World Applied Sciences Journal 12 (10): 1877-1882, 2011
ISSN 1818-4952

Effects of Arousal and Activation on Simple and Discriminative Reaction Time in a Stimulated Arousal State

[1]Jaleh Bagherli, [2]Mohammad Vaez Mousavi 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: The researches have been done so far in order to analyze the effects of arousal and activation on performance, focused merely on unstimulated and normal level, with disparate and contradictory results. The study of manipulation of arousal effect on the performance, results in more in-depth understanding. The purpose of current work is to analyze the impacts of stimulated arousal and activation on simple and discriminative reaction time (RT) performance. 30 non-athlete female university scholars (mean age: 21.3) volunteered to execute simple and discriminative RT tasks in unstimulated (Pre-test) and stimulated (Post-test) arousal states. Their Skin Conductance Level (SCL) was recorded constantly during performance. Multiple linear regression indicated that SCL has no effect on simple and discriminative RT performance in unstimulated and stimulated arousal level; whereas activation, reduces simple RT in stimulated arousal level ($p<0.002$). In addition, activation reduced discriminative RT in both unstimulated ($p<0.022$) and stimulated arousal levels ($p<0.001$). The results confirm the impact of activation on performance as well as emphasizing on the importance of the results obtained from real-life studies.

Key words: Activation % Arousal % Simple Reaction Time (RT) % Discriminative Reaction Time (RT) % Skin Conductance Level (SCL)

INTRODUCTION

Reaction time (RT) has been a favorite subject of experimental psychologists since the middle of the nineteenth century [1]. The RT measurement is prevalent in great number of sports activities while it is being studied to measure the speed of information processing. [2]. Despite RT (especially simple RT) depends widely on inheritance, researches indicated that internal factors (such as arousal) and environmental factors (such as number of stimulus - response) affect RT (particularly discriminative RT) [1].

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. These results mostly support Inverted U Hypothesis, which is the most popular explanation of relationship between arousal and performance. On the other hand, non-supportive conclusions lead to the formation of other hypotheses such as Emotion-Performance model, Individual Zones of Optimal Functioning (IZOF), Catastrophe Model, Reversal Theory, etc.

Sjoberg (1968), as well as Martens and Landers (1970) reported the best performance in an average arousal level. Arnet & Landers (2003) observed the optimal performance within the range of 60 - 70 percent of maximum arousal, in simple tasks, which complies with Inverted U Hypothesis. Kerr *et al.*, (2001) noticed that a high level of arousal may result in best performance during short - term strength trainings [3]; Whereas, Bargh & Cohen (1978) demonstrated that Inverted U Hypothesis solely exists in difficult tasks. Contrary to this belief, Collet *et al.*, (1996) suggested that there is only an Inverted U relationship between arousal and

Corresponding Author: Jaleh Bagherli, Department of Physical Education, Science and Research Branch, Islamic Azad University, Tehran, Iran, E-mail: alehbagherly@yahoo.com.

performance in simple tasks, while it is ambiguous in complex tasks. Demoja et al. (1985), Swain & Jones (1993) and Shepperd *et al.*, (2005) reported that better performance is being obtained in high arousal levels.

Pribram & Mc Guiness (1975, 1992) presented a new system called Activation System after studying the brain neurochemical mechanisms. In short, they interpreted different impacts of activation and arousal systems on physiological responses and performance. They noticed that arousal is the result of Amygdala and Reticular Activating System (RAS) activity which merely have affect on physiological responses; whereas the main cause of behavioral response processes is activation, which results from basal ganglia actions. Accordingly, psychophysiological researchers have recently defined arousal and activation as two separate and distinguished concepts and have studied the relationship of performance with each of them separately. Arousal at a particular time has been defined as the energetic state at that moment which is defined by measuring the change of SCL [4-8]. Activation has been also defined as changes in SCL compared to the base level.

