Middle-East Journal of Scientific Research 16 (5): 571-576, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.16.05.72140

Evaluating Elite Mountaineers' Levels of Attention at Different Altitudes with the D2 Attention Test

Fatih Bektas

Department of Recreation, School of Physical Education and Sports,
Karadeniz Technical University, Trabzon, Turkey

Abstract: The purpose of this study was to investigate theattention performances of the elite-level mountaineers at different altitudes with the help of the D2 test that measured attention. In total 29 people (22 male and 7 female professional athletes specialized in the sports of mountaineering, trekking, skiing, technical climbing, scuba diving), who climbed the Mount Ararat participated in this study. Repeated Measures Analysis of Variance was used to examine the difference between *(Xage = 49,06, Ss = 12.29; Xsport age = 9.41, Ss = 5.65;)*d2 Test scores in the applications were carried out at different intervals and the difference between applications for all scores of the D2 test was found ($p<0.05$). When mean scores were scrutinized, it was observed that there was an increase in the scores of selective attention and sustained attention [TN (Total Number of Items), CP (Concentration Performance)] and error scores [Total Number of Errors (E),(E_2)] after repeated measures. In conclusion, it could be concluded that the level of attention was decreased in higher altitudes; after the peak, lack of motivation was also added to the negative factors increasing the error rate; fatigue. Temporary brain damage (due to the high altitude) was also the reasons of differentiation of attention performances at different altitudes. The D2 attention test was one of the tests that has been used to evaluate visually focused attention performance of the athletes.

Key words: d2 Attention Test · Selective Attention · Sustained Attention · Mountaineering · High Altitude

INTRODUCTION

The majority of human settlements on earth are situated below 1500 meters (on average). In these settlements and areas up to 2500 meters, the changes in the body are not fast enough to cause health problems for an individual or the adaptation mechanisms can cope with every kind of activity very quickly. The altitude, which affects the individual to an extent that adaptation mechanisms of body cannot overcome, begins at 2500 meters and goes up to over 5500 meters elevation and it is defined as high altitude. At high altitudes, the body needs to adjust to lesser levels of oxygen and atmospheric pressure, as the altitude increases. Changes like hyperventilation, heavy breathing, increased urination and heart rate can occur in the body that acclimatizes to the new environment. These changes appear in 24 or 48 hours after the acclimatization begins. If the body cannot adapt to the high altitude of altitude sickness, it can develop problems like acute mountain sickness, high altitude pulmonary oedema, high altitude cerebral oedema, which are categorized under the group of diseases that affect the functions of the brain and lungs, seen especially in people who do not or cannot acclimatize. Acute Mountain Sickness-AMS is a constellation of symptoms that appear as a result of body's low tolerance to the hypoxic-hypobaric (low oxygen -low air pressure) environment above 2500 meters. AMS occurs depending on the speed of climbing, the height reached and adaptation to the altitude and personal ability to adapt [1]. The ability to direct adaptation to the relevant stimulus and to sustain attention is very important for sports. Attention has been defined in various ways in cognitive and neuropsychological literatures. Over the past years, it was often examined especially by experimental psychology [2]. Attention was usually identified with selective perception [3].

Sports have been the focused on studies related to selective attention. According to Singer *et al*. [4] individuals should be able to pay attention selectively

Corresponding Author: Fatih Bektas, Department of Recreation, School of Physical Education and Sports, Karadeniz Technical University, Trabzon/Turkey. Tel: +90 462 2481083.

and concentrate on relevant stimulus while ignoring the irrelevant ones in order to display successful psychomotor skills. Nideffer [5], said that the ability to control thinking process and concentrate on a task was the most necessary pivotal factor for efficient sports performance. At minimum, three analysis levels were used to have a better understanding of the phenomenon of attention in psychology and sports literatures, which are as follows: behavioural level of analysis, cognitive level of analysis, physiological/biological level of analysis. Physiological analysis covers measurements of a large quantity of physiological parameters. Commonly used contemporary ones are as follows: physiological measurements of attentional workland and selective attention; electroencephalographic and magneto encephalographic measurements of the brain activity, measurements related to cerebral blood flow and metabolism, measurements of cardiac variability and slowdown, visual activity measurements in regard to ocular fixations and pupil diameter. Although these methods were widely used for the cognitive tasks, they were rarely employed in the studies related to sports [6]. In Turkey, there are only a few studies about attention in the sports [7, 8].

