Effects of a 3–day survival training on selected coordination motor skills of special unit soldiers

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Andrzej Tomczak

General Staff of the Polish Armed Forces, Poland

Source of support: departmental sources

Received: 7 September 2011; **Accepted:** 13 July 2012; **Published online:** 22 July 2013

ICID: 1059798

Abstract

Background & Study Aim: Survival training is gaining popularity in Polish Armed Forces since soldiers on military missions are likely to fight for survival. The aim of the study was the effects of a 72-h workout combined with sleep deprivation on selected motor coordination and psychomotor indices in soldiers from a special unit.

Material & Methods: Eight male soldiers from a special unit exercised for 72 h under restricted sleep conditions. They were examined 4 times (Day 1: before the training; Day 2: after 32 h of training; Day 3: after 44 h of training; Day 4: after 72 h of training) using the following tests: motor adjustment skill, computer-aided perception skills, body balance disturbation tolerance skills (BBDTS) and handgrip force differentiation.

Results: The results of the divided attention test remained practically unchanged throughout the training. Handgrip force differentiation (Error corr.) significantly ($p<0.01$) worsened on Day 4 compared with other days (86 ± 74 vs. 26 to 35). The number of mistakes in the Rotational Test significantly increased in subsequent measurements from 4.4±3.8 on Day 1 to 9.4±1.4 on Day 4. Also the velocities in all 4 running tests significantly ($p<0.05$) decreased on Day 4 compared with other days.

Conclusions: The three-day survival training combined with sleep deprivation negative affected on the coordination motor performance (handgrip differentiation, body balance disturbation tolerance skills and running velocities) but not the divided attention. This could have been due to an uneven adaptation to adrenergic stimulation associated with central and peripheral fatigue.

Key words: survival training • coordination motor abilities • special forces • sleep deprivation • psychomotor performance

Author's address: Andrzej Tomczak, Rokosowska 1/87, 02-348 Warsaw, Poland; e-mail: atomczak33@wp.pl

Introduction

The execution of military tasks by soldiers requires enhanced precision and divided attention. This is associated with the necessity of using arms, handling increasingly complex equipment and acting in an environment, in which they may encounter persons directly involved in the military conflict and those not connected with it at all. This is characteristic for terrorism and for anti-terrorist actions [1].

The lack of precision in such tasks may have tragic consequences, e.g. unintentional shooting of accidental persons or destroying wrong objects. During military missions it is also quite likely that the

Body balance disturbation tolerance skills (BBDTS) – the ability to maintain the vertical posture in the circumstances of the fall hazard [15]

Survival of soldiers – psychomotor competence necessary to manage forced isolation in an environment occupied by the enemy

Coordination motor skills – psychomotor competence to an optimum control of motor activities

Special unit soldiers – soldiers trained to perform unconventional activities, e.g. antiterrorist, diversionary, reconnaissance, etc.

Sleep deprivation – limiting sleep to 2 – 3 h per day in course of training

Long-lasting (or prolonged) exercise – field activities lasting at least 24 h

Psychomotor performance – the degree of skill demonstrated by an operator in the completion of a task

soldiers would be forced to undertake a fight for survival. Consequently, survival training is becoming increasingly popular in the Polish Armed Forces. Theoretical and practical training engages increasing numbers of soldiers from various formations, especially those who are to participate in military missions. There are few studies concerning changes in psycho-physical fitness of soldiers subjected to such specialist military training but numerous reports exist on training on military field or on military training undertaken by civilians. Those reports pertain to physiological changes [2-6] or to physical fitness under the impact of undertaken military actions [7-12].

No sufficient attention was paid in the available literature to the impact of sleep deprivation and long-lasting physical activity on keeping body balance. Sleep deprivation was reported to result in body balance disorders in the morning hours [13, 14]. Mikulski et al. [4] applied posturography in course of military activities lasting 36 h, the activities consisting of moderate physical tasks combined with sleep deprivation; they found that night activities impaired body balance but daytime activities brought it back to normal. In this study the 'Rotational Test' [15 (that is still pilot version of measurement the body balance disturbation tolerance skills)] was applied to assess the capacity to keep body balance. Kruszewski et al. [16] who applied the same test reported that regular, specific physical training improved that capacity in athletes and soldiers.

