THE EFFECTS OF BASIC MILITARY TRAINING ON SHOOTING TASKS IN CONDITIONS OF SLEEP DEPRIVATION

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Abstract:

The aim of this research was to determine the influence of Special Operations Battalion (SOB) basic training on specific shooting tasks in conditions of sleep deprivation. The research was conducted on a sample of 19 members of the Croatian Armed Forces for Special Operations. A specific task of shooting was carried out in four different ways with regard to body position in relation to the target (Sector 1-4). The shooting target was a head and chest silhouette. The paired-samples *t*-test has shown significant differences ($p<.05$) in the specific tasks of shooting before and after sleep deprivation. In addition, the results have shown that the SOB basic training had a positive impact on the reduction of sleep deprivation effects in shooting tasks. The obtained data suggest that during the SOB basic training (62 days), adaptation to stress and improvement of the skills of handling weapons has occurred, contributing significantly to better shooting results in stressful conditions, primarily in terms of lack of sleep.

Key words: *military personnel, fatigue, specific shooting task, acute sleep deprivation*

Introduction

Specific tasks in the military, such as shooting, are one of the most important segments of the combat effectiveness of soldiers. Since during the implementation of operations soldiers are often placed in situations with an insufficient amount of sleep, resulting in a reduction of capabilities (Guezennec, Satabin, Legrand, & Bigard, 1994; Jouanin, et al., 2004; Mcbride, Balkin, Kamimori, & Killgore, 2006; Nindl, et al., 2002; Welsh, et al., 2008), this would certainly affect combat effectiveness. Current military tasks often require combat readiness of soldiers who are likely to spend a continuous period of activity without sleep. This is of significant importance for the operation since the special operations are carried out mainly at night, and due to the large number of tasks that are carried out nowadays by special operations forces, there are frequent cases of sleep deprivation.

Some of the earlier studies have used different tasks through which they studied the impact of lack of sleep on motor performance (Webb, Kaufmann, & Devy, 1981). However, some studies were focused on the tasks that assess fundamental skills, such as prudence and reaction time (Krueger, 1989; Pilcher & Huffcutt, 1996). In fact, a great number of researches have shown that sleep deprivation and chronic sleep restriction have affected various tasks even when they are simple, monotonous and well trained (Belenky, et al., 2003; Cajochen, Knoblauch, Krauchi, Renz, & Wirz-Justice, 2001). Despite the fact that the tasks that are less interesting could be very sensitive to the effects of sleep deprivation, there is still a need for studies that examine the effects of sleep deprivation on a wider range of tasks, especially tasks that are relevant and significant to the real working environment, particularly those related to the military.

Studies on sleep deprivation indicate that it negatively affects the performance of a wide range of tasks (Harrison & Horne, 2000; Philibert, 2005), such as complex cognitive tasks, the ability to understand, adapt and plan in rapidly changing conditions, decision-making abilities, mental flexibility and divergent thinking, the basic cognitive functions, including vigilance, reaction time, care and attention (Wesensten, Belenky, Thorne, Kautz, & Balkin, 2004), negative changes in mood (Angus, Heslegrave, & Myles, 1985; Kajtna, Stukovnik, & Dolenc-Groselj, 2011; Scott, McNaughton, & Pol-

man, 2006), an increase of negative emotions in response to unpleasant events and the reduction of positive emotions in response to pleasant experiences stimulate anxiety in healthy subjects (Vardar, et al., 2007).

However, it is still not clear what type of cognitive tasks sleep deprivation impairs. Harrison and Horne (2000) found that sleep deprivation reduces the efficiency in performing complex cognitive tasks when the task requires cognitive skills, decision-making, creative thinking, effective communication and revision plans. Long-term (chronic) lack of sleep causes pseudo-illusions, real illusions and hallucinations in a person, especially at night. Haslam (1984) stated that the consequences of sleep deprivation are more psychological than physiological, and this is a high probability of military inefficiency after 48 – 72 hours of lack of sleep.

The most important impact of sleep deprivation is on the performance of shooting. Based on that assumption, Antal (1975) conducted a study in which he showed the decrease in shooting performance as a result of a lack of sleep. Shooting after acute sleep deprivation (24 hours) was still fairly accurate. However, after an extended time of not sleeping, the results got worse. The worst performance was in the period from midnight to 5 a.m. Similar results were confirmed by Tharion, Shukitt-Hale and Lieberman (2003), where degradation of shooting performance was measured after 22 hours of sleep deprivation. Furthermore, they confirmed that sleep deprivation affected the decrease in shooting accuracy, and that caffeine can decrease the time needed to detect the target. Haslam (1984) showed that a period of more than 48 hours without sleeping resulted in 25% less target hits during the prone position. Furthermore, when sleep deprivation was prolonged to 90 hours and stationary targets were aimed at without a time limit, shooting was less accurate (10%), compared with the initial firing, which was conducted at targets that have occurred randomly at different locations.

