Middle-East Journal of Scientific Research 12 (3): 331-335, 2012
ISSN 1990-9233
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DOI: 10.5829/idosi.mejsr.2012.12.3.64147

Arousal and Activation in a Dynamic Balance Task

[1]*Amir Hamze Sabzi,* [2]*VaezMousavi and* [3]*Pouneh Mokhtari*

[1]Department of Physical Education, Science and Research Branch,
Islamic Azad University, Tehran, Iran
[2]Department of Psychology, Exercise Physiology Research Center,
Baqiyatallah University of Medical Sciences and University of Imam Hossein, Tehran, Iran
[3]Department of Physical Education, Tehran Central Branch, Islamic Azad University, Tehran, Iran

Abstract: Balance control is a key factor in daily activities and learning a new skill. The aim of the present study was to investigate the relationship between arousal and activation with performance in a dynamic balance task. Thirty voluntary subjects participated (mean age: 22.1±1.23) in this study. Skin Conductance Level (SCL) as arousal index was recorded continuously during the performance of a dynamic balance task. Reaching distance was recorded on Y balance test (YBT) as performance measure. Pearson correlation coefficient was used to analyze the data. Results indicated a negative linear relationship between activation and performance, while arousal did not correlate with performance. Activation also predicted performance with a medium strength (r=0.57). The quality of the task was affected by activation, but not arousal. Confirmation of these data in future studies will lead to comprehension of the interaction between physiological measures and its behavioral associations in high level sport performance, especially in emotional contexts.

Keywords: Arousal・Activation・Skin Conductance Level・Static Balance・Performance

INTRODUCTION

The concept of “arousal,” “activation,” or “energy mobilization,” as developed by the writer over a period of many years [1, 2] and employed by others in various contexts [2, 3], has wide applicability in psychology. Pending its appearance, however, it may be of interest to point out some of the areas which this concept should serve to illuminate. It has been argued that all variations in behavior may be described as variations in either the direction of behavior or the intensity of behavior [4].

The chief point in regard to arousal [5], is that arousal occurs in a continuum, from a low point during deep sleep to a high point during extreme effort or great excitement, with no distinguishable break for such conditions as sleep or "emotion." Evidence supporting this contention has been presented specifically for skin conductance, muscle tension and the electroencephalogram (EEC) [6, 7].

Among the physiological measures which may be employed are skin conductance, muscle tension, EEG, pulse rate, respiration and others. Skin conductance level (SCL) reflects individual’s state as well as electrical changes of sweat glands activities on palms and soles momentarily. SCL is considered as a key indicator in measuring arousal [5, 8].

The relationship between arousal and performance is one of the most debated topics in sport psychology. So far, lots of studies have been performed in order to find the relationship between arousal and activation which created different and rather disparate results. Until recently, the traditional inverted-U hypothesis had been the primary model used by sport psychologists to describe the arousal-performance relationship [9, 10]. This hypothesis is based on work by Yerkes and Dodson [9], which focused on the decision-making abilities of mice when presented with varying intensities of stressor: according to the basic tenets derived from this research, optimum performance should be seen at levels of moderate arousal, as arousal approaches extremes (a comatose state on one end and panic attack on other), performance will decline accordingly. The end result is a curvilinear relationship between arousal and performance that resembles an inverted-U. Modification of this hypothesis for application to sport has also suggested

Corresponding Author: Amir Hamze Sabzi, Department of Physical Education, Science and Research Branch, Islamic Azad University, Tehran, Iran. Mob: +989126703574.

that this relationship is dynamic [9, 10]. That is, the curvilinear function can shift to left or right depending on individual characteristics (i.e., high skilled or low skilled, extroverted or introverted) and the type of task (i.e., simple or complex).

But the arousal concept has not been particularly influential in psychophysiology. One reason for this is the lack of consistency reported between a range of measures often taken to apply to arousal, such as heart rate and skin conductance level [4, 5, 11]. Barry *et al*. [5] considered that another reason is uncertainty arising from poor definition of the terms “arousal” and “activation”, which have often been used interchangeably. Various terminologies that have been used to describe states of attentiveness in the CNS include arousal, alertness, vigilance and attention.