Those researchers mentioned that results discrepancies partly depend on incomplete definition or equivalent assumption of various aspects of arousal, such as activation, stress and anxiety. They suggested that defining Arousal and Activation in a separate and clear form may lead to more contrast conclusions and solve part of the available discrepancy. SCL reflects individual's state as well as electrical changes of sweat glands activities on palms and soles momentarily. SCL considered as a key indicator in measuring arousal [9]. In other words, arousal depends on SCL in both baseline and activated states (during a task); whereas activation depends on changes in SCL from the baseline to the task performance. Researchers believe changes in arousal or activation, affect effectively on performance [4-8, 10]. These researchers explained, arousal is related to physiological responses (such as Phasic Orienting Response) but has no relationship with performance. Barry *et al.*, (2004) applied continuous task performance RT in children to study the relationship between activation and performance indicators. They clearly demonstrated that arousal has no relationship with performance (behavioral responses), whereas only activation can anticipate performance. VaezMousavi *et al.*, (2007-A, 2007-B) replicating some aspects of the above research on healthy adults, supported Barry *et al.*, (2005) results of the differentiation between arousal and activation and the influence of activation (not arousal) on performance. As outlined by VaezMousavi *et al.*, (2008), it is valuable to study the differentiation between arousal and activation in field tasks such as sports skills. Barry *et al.*, 2004, 2005; VaezMousavi *et al.*, 2007-A, 2008, 2009, reported a linear (not an inverted U) relationship between activation and performance.

The researches performed so far have studied the effects of Activation on performance in an unstimulated state; while the current research examines the relationship between activation and performance on an individual under increasing arousal condition. 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 whether due to the physiological basis, these situations can affect the relationship between activation and performance, is not clear so far. This work provides unstimulated and stimulated arousal level and studies the relationship between activation and performance in stimulated arousal state, while compares its findings to unstimulated arousal state. Therefore, the hypotheses for the current research are as follows: Activation can predict both discriminative and simple reaction time performance in normal (unstimulated) and arousal states; Arousal can't predict performance in neither stimulated nor unstimulated arousal states.

MATERIALS AND METHODS

Subjects: 30 nonathletic, right-handed, university bachelor's degree female scholars, aged between 18 to 24 years (mean age: 21±3 years old, weight 66±2.4 kg and mean height 173±8.4 Cm), were selected via simple non-probability sampling method for executing this study. None of the subjects had serious head injury, hearing or vision problems with no prior experience in RT task, who voluntarily participated in this study.

Equipment and Tools

Vienna Test System: Vienna Test System designed by Austrian Schuhfried Company, evaluates human being's different types of motor cognitive and psychological performance. This tool is being used in this research to measure the simple and discriminative RT. There were two stimuli in this research: sound and light which the latter appeared in yellow, red and white colors. Two separate push-buttons for resting and reaction task make it possible to distinguish RT from movement time in this research. Mean reaction time is measured on milliseconds.

Procomp Infinity Biofeedback Device: Procomp infinity biofeedback device which includes hardware and software parts, records physiological (in this research: skin conductance level) data. The hardware part contains an 8-sensor precision encoder for collecting physiological data. This system sends sensed signals from the sensors to another part, called TT-USB which is connected to a computer, via an optic fiber. TT-USB coverts Physiological data from analog to digital and the built-in software helps the data being recorded in the output folder.

Procedure: Participants were asked to turn off their mobile or cellular phones or any other electrical devices that may interfere with the biofeedback device system. Then, SCL sensors were connected to participants' right hand middle and index fingers in order to record their continuous SCL during the test, based on MicroSiemens (µS). Participants were presented separately with simple and discriminative RT tasks (5 minutes each), provided by Vienna Device in unstimulated (Pre-test) and stimulated (Post-test) arousal states.

During the test, the reaction was shown by pressing a push-button as quickly as possible after a tone (simple reaction test) or a combination of two stimuli, yellow and red light (discriminative reaction test), was presented. 14 correct stimuli responses collected on the first and 24 ones were collected on the second test.

After accomplishing these tests, the researcher manipulated individuals' arousal level. Participants were asked to execute tests at the maximum of velocity and precision one more time in order to gain a reward. The reward was defined as adding 2 to 5 scores to the final exam of their physical education course. After concluding the previous 2 tests, participants' physiological data was also recorded in a resting state of about 10 minutes. For calculating the Activation, This data considered as a baseline physiological data subtracted from data during performing task.

RESULTS AND DISCUSSION

Participants SCLs which were recorded by biofeedback device during the tests was used as arousal index. In order to measure the activation, Mean time of 120 seconds of minimum SCL level, was considered as baseline; which was subtracted later from simple and discriminative RT task SCL [11, 12].

The study employed stepwise multiple linear regressions model in order to investigate the influence of arousal and activation on simple and discriminative RT performance.

Generally, activation amount during the execution of discriminative task was less than the amount of a simple task. Mean activation during simple RT task in pre-test and post-test were 1.0246 and 1.0606 µs, respectively and their difference was close to significancy ($p= 0.07$); whereas, the same amounts during discriminative RT task were 0.6927 and 0.7665 µs and their difference was statically significant ($p<0.01$).