Lieberman, Tharion, Shukitt-Hale, Speckman and Tulley (2002) suggest that sleep deprivation along with environmental stress can adversely affect the performance of military tasks, and that in combination with other stressors it causes a significant reduction in precision shooting and increases the time taken to observe the target.

However, despite the fact that numerous studies investigated the effect of sleep deprivation on performance, the results are not always interpretable. Very few papers that examined the impact of sleep deprivation on the performance of tasks were specifically linked to the performance such as precision shooting (Pilcher, Band, Odle-Dusseau, & Muth, 2007).

Based on this, we can conclude that any further research on the impact of sleep deprivation on the specific tasks in the military, such as assault rifle shooting, will be of significant importance. Therefore, the aim of this research was to determine the influence of SOB (Special Operations Battalion) basic training on specific shooting tasks in conditions of short-term sleep deprivation.

Methods

The research was conducted on a sample of 19 members of the Croatian Armed Forces called Special Operations Battalion (SOB) (age 24.10 ± 2.17 years; height 179.04 ± 6.40 cm; body mass 81.74 ± 7.45 kg). The population from which the sample has been chosen were healthy and physically active people. The term *healthy people* implies that a person has undergone a medical examination for military paratroopers and a *physically active person* means that a person is engaged in various sporting disciplines.

All the subjects were submitted to a health inspection before the testing and only the ones with adequate health status and with the doctor's permission were allowed to participate in the study.

The group that underwent the training was to undergo a planned, programmed and standardized treatment of military training that lasted 62 days and during that time had strictly controlled life and work conditions (Table 1). Strictly controlled conditions relate to the complete isolation from the outside world, the same kind of food, the same type of accommodation, the same amount of sleep, the same geographic, that is, weather conditions (cold, heat, water, rain, and wind) and the same amount of the total training load. The process of this training is very similar to Ranger training conducted by the U.S. Army ground forces.

Procedure

Specific shooting tasks are related to the instinctive shooting with an automatic rifle AK-47 in four different ways with regard to body position that is in relation to the target – Sector 1, Sector 2, Sector 3 and Sector 4. This task was carried out in specific tactical situations.

The procedures of shooting task

Sector 1

1) Take the basic stance (feet at the width of the hips, knees slightly bent, holding the rifle with both hands, the rifle barrel is located at 45 degrees in front of the body and aimed at the floor, look towards the target); 2) Spot the target (a soldier notices the situation and finds the target); 3) Make a half step forwards with the left foot and take the position for shooting; 4) Bring the gun to the shoulder joint and turn it towards the target; 5) Execute shooting (Targeting reticle is made via the front with both eyes open, the shot in the target is with a

Table 1. Basic training protocol for the Special Operations Battalion (62 days)

	Phase				
Programme elements	**I**	**II**	**III**	**IV**	**V**
Long-distance cross-country running	14	1	4	3	/
Muscle endurance drills	16	3	4	3	/
Swimming	/	8	/	/	/
Drills with natural accessories	4	/	/	/	/
Martial arts	10	2	4	4	2
March	5	/	1	/	21
Obstacle course	6	/	/	/	2
Swimming with gear	/	5	/	/	/
Rowing	/	5	/	/	/
Mountain and rock climbing	1	/	7	1	/
Parachuting	5	/	/	/	/
Tactical drills	35	15	*	21	**

* Tactical drills in the third phase were carried out as a part of mountain and rock climbing assignments.
** Tactical drills in the fifth phase were carried out as a part of marching assignments.

two-bullet shot, hammer pair technique); 6) Return to the basic stance.

Sector 2

The procedure for sector 2 is the same as the previous one except this time the shooter is turned 90 degrees to the left from the target.

Sector 3

The procedure for sector 2 is the same as the previous one except this time the shooter is turned 90 degrees to the right from the target.

Sector 4

The procedure for sector 4 is the same as the previous one except this time the shooter is turned 180 degrees from the target (looking away from the target).