Following the separation proposed by Pribram and McGuiness [12, 13], Barry *et al*. [5] used “arousal” to refer to the current energetic state and “activation” to refer to task-related mobilization of arousal. Arousal generally increases from baseline levels when the individual is engaged in a task and this change in arousal (from baseline to task) is identified as task-related activation. The construct of “arousal” is always specific to the time of SCL measurement, either resting (“baseline”) or “activated” (during the task), while “activation” always refers to a change in SCL from baseline to task. VaezMousavi *et al*. [14] then linked the effects of arousal to phasic physiological responses and related the effects of activation to behavior/performance measures. They used this conceptual division to study children’s performance in a continuous performance task (CPT). VaezMousavi *et al.* [14] in a follow up study and in an across subjects/between trials approach also used this conceptualization to study adults' performance in a CPT. Using SCL as the index of arousal and its mobilization from the baseline as the index of activation, Barry *et al*. [5] found that performance measures (mean RT and number of errors) were predicted by activation, but not with arousal. Similar finding was reported by VaezMousavi *et al*. [8, 15, 16]. They concluded that further investigations using arousal and activation as defined separable aspects of energetic function and examining their effects on skilled behavior, in terms of sport skills would be of value.

Therefore, the relationship between activation and performance in challenging and sensitive situations (such as sport competitions that an individual has high levels of arousal) is ambiguous and researchers concluded that further investigations using arousal and activation as defined separable aspects of energetic function and examining their effects on physiological responding and behavior, would be of value [11, 17]. Therefore, the hypotheses for the current research were as follows: Activation can predict reaching distance in dynamic balance; Arousal can’t predict performance.

MATERIAL AND METHODS

Participants: Thirty healthy male subjects (mean age: 22.1±1.23) voluntarily participated in this experiment.

Apparatus and Task: After the study was described and written informed consent was obtained, two sessions of data collection were introduced to the subjects: the baseline and the task. During an initial 17 min baseline resting period, the subject was asked to sit quietly with eyes closed. Electrodermal activity was recorded, using a constant voltage device (UFI Bioderm Model 2701) from 7.5 mm diameter Ag/AgCl electrodes on the sole of the participant’s right hand middle and index fingers in order to record their continuous SCL during the test, based on MicroSiemens (μS), at a constant voltage of 0.5 V, with an electrolyte of 0.05 M NaCl in an inert viscous ointment base [5, 7, 8, 11]. During the task period, the data were collected from each subject in a standard hall, while they were performing dynamic balance test.

Dynamic balance was evaluated by YBT (Y Balance Test™) in anterior, postomedial and postolateral directions [18-22]. Before starting, the dominant leg was determined in order that if right leg was dominant, the test would be counter-clockwise; on the contrary, if the left one was dominant, the test would be clockwise [20, 21]. Participants stood on the dominant leg on a centre of Y-Junction shape surface. Then as long as they had no error, they did the reaching via indicators movement in a direction which was randomly selected by experimenter and finally, they returned to standing on double leg position. The errors included leg stance movement, lean on the leg that did reaching and falling. Amount of displacement of indicators was their reaching distance. In introductory test, they practiced each direction six times in order to remove learning effect. In main test, they performed each direction three times; then the average of three attempts in each direction was computed. Finally, it was divided on the length of leg (cm) and multiplied by 100 to obtain the reached distance as a percentage of leg length [18, 19, 22]. During participants performed the tasks, electrodermal activity was sampled continuously at 10 Hz.

Baseline arousal level was derived for each subject as the lowest one-min mean SCL within that period. Activated arousal level was derived as the mean of the six lowest SCL during balance task. The difference between these two estimated arousal levels (activated-baseline) was taken as the task-related activation [5, 8, 15].

Data Analysis: We used r Pearson to determine the relationship between arousal/activation with dynamic balance task. The significance level for the tests was set at $\alpha \leq 0.05$. All analyses were executed using the statistical package SPSS 16.

RESULTS

The distributions of YBT towards the arousal were shown in Diagram 1. Performance towards arousal has shown a very weak linear relationship. Correlation of arousal with the YBT was 0.28 and the determination coefficient was 0.08. This relationship was not statistically significant ($P > 0.05$).

The distributions of YBT towards the activation were shown in Diagram 1. Performance towards activation has shown a very strong linear relationship. Correlation of activation with the YBT was 0.57 and the determination coefficient was 0.32. This relationship was statistically significant ($P < 0.05$).

DISCUSSION

The purpose of this study was to examine the relationship between arousal and activation with dynamic balance task. The arousal mean of the whole participants could not predict their balance in YBT. The inability of arousal in predicting the performance was probably due to the considerable variability of this variable during the performance. It was likely that the lack of acquisition of tonic arousal as a basal level led to decrease in the correlation between the two variables similar to what happened in the evaluation of activation. Using the basal level introduced in previous studies [5, 7, 8, 15] caused the appearance of a considerable level of activation in the present study which represented the features introduced by Barry *et al*. [5].