The study of correlation coefficient showed, there is no relationship between SCL and simple or discriminative RT tasks in neither stimulated nor unstimulated arousal states ($p> 0.05$). The study also showed, there is an inverse relationship between activation and simple RT performance in stimulated arousal state ($p<0.002$, $r= -0.534$). Activation and discriminative RT performance in unstimulated arousal state ($p<0.022$, $r=-0.409$) and activation and discriminative RT performance in stimulated arousal state ($p<0.001$, $r= -0.653$) also had inverse relationships. These findings showed common variance amounts of %25.9, %13.7 and %40.6 respectively.

Variance analysis demonstrated arousal had no impact on simple and discriminative RT in none of the arousal states; however, activation influenced RT in the following three cases:

Simple RT in stimulated arousal state ($p<0.002$, $F_{(1, 28)} = 11.149$), discriminative RT in unstimulated arousal state ($p<0.025$, $F_{(1, 28)} = 5.616$) and discriminative RT in stimulated arousal state ($p<0.001$, $F_{(1, 28)} = 20.80$).

Standardized coefficient ($) amounts revealed that, one standard deviation change results in 0.409 standard deviation change in discriminative RT; while in stimulated activation state, simple and discriminative RTs change -0.534 and -0.653 standard deviation, respectively. These findings are supported by partial correlation amounts ($r_{x1y.x2}= -0.653$) for simple reaction time in stimulated state and ($r_{x1y.x2} = -0.534$, $r_{x1y.x2}= - 0.409$) for simple and discriminative RT in unstimulated arousal state.

The relationships between SCL and activation in simple and discriminative RTs are shown in Figures 1, 2.

Considering more difficult nature of discriminative task, it was expected that activation level in discriminative task becomes more than simple task; while it is observed that activation amount in discriminative task was less than simple task (1.0846>0.6927).

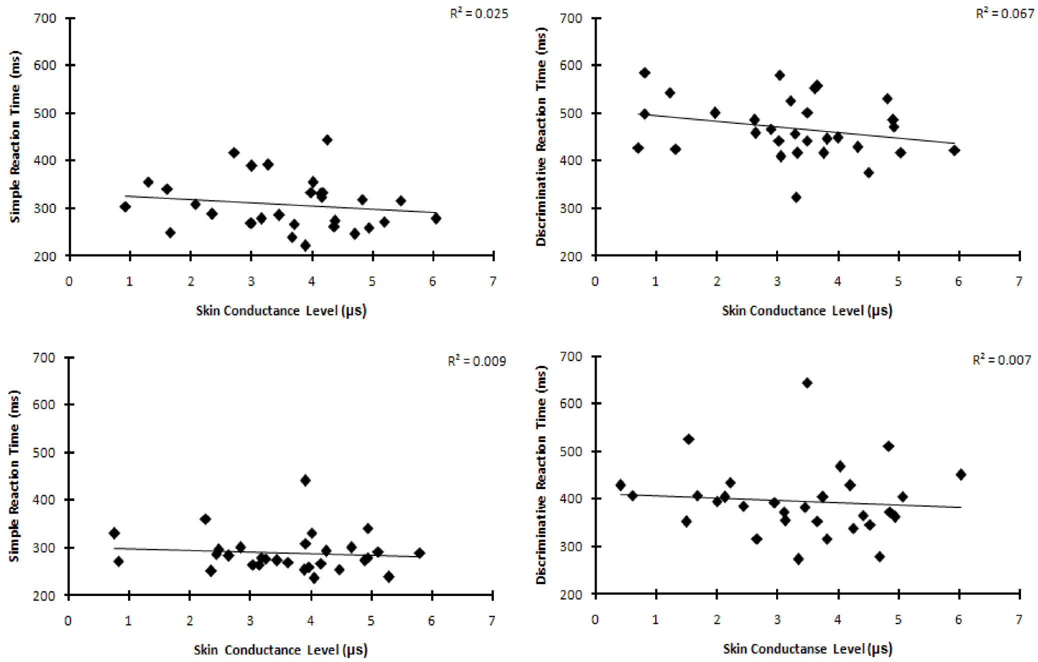

Fig. 1: Simple reaction time mean in unstimulated (left top panel) and stimulated arousal level (left bottom panel) and discriminative reaction time mean in unstimulated (right top panel) and stimulated arousal level (right bottom panel) are plotted as a function of SCL. line of regression and the coefficient of determination indicate, there is no correlation between SCL and reaction time performance in neither stimulated nor unstimulated arousal level