The target for shooting was a head and chest silhouette (Figure 1). The distance from the target was 15 metres and the shooting was with two-bullet shots, one shot immediately followed by the second. Shots were taken after the signal for the start of the implementation of the tasks. After firing a two-bullet shot, the participants returned to the starting position and the task started all over again. One task (shooting in one sector) lasted until all the ammunition in the magazine (30 pieces) was spent.

Specific tasks were measured by shooting the target (Figure 1) in four different ways (Sectors 1-4). One sector was tested with a full magazine of 30 rounds, a total of 120 rounds per participant. The final score of each sector was the sum of the confirmed target hits, thus the maximal score of each sector could be 30.

The initial measurement procedure was implemented in a way that in the first week the SOB participants had a specific shooting task after a normal

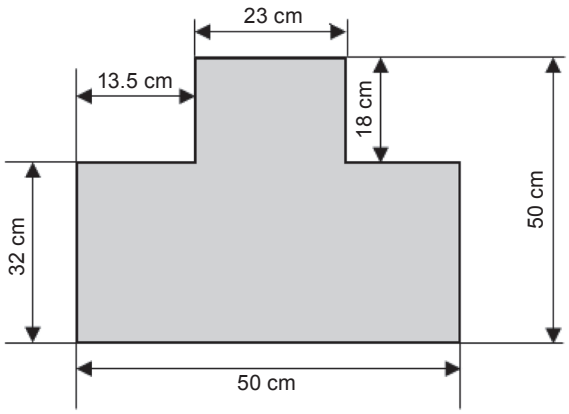

Figure 1. Target – head and chest silhouette

sleeping routine. Then, a period of sleep deprivation followed (48 hours). After sleep deprivation, the shooting task was conducted in the same conditions.

The final measurement was carried out in the last week of the SOB basic training, again the specific shooting task identical to the initial procedure was conducted. During the period without sleeping the participants spent their time according to the prescribed curriculum of the SOB basic training.

Statistical analyses

The collected data were analysed using Windows statistical software (Statistica for Windows 7.0). Descriptive statistics were calculated for all experimental data. Kolmogorov-Smirnov test was used to test the data for normal distribution. Effect sizes (ES) were calculated for the magnitude of treatment effects within the groups. The paired-samples *t*-test was used to determine if significant

differences in specific variables of shooting between the initial and final measurements existed. The percentage difference for the results (%) was also calculated to get an insight into the percentage by which one group was either better or worse than the other in the observed variables. Variable differences were obtained by subtracting the number of hits in the target after 48 hours of sleep deprivation with the number of hits in the target prior to the 48-hour sleep deprivation for each sector.

Results

Kolmogorov-Smirnov test results indicated that variables of specific shooting did not differ significantly from normal distribution. The analysis of other statistical parameters has shown that the mean values were lower after 48 hours of sleep deprivation in all variables at the beginning and end of the training (Table 2). The values of standard deviation indicated relatively little variability in the results of shooting across all measurement points. Also, the values of all shooting variables were smaller in the final measurement after sleep deprivation when compared with the initial results of shooting before sleep deprivation (Table 2).

The results of shooting before sleep deprivation in the initial test (21.79 ± 5.08) were lower than in the final shooting (24.16 ± 4.55), although not statistically significant (Table 3). Significant change was found in variable Sector 4, where the *t*-test showed that the differences before and after the basic training were statistically significant (Table 3). This variable had the largest effect size (ES=.46).

The results obtained from the initial and final testing before and after sleep deprivation confirmed a significant negative impact of lack of sleep on the shooting task performed after sleep deprivation in all the positions tested and in both the initial and final testing (Table 4).

Table 2. Descriptive information for specific shooting tasks

	Before sleep deprivation (N=19)		**After sleep deprivation (N=19)**	
	Initial testing	Final testing	Initial testing	Final testing
Sector 1	21.79±5.08	24.16±4.55	17.74±5.09	21.05±3.66
Sector 2	24.21±3.38	24.79±3.55	19.11±4.29	20.84±3.18
Sector 3	23.47±3.86	23.63±4.23	17.84±5.21	20.74±3.83
Sector 4	23.11±4.93	24.63±3.85	18.16±4.73	21.89±3.48

Values are means ± SD, initial testing = before basic training, final testing = after basic training

Table 3. The results of paired-samples t-test in differences variable between the initial and the final testing before and after the basic training

	%	**ES**	**Diff.**	**t**	**p**
Sector 1	10.36	.14	0.94	0.63	.54
Sector 2	13.16	.32	1.16	1.46	.16
Sector 3	12.1	.41	2.00	1.95	.07
Sector 4*	9.13	.46	2.21	2.19	**.04**

% – percentage difference between groups, ES – effect size, Diff. – differences variable
* Statistical significance (p<.05).