In the present study, activation was a predictor of performance from the obtained scores' perspective. This finding is consistent with previous findings which suggested that activation is the predictor of behavior, but not arousal [5, 7, 8, 11, 15]. Results of study by Barry *et al*. [5] and VaezMousavi *et al.* [7, 8, 15] showed the linear relationship between activation and performance. These results are against Landers [10] and Arnet *et al*. [23] and do not follow the inverted U model. The mentioned suggestion which was supported by the findings of this study is consistent with the theoretical basis presented

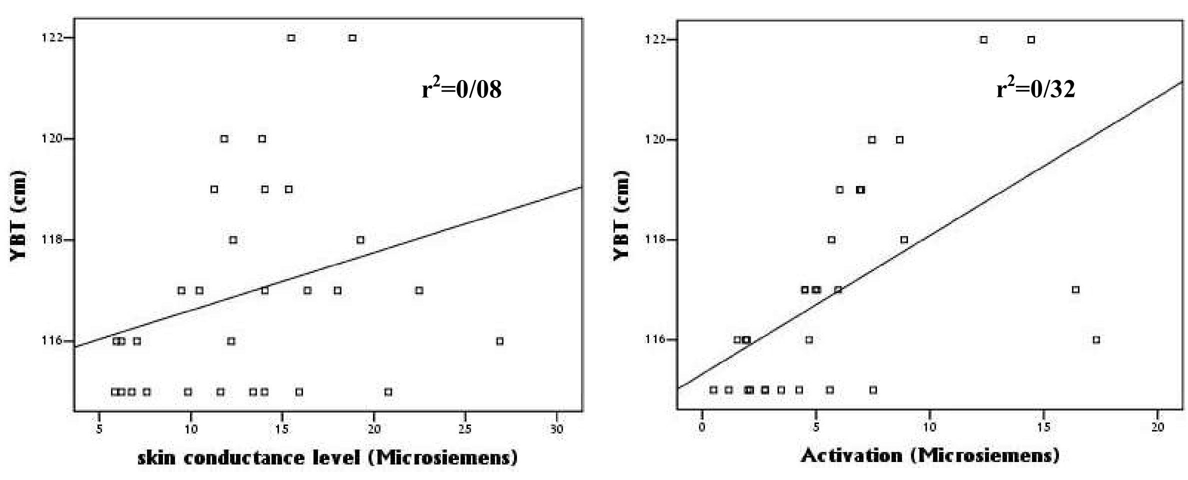

Diagram 1: The left part shows the distribution of YBT scores towards the arousal. A regression line was added to each group of data so that the image would indicate the relationship and the determination coefficient was written above it in order to show the strength of this correlation. Each point in the image represents one participant. In the right part, the dispersion of YBT scores towards the activation is plotted. The higher determination coefficient shows the higher power of the relation. Each point in the image also represents one participant. The drawn line among the data shows the strength of relationship between the two variables.

by Pribram and McGuiness [12, 13] who defined the different nervous sub layers for these two concepts. From the neurological studies related to this phenomenon, it can be concluded that arousal is caused by amygdale activity and the Ascending Reticular Activating System and only affects the physiological responses, but the factor affecting the motor fitness processes is activation which is the outcome of the activity of the basal ganglia. In addition, Pribram and McGuiness [13] stated that arousal controls the stage physiological responses especially the orientating response. According to them, the arousal can be considered as a factor to strengthen the response [12, 13]. From these researchers' point of view, activation is related to a kind of fitness for the related behavior. This finding is consistent with what already reported in laboratory tasks [5, 7, 8, 11].

The common variance was 32% which showed that 32% of YBT scores were related to activation. The assumption of the researcher was that the characteristics of the balance task have caused the increase of Skin Conductance Level (SCL) from the basal level to the observed level during the task. The researcher has also assumed that the increase of Skin Conductance Level (SCL) that is the task related activation has increased the balance in YBT.

The findings of this study did not support the hypothesis of the inverted U. Retesting the inverted U relationship requires the experimental manipulation of the activation level or at least the classification of the subjects according to the initial level of arousal [10, 23]. Thus, it seems that in further studies, researchers could investigate relationship between arousal and activation in other functional tasks. This would encourage us to understand the interaction between the scales which reflect our physiological energetic aspects and their behavioral links at the advanced level of sport skills.

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