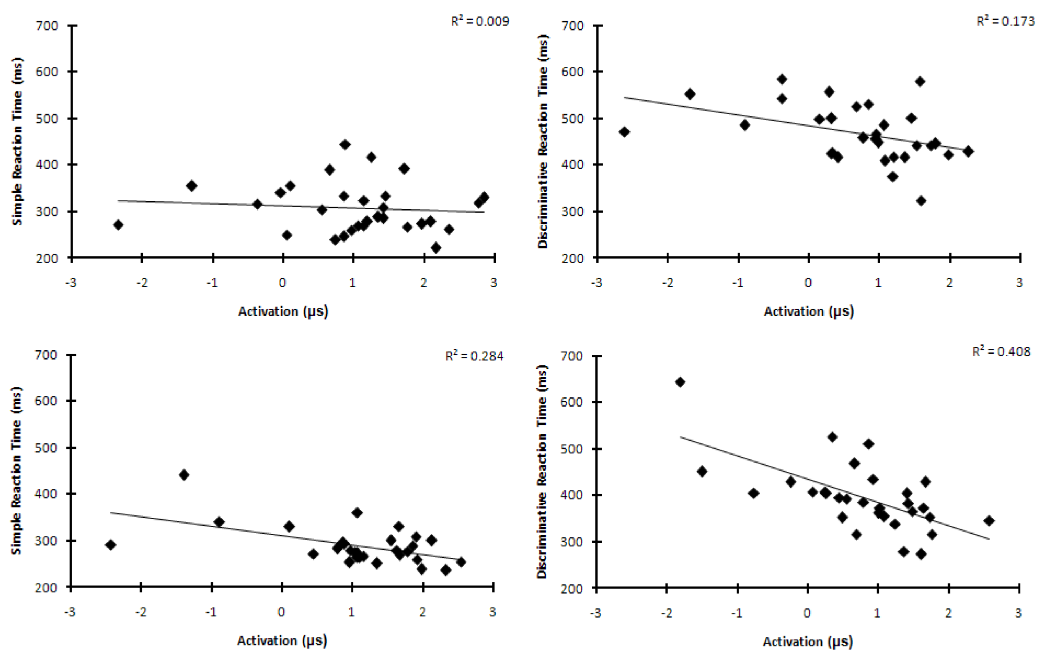

Fig. 2: Simple reaction time mean in unstimulated (left top panel) and stimulated arousal level (left bottom panel) and discriminative reaction time mean in unstimulated (right top panel) and stimulated arousal level (right bottom panel) are plotted as a function of activation. line of regression and the coefficient of determination indicate, activation correlates with either simple reaction time performance in stimulated arousal level or discriminative reaction time performance in unstimulated and stimulated arousal level

This finding is likely related to the nature of activation which is described by Barry *et al.,* (2005) as the activation of nervous system in order to perform behavioral task. Based on this conceptualization, adjusting the activation level according to required task has more impact on optimizing task performance rather than increasing its level. Small amount of activation measured during discriminative task in this research, supports Barry *et al.,* (2005) conceptualization.

Results of this research in line with Barry *et al.,* (2005) & VaezMousavi *et al.,* (2007-A, 2007-B, 2008, & 2009) results show linear relationship between activation and performance. These results are against Sjoberg (1968), Martens and Landers (1970) and Arnet & Landers (2003) and do not follow the inverted U model.

Simple and discriminative RT tasks in both stimulated and unstimulated arousal states didn't change by increasing the arousal (Figure 1).

This result is in accordance with Barry *et al.,* (2005) suggestion which declares arousal has no influence on performance. These results which were confirmed later by VaezMousavi (2007-A, 2007-B, 2008, 2009), demonstrated that physiological responses are being adjusted by Arousal, while Activation affects on performance.

In this research, both simple unstimulated as well as discriminative simulated and unstimulated RT performance states dropped significantly with a rather sharp slope, by increasing the activation (Figure 2). Thus, increase in activation results in decrease in RT and improvement in performance. In other words, activation has no effect on simple RT in unstimulated arousal state; whereas, it has influence on discriminative RT in both states.

These findings confirm Barry *et al.,* (2005) conceptualization which considered arousal and activation as two separate concepts.

Regressions amounts show that applied regressions model was appropriate in which, changes in dependent variable (RT performance) were perfectly demonstrated by independent variable (activation).

Standardized coefficient ($) amounts show that activation proportional share during stimulated arousal RT task state is more than unstimulated state. In other words, the effect of activation on RT performance in a challenging and sensitive situation is more than normal situation.

This research results confirms all its hypotheses which are: activation in stimulated state is an anticipant factor of RT performance; activation in unstimulated state also can partly predict RT task and finally, arousal can't predict performance in both unstimulated and stimulated states.