Table 4. The results of paired-samples t-test of shooting in the initial and the final testing before and after sleep deprivation

	INITIAL before vs after					**FINAL before vs after**				
	%	ES	Diff	t	p	%	ES	Diff	t	p
Sector 1	- 18.59	.37	4.05	3.14	**.01***	-12.87	.35	3.11	8.68	**.00***
Sector 2	- 21.07	.55	5.11	6.93	**.00***	-15.93	.50	3.95	7.74	**.00***
Sector 3	- 23.99	.52	5.63	5.15	**.00***	-12.23	.34	3.63	6.51	**.00***
Sector 4	- 21.42	.45	4.95	4.73	**.00***	-11.12	.35	2.74	9.62	**.00***

% – percentage difference between groups, ES – effect size, Diff. – differences variable
* Statistical significance (p<.05)

Table 5. The results of paired-samples t-test of shooting in the initial and final measurement before sleep deprivation and after sleep deprivation

	Before sleep deprivation					After sleep deprivation				
	%	ES	Diff.	t	p	%	ES	Diff.	t	p
Sector 1	10.88	.23	-2.37	-1.63	.12	18.66	.35	-3.32	-2.57	**.02***
Sector 2	2.40	.08	-0.58	-0.55	.59	9.05	.22	-1.74	-2.14	**.05***
Sector 3	0.68	.02	-0.16	-0.15	.88	16.26	.30	-2.16	-1.96	.07
Sector 4	6.58	.17	-1.53	-1.05	.31	20.54	.41	-3.74	-3.08	**.01***

% – percentage difference between groups, ES – effect size, Diff. – differences variable
*Statistical significance (p<.05)

The difference in the results before and after sleep deprivation at the end of the SOB basic training was statistically significantly smaller than the difference in the results before and after sleep deprivation at the beginning of the training (Sectors 1, 2 and 4; p<.05) (Table 5). A significant difference found also indicated that the results of shooting after sleep deprivation were better at the end of the SOB basic training.

The results of the *t*-test showed a statistically significant difference in the number of hits in the target in the variable specific shooting in the initial and final testing, before and after the 48-hour sleep deprivation. The number of hits after sleep deprivation in both points of testing was significantly lower in all variables.

Discussion and conclusions

The SOB basic training and its curriculum had a positive impact on the performance of specific shooting in terms of sleep deprivation. The skill of performing specific shooting tasks among all the participants at the beginning of the SOB basic training was at a relatively high level, which can be seen from the shooting result in the initial measurement before sleep deprivation. The participants were exposed, during the SOB basic training, to different specific and situational shootings and the emphasis was on working in a stressful environment with the implementation of complex tactical actions. In relation to other variables, the variable Sector 4 represents a complex and demanding action, especially in a state of intense fatigue. Due to the complex mode of this variable, it requires a greater level of stability during the performance.

Because experience and a stable shooting position are vital for successful shooting, it is obvious that during the SOB basic training there has been a significant improvement in shooting skills, especially under stressful conditions. Continuous handling of weapons in different environments and different specific and situational tasks under stressful conditions have contributed to experience, better skills and developing greater security and improvement of quick reactions with weapons. This was one of the reasons for better shooting in the final testing after sleep deprivation, which led to significant changes in specific shooting at the end of the SOB basic training.

The obtained results are in accordance with some other studies (Belenky, et al., 2003; Tharion, et al., 2003). However, Lieberman et al. (2002) have found that the precision was relatively well preserved after a period of short-term sleep deprivation. Moreover, the soldiers had relatively good precision after they experienced lack of sleep but problems arose in identifying targets. The soldiers who participated in this study were constantly exposed to different stressors along with sleep deprivation, like reduced food intake and high levels of physical activity. Previous studies suggest that such conditions cause a significant reduction in the shooting accuracy and increase the time to observe the target (Belenky, et al., 2003; Lieberman, et al., 2002). The sleep deprivation and the previously mentioned stressful conditions contributed to a significant reduction in the number of hits after the 48-hour sleep deprivation.