The purpose of this study was to explore the effects of altitude (as independent variable) on the sustained attention of the athletes by examining the attention levels of elite-level mountaineers at different altitudes.

MATERIALS AND METHODS

Research Group: 22 male 7 female athletes (professional mountaineers besides their sub-branches of trekking, skiing, technical climbing and scuba diving) who came to the Mount Ararat for climbing, participated in the research (Table 1).

Statistics about distribution of participated sportsmen' qualifications by gender were given in Table 2.

Table 3 provided the statistics about their qualifications, distributed by years of education, while distribution by gender and age group was shown in the Chart 1.

Data Collection Tool: The D2 test that was used in the research was developed by Brickenkamp in [9]. In later years, it was subjected to several revisions. The purpose of the test was to evaluate sustained attention and visual scanning ability [10]. In the handbook of the test, "attention and concentration" structure was used to focus on selecting a stimulus and performance-oriented sustainability [11]. The front page of the test included a section for registering participant's personal information and performance results and a line for research. The back page had a standard test form. The test page consisted of 14 lines, 47 signs with letters in each. Each line had 16 different letters,'d' or 'p' marked with one, two, three or four small dashes. During the test, the participant must look for "d"s with two dashes ignoring the unrelated letters and scan the lines to strike them. The test subject would be given 20 seconds for each line. The test can be applied individually or in group [10, 11]. Scores of d2 test and their meanings are given below [10, 11]:

Total Number of Items Processed (TN): The quantitative measure of performance of all items processed both relevant and irrelevant ones.

Total Number of Errors (E): Contains errors of omission (E_1) and errors of commission (E_2).

Percentage of Errors (%E): A variable that measures the quality of performance. It represents the proportion of errors made across all items processed. Lesser the percentage of errors, better the subject's accuracy, quality of the task and attention level.

Total Number-Errors (TN-E): Total number of items processed minus errors. TN-E is a Total Performance score. TN-E, shows normal distribution, it is highly reliable and provides a measure of correlation between accuracy and speed of the performance. However, while TN-E gives more weight to the quantitative side of the performance, it gives less importance to its qualitative side. Under unusual circumstances, when quantitative and qualitative scores (total score and percentage of errors) are exceptionally high; TN-E has a tendency to overestimate the total performance. Overestimations can be avoided by taking error scores into account or alternatively by examining concentration performance score as it is done lately.

Concentration Performance (CP): Is derived from the number of correctly processed items minus E2. In contrast with TN-E, it cannot be distorted by such tendencies like crossing out all letters indiscriminately or skipping over of sections randomly. It's an excellent index with respect to the accuracy of performance and the coordination of speed.

Table 1: Distribution of all athletes participated in the research by gender and branch

	Male		Female		Total	
	Number	%	Number	%	Number	%
Skiing	9	40.9	3	42.9	12	41.4
Techn- Climbing	4	18.2	1	14.3	5	17.2
Trekking	8	36.4	3	42.9	11	37.9
Scuba Diving	1	4.5	0	0	1	3.4
Total	22	100	7	100	29	100

Table 2: Qualifications of all athletes participated in the research

	Male (n=22)		Female (n=7)		Total (n=29)	
	X	SS	X	SS	X	SS
Age (years)	50.5	13.04	44.5	8.92	95	21.96
Sports age (years)	9.6	6.06	8.7	4.57	18.3	11.57
Education (years)	14.7	1.90	13.7	2.13	28.4	4.03