During long-lasting sport competitions (such as adventure racing) and military actions the capacity to maintain the simple reaction time, complex reaction time to visual stimuli, sight and motor coordination and division of attention at maximum are of utmost importance. It was found that the multiple-choice reaction time (MCRT) was kept at maximum up to 70 – 80% VO_2 max intensity in graded exercise tests till exhaustion [17-20]. An improvement in the psychomotor performance was noted after 100 – 120 min of moderate physical activity [21-23]. On the other hand, the results of psychomotor performance tests applied during prolonged exercise of moderate intensity were inconsistent. Lucas et al. [24] reported no effect of a 100-h exercise on psycho-motor performance; no effect on the visual coordination was found either following a 36-h winter survival training of moderate intensity [12]. However, Lieberman et al. [25] found that in ultra-long lasting events psychomotor abilities became impaired.

Another issue, rarely studied, is the so-called motor adjustment. Waśkiewicz [26] applied 4 running tests following anaerobic exertions. In my earlier study significant changes in test results were brought about by winter survival training [12].

Hand force, performed at a preset level (handgrip differentiation test), was studied following prolonged exertions in sports or in military actions. Leyk et al. [9] reported that carrying a wounded subject on a stretcher for only 3 – 4 min impaired handgrip differentiation for as long as over 24 h. The test executed during 36-h survival training showed no change in maximum handgrip but an increased error was noted in the preset 50%max test [12]. However, no studies on psycho-physical fitness of soldiers subjected to survival training were reported.

The aim of this study was the effects of a 72-h workout combined with sleep deprivation on selected motor coordination and psychomotor indices in soldiers from a special unit.

Material and methods

Subjects

Eight male soldiers from a special unit volunteered to participate in the study consisting of three-day continuous survival training and approved by the local Committee of Ethics. The subjects aged 25 – 33 years, they were in service for 2 – 10 years, their body height ranged 170 – 188 cm, body mass 71 – 95 kg.

The training took place on military training grounds, in winter (night temperature ranging from –8 to –10°C). The tests were applied pre-training in the morning (8.00 – 9.30; Day 1), then after 32 h (Day 2), after 54 h (Day 3), and directly post-training (after 72 h; Day 4). During the first two nights the subjects could sleep for 3 h. On the third night they were fully deprived of sleep and performed an orienteering march (approx. 35 km), which included e.g. carrying an injured subject on stretcher, carrying loads and construction of shelters. During the march the average heart rate was 102 bpm. Throughout the entire course the soldiers carried personal arms (machine guns) and a rucksack with basic equipment. The whole equipment weighed 15 kg. The main tasks of soldiers during the training course were creeping, setting campfire, preparation of meals and training in operational military tactics in forested areas.

Methodology

The following measurements were conducted:

1. Handgrip differentiation test using PZA/3359

dynamometer (Fabrication Enterprises Inc., USA). The device was held in the preferred hand in standing posture, arms along the trunk. The test was repeated 3 times and consisted of 3 tasks: maximum handgrip, executing the preset 50%max handgrip, and adjusting the force so as to attain the requested 50%max. Before the first session on Day 1 subjects were familiarized with the handgrip differentiation test procedure and performed the complete session as a warm-up. The results were presented as maximum force (in N) and as differences between the actual and preset 50%max results.

2. Motor adjustment skills ("speed adjustment index") were determined with the use of 4 running tests: 15-m sprint, shuttle run 3×5 m (standing start), 15-m slalom run (first pole at a 5-m distance from the start, the remaining 4 spaced by 1.2 m; standing start) and 15-m squat, crouching start. Running times were recorded electronically with 0.01 s accuracy; the results were presented as velocities (15/time) and as the speed adjustment index which was the sum of differences between running times of the tests and running time of the 15-m sprint [27].

3. Computer-aided, divided attention effect [28]. Two types of signals were displayed on the screen: figures (square, circle or cross) in the central part of the monitor. When displayed in the above sequence, the "+" key was to be pressed with the right thumb (or the "Q" key with the left thumb) each time when the asterisk appeared, all other sequences of figures being incorrect. The second type of signals consisted of small squares displayed in the corners of the monitor. When 4 squares were displayed in one of the corners, the "–" key was to be pressed with the right index finger (or the "l" key with the left index finger). The following results were presented: the number of perceived signals, the number of errors (omitted signals and incorrectly pressed keys) and the respective percent indices.

