5kg	72,11	10,88	72,75	11,98

SD: standard deviation; RMS: root mean square of the electromyographic activation frequency; MF: mean frequency; MFED: median frequency.

DISCUSSION

This study examines the anticipatory response of biceps brachii muscle activation under different conditions, using surface electromyography (EMG) as the evaluation method. Four distinct conditions were analyzed: without visual deprivation and without weight (SPV_0Kg); without visual deprivation and with 5kg (SPV_5Kg); with visual deprivation and without weight (CPV_0Kg); and with visual deprivation and 5kg (CPV_5Kg). The objective was to determine whether these different conditions would alter the anticipatory response of biceps brachii muscle activation.

The results indicate that, both in the gender-based analysis and in the analysis of the total sample, no statistically significant differences were found in the biceps brachii muscle activation variables across the four conditions. This suggests that, at least within the age range and characteristics of the participants, the anticipatory response of biceps brachii muscle activation is not influenced by the mobilized load or by the deprivation of visual feedback.

Some studies have assessed the influence of vision restriction on muscle strength performance. A study by Maior and colleagues (2007) evaluated 12 young, trained men in 1RM tests for bench press, leg press, and lat pulldown. The results showed a difference related to visual deprivation, indicating that visual deprivation could enhance self-efficacy in individuals by reinforcing the belief that they can achieve what they set out to do (Bandura, 1997). Other studies support this finding of enhanced performance under no visual feedback conditions (Serapicos et al., 2009; Costa et al., 2013; Dias Neto et al., 2015; Federizzi et al., 2018).

However, all the studies mentioned focused on electromyostimulation through EMG or the effect of visual deprivation on musculoskeletal strength during the contractile process. Research examining the anticipatory aspect of muscle activation remains limited in the literature.

A possible physiological mechanism explaining the results of this research is the adaptability of the neuromuscular system, which is capable of maintaining relatively consistent muscle activation patterns regardless of variations in experimental conditions (Vigotsky et al., 2018). This highlights the body's remarkable ability to adjust and modulate muscle activation to meet specific environmental demands, even in the presence of visual restrictions.

Another possibility is that the pathway from sensory information to the motor action of elbow flexion could be influenced by the proprioceptive system, specifically the muscle spindle. The muscle spindle, a receptor responsible for the stretch reflex of muscle fibers, detects changes in muscle length and the rate of length change (Moritani, 2008). It acts as a precursor influencing the increase in the mean and median electromyographic frequencies during the anticipatory response of biceps brachii activation.

Considering the time-space between intention and execution in the muscle fiber, this process is directly linked to the alterations identified by the spindle, transmitting signals to the spinal cord through a primary afferent sensory pathway that stimulates α-motoneurons, ultimately leading to biceps brachii contraction (Heckman, 2009).

Thus, the EMG results may have been impacted by the muscle spindle, as no significant changes occurred in the length of the musculoskeletal fiber. This stability could explain the absence of significant differences in the electrical activation analyses, both in the sex-segmented and the overall sample analyses.

This suggests a remarkable ability of the body to adjust and modulate muscle activation to meet specific ecological demands, even under visual restrictions.

However, it is crucial to acknowledge some limitations of this study. The relatively narrow age range of participants may restrict the generalization of the results to other age groups.

Future research could benefit from expanding the sample to include a broader range of ages and physical ability levels.

Additionally, exploring other variables, such as the influence of physical training or specific neurological conditions, could provide a more comprehensive understanding of the underlying mechanisms of muscle activation.

CONCLUSION

Based on the results of the present study, it can be concluded that for the analyzed sample and the adopted protocols, there is no difference in the anticipatory response of biceps brachii muscle activation, regardless of the mobilized load or the deprivation of visual feedback, both for young men and women without prior training experience.

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