Table 3: Descriptive statistics

	N	*Min.*	*Max.*	*Mean*	*Sd*
TN3200	29	258,00	614,00	502,06	70,09
TN4200	29	350,00	631,00	508,24	64,99
TN4200DE	29	89,00	136,00	109,62	13,53
E13200	29	,00	60,00	23,00	17,15
E14200	29	,00	55,00	27,65	16,85
E14200DE	29	26,00	46,00	35,75	4,96
E23200	29	,00	17,00	3,65	3,91
E24200	29	,00	12,00	3,82	3,08
E24200DE	29	25,00	46,00	35,10	5,08
CP3200	29	99,00	252,00	162,03	42,34
CP4200	29	20,00	142,00	88,06	26,27
CP4200DE	29	-35,00	-5,00	-19,13	7,189

Table4: Results of Repeated Measures ANOVA

Source of Variance	Sum of Squares	Sd	Mean Square	F	p
Between subjects	45296.72	28	1617.74		
Measure	1.096	2.639	4155609.57	1006.68	.000
Error	304978.79	73.881	4128.00		
Total	350276.61	137.475	3960012.13		

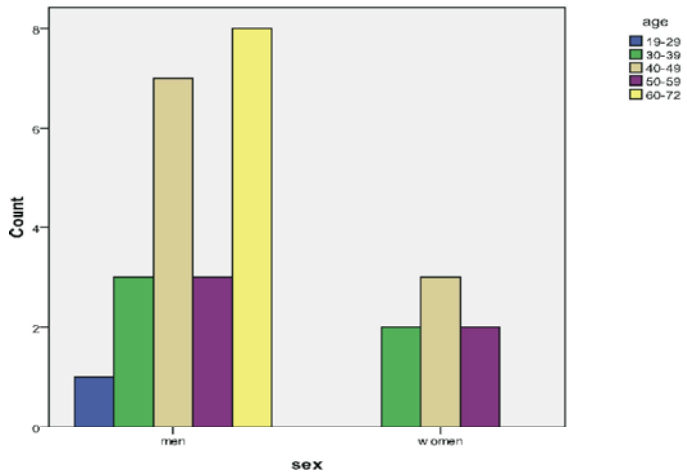

Chart 1: Distribution of the athletes participated in the research by gender and age groups

The Fluctuation Rate (FO): Is the difference between maximum number of items processed-minimum number of items processed and the line with the maximum number of items-the line with the minimum number of items processed. It's one of the less reliable measurements of the test. Excessive FO scores may indicate an inconsistency in work speed, which might be related to poor motivation [8].

D2 test was adapted to athletes in Turkey by Çağlar and Koruç [8]. Cronbach's Alpha-coefficient of internal consistency was calculated as follows: (n=701), TN=0.95, E=0.93, %E=0.93, TN-E=0.96, CP=0,96. The correlation between two halves of the test and Spearman Brown coefficient of internal consistency were found as follows: (n=701) r=0.92 for the first and second seven lines of TN, r=0.86 for E, r=0.87 for %E, r=0.93 for TN-E, r=0.93 for CP.

Gathering Data: The participants were elite-level mountaineers; all of them were foreigners, who visited the Mount Ararat at different time intervals to climb its peak. After explaining the test protocol, the test was administered to the subjects in groups of 2 or 3 at the main camp (3200 meters) and at the intermediary camp (4200 meters) before the peak. After the peak, the test was repeated with the same groups at the intermediary camp (4200 meters) in the tents before breaking the camp. The interval between tests was two days.

Analysis of Data: Besides descriptive statistics, applied to all data, Repeated Measures ANOVA was employed.

RESULTS

While comparing the tests, significant differences were found between the means. (F=1006.68, p<.000). When descriptive statistics were examined, although no significant difference was found between the means of 1st measurement (TM3200) and 2nd measurement (TM4200), a significant difference was seen in the means of 3rd measurement. A scrutiny of averageerror scores revealed a significant increase in the errors at E1 3200, E1 4200 and E1 4200. Although there was a difference between the means of E2 3200 and E2 4200, it was not significant. Nevertheless, it was highly significant compared to the E2 4200 on descending. There were also significant differences between CP 3200, CP 4200 and CP 4200 on descending.