As shown in the results, no significant difference was found in the initial and final shooting measurements before sleep deprivation. This means that the soldiers were equally good at shooting at the beginning and the end of the SOB basic training, before 48-hour sleep deprivation, which was confirmed by the percentage of shooting success that ranged from 77% – 82%. However, there were significant differences in the variables after sleep deprivation in the initial and final measurements, that is, at the beginning and at the end of the SOB basic training. Significant differences were found in the variables *Sector 1*, *Sector 2* and *Sector 4*. These results showed that at the end of the SOB basic training, negative impact of sleep deprivation on the specific shooting decreased, which was reflected in a significantly higher number of hits in the target in spite of insufficient sleep. Since throughout the training programme, the participants were constantly subjected to a reduced amount of sleep, we can conclude that it was the regimen of life and work that led to the positive adaptation. It enabled

better results in shooting at the end of the basic training.

It is known that a reduced amount of sleep significantly affects the cognitive and motor performance that is similar to alcohol intoxication (Williamson & Feyer, 2000). So, we can also assume that the presented programme lead to some psychological and physiological changes, which allow a better functioning under stressful conditions. Better shooting results are the consequences of better tolerance to the psychological stress developed during the training.

It is known that stressors such as heat and high levels of physical activity affect the accuracy of shooting (Antal, 1975). As noted, participants in the SOB basic training are constantly in stressful situations, and those who manage to finish the basic training inevitably have to learn to cope with similar levels of stress that short-term sleep deprivation can cause. In addition, the soldiers are constantly expected to perform best under stressful conditions. So, they are expected to do well and to shoot when they are tired, weary or in poor weather conditions.

One additional psychological criterion that pushes participants to the maximum performance is the fact that any candidate can be removed from training at any time if performed poorly. Trainees are aware that they must operate in difficult conditions and that their success depends mostly on themselves. One of the most important aspects that contribute to the successful completion of the SOB basic training is the specific mind-set: one knows he/she can give his/her best, regardless of fatigue, pain and discomfort. This is one of the goals of the SOB basic training. A member of a special unit must overcome the effects of stress and with training adaptation learn to gain a psychological advantage in the execution of the tasks.

The results indicated that there were significant differences in shooting accuracy after sleep deprivation at the beginning and at the end of the SOB basic training, which confirmed the negative impact of lack of sleep on the precision in shooting. However, the results of shooting following sleep deprivation at the end of the SOB basic training were better in the three variables than the results of shooting following sleep deprivation at the beginning of the SOB basic training. The obtained data suggest that during the SOB basic training, adapting to stress and improving the skills of handling weapons has occurred which contributed significantly to better results in shooting under stressful conditions such as short-term sleep deprivation.

The conclusion based on the analysis of the results presented is that the adaptation to stress, improvement of shooting skills, increased experience and safety in working with weapons have led to an improvement of shooting performance under demanding conditions. The results obtained, due to the high relevance of the tasks performance in a close to real situation, should be primarily viewed from the standpoint of usefulness in practice.

Further research that would include different stressful stimuli, such as longer periods of sleep deprivation, different weather conditions and physical activity in the various specific forms of shooting could further contribute to the understanding of this problem.

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UČINCI TEMELJNE VOJNE OBUKE NA ZADATKE GAĐANJA U UVJETIMA LIŠAVANJA SNA

Cilj je ovog istraživanja bio utvrditi utjecaj osnovnog treninga bojne za specijalna djelovanja na specifični zadatak gađanja u uvjetima nedostatka sna (prisilne produžene budnosti). Istraživanje je provedeno na uzorku od 19 pripadnika Hrvatskih oružanih snaga ogranka Bojne za specijalna djelovanja. Specifični zadatak gađanja je proveden na četiri različita načina s obzirom na početni položaj tijela u odnosu na metu (sektori 1-4). Meta je bila silueta čovječje glave i prsa. Zavisni *t*-test je pokazao značajne razlike ($p<.05$) u specifičnim zadacima gađanja puškom prije i nakon lišavanja sna. Nadalje, rezultati pokazuju da osnovni trening bojne za specijalna djelovanja pozitivno utječe na smanjenje negativnih učinaka lišavanja sna u izvođenju specifičnog zadatka gađanja puškom. Ovo istraživanje pokazuje da tijekom bazičnog treninga bojne za specijalna djelovanja dolazi do adaptacije na stres izazvan nedostatkom sna te da se vještina rukovanja oružjem poboljšava. Sve zajedno, osnovni trening bojne za specijalna djelovanja (62 dana) pokazao se kao pozitivan faktor koji značajno doprinosi boljim rezultatima gađanja puškom u stresnim uvjetima kao što je to nedostatak sna.

Ključne riječi: *vojno osoblje, umor, specifični zadatak gađanja, akutni nedostatak sna*