These findings highlight previous researchers' suggestions in studying the arousal and activation separately. Our results, in accordance with other researches, underline the impact of activation (not arousal) on performance.

These results also show that findings of other researchers can be applied in stimulated arousal state in addition to unstimulated one and activation in competitive situations can affect performance, as well. In future works, psychological variables would be controlled in order to clarify whether individuals' different psychological characteristics lead to any difference in activation - performance relationship under stressful conditions or not.

REFERENCES

1. Kosinski, R.J., 2005. A literature review on reaction time. Retrieved May 14, 2006, from: http://www.biae.clemsion.Edu/Pbc/bP/Lab/110 /reaction time.htm.
2. Schmidt, R.A. and T.D. Lee, 2005. Motor control and learning. (4th ed). Champaign. IL: Human Kinetics.
3. Perkins, D., G. Wilson and J. Kerr, 2001. The effects of Elevated Arousal and Mood on Maximal Strength Performance in Athletes. J Appl. Sport Psychol., 13: 239-259.
4. Barry, R.J., A.R. Clarke, R. McCarthy, M. Selikowitz and J.A. Rushby, 2005. Arousal and activation in a continuous Performance task. J. Psychophysiol., 19(2): 91-99.
5. Vaez Mousavi, S.M., R.J. Barry', J.A. Rushby and A.R. Clarke, 2007a. Evidence for differentiation of arousal and activation in normal adults. Acta Neurobiol. Exp., 67: 179-186.
6. Vaez Mousav, S.M., R.J. Barry, J.A. Rushby and A.R. Clarke, 2007b. Arousal and Activation effects on Physiological and behavioural resPonding during a continuous Performance task. Acta Neurobiol Exp., 67: 461-470.
7. Vaez Mousav, S.M., E. Hashemi-Masoumi and S. Jalali, 2008. Arousal and activation in a sport shooting task. World Appl. Sci. J., 4(6): 824-829.
8. Vaez Mousav, S.M., R.J. Barry and A.R. Clarke, 2009. Individual differences in task-related activation and Performance. Physiology & Behavior 98: 326-330.

9. Barry, R.J. and E.N. Sokolov, 1993. Habituation of Phasic and tonic comPonents of the orienting reflex. Int. J. Psychophysiol., 15: 39-42.
10. Tremayne, P. and R.J. Barry, 2001. Elite Pistol shooters: Physiological Patterning of best vs. worst shots. International J. Psycho Physiol., 41: 19-29.
11. Barry, R.J., A.R. Clarke, R. McCarthy, M. Selikowitz, J.A. Rushby and E. Ploskova, 2004. EEG differences in children as a function of resting-state arousal level. Clin Neurophysiol., 115: 402-408.
12. Barry, R.J., 2004. Stimulus significance effects in habituation o the phasic and tonic orienting reflex. Integ Physiol Behave Sci., 39: 166-179.
13. Bargh, J.A. and J.L. Cohen, 1978. Mediating factors in the arousal-Performance relationship. J. Motivation and Emotion., 2: 243-257.
14. Collet, C., R. Roure, H. Rada, A. Dittmar and E. Vernet-Maury, 1996. Relationships between Performance & skin resistance evolution involving various motor skills. Physiol. Behaves, 59(4-5): 953-630.
15. Demoja, C.A., M. Reitano and E. Caracciolo, 1985. General arousal and performance. Percept Mot Skill. (3 Pt 1): 747-53.
16. Heywood, C., 2006. Psychological aspects of archery. In J. Dasil, (Ed.) The sport psychologist's handbook": A guide for sport-specific performance enhancement. John Wiley and Sons.
17. Pribram, K.H. and D. Mc Guiness, 1975. Arousal, activation & effort in the control of attention. Psychological Review, 82: 116-149.
18. Pribram, K.H. and D. Mc Guiness, 1992. Attention and Para-attention Processing Event- related brain Potential as tests of a model. Ann. N.Y. Acad Sci., 658: 65-92.
19. Robazza, C., L. Bortoli and S. Nougier, 1998. Physiological arousal and Performance in elite archers: a field study. Eur Psychologist, 3(4): 263-270.
20. Shepperd, J.A., J. Grace, L.J. Cole and C. Klein, 2005. Anxiety and outcome predictions. Pers. Soc. Psychol. Bull., 31(2): 267- 275.
21. Swain, A.B.J. and G. Jones, 1996. Explaining performance variance: The relative contribution of intensity and direction dimensions of competitive state anxiety. Anxiety, Stress and Coping: An International J., 9: 1-18.