DISCUSSION

Attention is seen as one of the most important psychological skills affecting the success of an athlete's performance, since ability for mental effort is fundamental for the athletes' maximum performance [12-14]. This research aimed to examine attention performances of the mountaineers (depending on their altitudes) by the d2 test. When findings were compared for different altitudes, a significant difference was found between the means (F=1006.68, p<.000). Based on descriptive statistics and means, it can be said that although the difference between TN 3200 and TN 4200 was minimal, a positive and statistically significant correlation existed between TN 3200 and TN 4200 (r= 0.703, p= 0.01), which means, the participants who processed more items at 3200 meters also processed more items at 4200 meters. When we looked at the descriptive statistics of the means of TN 4200-descending, it showed a significant decrease in the items processed. For example, Maxeiner [15] compared the performances of 30 gymnasts and 30 tennis players with the d2 test and contrasted two performances with the reaction-time test in which the participants were asked to start pedaling as soon as a square appears on the screen. The participants were given either a single test (the d2 test or the reaction time test) or multiple-simultaneous tests of both d2 test and reaction-time test. Reaction times for gymnasts showed significant and strong increases in tests with multiple tasks (approximately 28%). No significant difference was found in the single test situations between the gymnasts and the tennis players. The writer concluded that although the tennis players displayed better attention distribution skills compared to the gymnasts, there was no significant difference between tennis players and gymnasts with respect to the D2 test items processed and error rates either in singular or multiple tests. While TN and error rates didn't reveal a significant difference in terms of attention deficit for the branches of tennis and gymnastics, our study found a difference between professional mountaineers for the first two tests and this rate showed a significant difference in the last test. It can be said that the reason for this was the heaviness of conditions that affect the level of attention at higher altitudes. In their study about anxiety and attention, Vickers and Williams [16], examined the relationship between visual attention control and workload stimulation under low and heavy pressure for the elite biathletes. As we can understand from this

example, Ibrahiem M.M and at al [17], found that keeping one's knowledge to oneself is not what knowledge management requires, since such knowledge must be transferred with sharing through inter-organizational knowledge ease and must not be withheld.

One of their findings was as follows: for these biathletes both fixation to a target, which is known as the quiet eye duration and attention level were susceptible to performance disruption as physiological arousal increased to maximum. In broader terms, the most important characteristic of the phenomenon of panicking seemed to entail a paradox with regard to the motivation. Especially the performance of an athlete, who panics, decreases as much as he strives for a better performance. In our study, it is possible to talk about the existence of anxiety by looking at the average age (18.3), sports branches (skiing, technical climbing, trekking, scuba-diving) of the participants; this anxiety together with the high altitude effect and weariness, contributed to the significance of the results of TN, E1, E2 and CP.

When we examined E1 3200, E1 4200 and E1 4200 on descending, we observed an increase in the items unprocessed. The increase of unprocessed items at the altitude of 4200 when descending can be explained by weariness and lack of concentration. Although closer examination of means of E2 3200, E2 4200 and E2 4200 (on descending) showed that the rate of wrongly processed items was low between E2 3200 and E2 4200, this rate increased significantly in E2 4200. It was clear that as the altitude increased, error rates also increased while the scores of selective and sustained attention (TN, TN-E, CP) decreased. This showed that practice effect was not seen in the test scores. It can be said that increase in the error scores was directly related with lesser oxygen levels at higher altitudes. The d2 test has never been studied for the mountaineers and other athletes in Turkey. Thus, this study neither confirmed nor contradicted previous studies.

CONCLUSION

To sum up, it could be concluded that the level of attention was decreased at higher altitudes; after the peak, lack of motivation also joined to the negative factors increasing the error rate; fatigue and temporary brain damage (due to the high altitude) were the reasons of differentiation of attention performances at different altitudes, that were measured by the D2 attention test, which was one of the tests that had been used to evaluate visually focused attention performance of the athletes. In high-altitude mountaineering. It is known that most accidents occur on descending. In our study, the finding about higher error rates at 4200 meters on descending showed the relevance of this popular wisdom suggesting that most accidents happen while descending.

Depending on the conclusions of the research, following recommendations should be followed:

- This research can be a source for understanding attention levels of the mountaineers.
- The D2 test can be used as a tool to measure the attention levels of athletes according to their branches.
- The D2 attention test can be used as a strong *research tool* for understanding, exploring and revealing the levels of athletes with regard to the concept of "*attention*".
- Norms for attention can be determined for the athletes in Turkey.

REFERENCES

1. http://www.explorer.gen.tr/teori/yih1.htm [date of access: 21.12.2012].
2. Kahneman, D., 1973. Attention and Effort. New Jersey: Englewood Cliffs, Prentice Hall.
3. Hocker, H., 2004. Aufmerksamkeitstests-Konzentrationstest. (14th edition). Dorsch, F. (ed). Dorsch Psychologisches Wörterbuch. Bern: Huber.
4. Singer, R.N., J.H. Cauraugh, L.K. Tennant, M. Murphey, D. Chen and R. Lidor, 1991. Attention and Distractors: Considerations For Enhsncing Sport Performances. International Journal of Sport Psychology, 22: 95-114.
5. Nideffer, R.M., 1993. Concentration and Attention Control Training. Williams, J.M. (ed). Applied Sport Psychology Personal Growth To Peak Performance. California: Mayfield Publishing Company.
6. Abernethy, B., J. Jsummers and S. Ford, 1998. Issues in the Measurement of Attention. Duda, J.L. (ed). Advances in Sport and Exercise Psychology Measurement. Morgantown: Fitness Information Technology.
7. Çolakoğlu, M., Ş Tiryaki and S. Moralı, 1993. The Effect of Concentration Studies to on the Reaction Time. Journal of Sport Sciences, 4(4): 32-47.

8. Çağlar, E and Z. Koruç, 2006. Reliability and Validity of d2 Test of Attention for Athletes. Hacettepe J. Sport Sciences, 17(2): 58-80.
9. Brickenkamp, R., 1962. Aufmerksamkeits-Belastungs-Test (Test d2). [The d2 test of Attention] (1th edition). Germany, Göttingen: Hogrefe.
10. Spreen, O. and E. Strauss, 1998. A Compendium of Neuropsychological Tests: Administration, Norms and Commentary: Administration, Norms and Commentary. (2th edition). New York: Oxford University Press.
11. Brickenkamp, R and E.A. Zillmer, 1998. d2 Test of Attention. Germany, Göttingen: Hogrefe & Huber.
12. Mahoney, M.J., J.G. Tyler and TS. Perkins, 1987. Psychological Skills and Exceptionalathletic Performance. The Sport Psychologist, 1: 181-199.
13. Orlick, T. and J. Partington, 1988. Mental Links to Excellence. The Sport Psychologist, 2: 105-130.
14. Thomas, P.R. and R. Over, 1994. Psychological and Psychomotor Skills Associatedwith Performance in Golf. The Sport Psychologist, pp: 873-886.
15. Maxeiner, J., 1987. Concentration and Distribution of Attention in Sport. International Journal of Sport Psychology, 18: 247-255.
16. Vickers, J.N. and A.M. Williams, 2007. Performing Under Pressure: The Effects of physiological Arousal, Cognitive Anxiety and Gaze Control in Biathlon. Journal of Motor Behavior, 5: 381-394.
17. Ibrahiem M.M. El Emary, Bader A. Alyoubi and Mohammad J. Arif, 2012. Toward Investigating the Requirements of Knowledge Management in the Arab Cities: Case Study of the Dubai City. Middle-East Journal of Scientific Research, 12(3): 357-364.