4. Body balance disturbation tolerance skills (BBDTS) – the 'Rotational Test' of Kalina et al. [15] was applied. The subject, standing on the line, was supposed to jump up with full rotation in the air, alternately clockwise and counter-clockwise, repeated 3 times, and land with both feet on the line in approx. 12 s in a constant rhythm. Several training jumps were allowed. The accuracy of landing and maintaining the balance was scored (0 – clean jump, 1 – one foot off line, 2 – both feet off line, 3 – lost balance with hand support) and totalled for all 6 jumps (score range from 0 – excellent to 18 – unsatisfactory). Criteria of an individual level assessment determined by the 'Rotational Test' are as follows: very high (0-1), high (2-3), average (4-9), low (10-12), very low (13-15), insufficient (16-18).

Data processing

The data were subjected to one-way ANOVA with the post-hoc Scheffé's test using Statistica 6.0 software. The level of p0.05 was considered significant.

Results

The divided attention results were pretty uniform throughout the study (Tab.1). The same applied to maximum handgrip and to the 50%max results but the correction error proved significantly ($p<0.01$) highest on Day 4. Running velocities remained relatively stable on the first 3 occasions but on Day 4 significantly ($p<0.05$) decreased. The same was true for the speed adjustment index but the mean result on Day 4 was due to 3 subjects only. The 'Rotational Test' results showed a steady, significant ($r = 0.563$; $p<0.01$) deterioration with time.

Discussion

The capacity to execute fast, precise movements and to modify them depending on changing combat conditions is considered superior to being physically fit and strong only. That capacity in military tasks requires an adequate psychomotor fitness. Divided attention, reaction time, perception, and sight and movement coordination depend on numerous factors like age, vigilance, mood, fatigue, etc. In this study, the degree of divided attention did not change during subsequent days of survival training. The soldiers performed the 90-s test on a similar level, irrespectively of mounting fatigue. The results obtained in earlier studies [4, 12] indicated that combined application of prolonged exercise and sleep deprivation did not affect psychomotor performance. Test duration was so short that subjects could remain focused long enough to overcome detrimental effects of sleep deprivation. It might be expected that application of longer-lasting, e.g. 5-min tests, adverse consequences of fatigue brought about by training and limited sleep deprivation could be noticed [29].

Among the desired skills during military actions is the capacity to differentiate the hand force output as this is a prerequisite for accuracy and economics in the execution of numerous tasks. It was shown in this study that special unit soldiers exhibited a decrease in that capacity only on Day 4 after a sleepless night and, thus, performed better than physical education students subjected to survival training. Namely, the

Table 1. Mean values (±SD) of handgrip strength, running velocity, divided attention and BBDTS indices in male soldiers (n = 8) participating in 72 hours survival training

Variable	Day 1	Day 2	Day 3	Day 4
Hand strength [N]				
max	1005 ± 102	1069 ± 135	1175 ± 101	1001 ± 145
50% max	534 ± 54	546 ± 33	624 ± 94	527 ± 77
corrected 50% max	528 ± 53	522 ± 16	586 ± 93	510 ± 66
Error 50%	61 ± 19	11 ± 53	37 ± 61	–55 ± 58
Error corr.	26 ± 5	–12 ± 45	–1 ± 35	87 ± 4*
Error 50% (absolute values)	73 ± 45	45 ± 27	58 ± 35	81 ± 60
Error corr. (absolute values)	27 ± 22	35 ± 27	26 ± 21	86 ± 74**
Running velocity [m/s]				
15 m	5.10 ± 0.22	4.72 ± 0.32	4.75 ± 0.48	4.17 ± 0.46*
3×5 m	3.08 ± 0.13	3.08 ± 0.12	3.01 ± 0.23	2.50 ± 0.24*
15 m slalom	3.08 ± 0.15	2.83 ± 0.14	2.86 ± 0.21	2.50 ± 0.20*
15 m squat	2.86 ± 0.39	2.93 ± 0.32	2.92 ± 0.28	2.42 ± 0.53*
Speed adjustment index	6.26 ± 0.76	5.81 ± 0.38	5.90 ± 0.45	7.63 ± 1.60*
Divided attention [%]	66.9 ± 15.5	69.1 ± 19.3	72.5 ± 15.9	68.5 ± 22.9
BBDTS [points]	4.4 ± 3.9	6.5 ± 3.5	8.3 ± 2.3^	9.4 ± 1.4**

* Significantly ($p<0.05$) different from the three others days; ** Significantly ($p<0.01$) different from Days 1 and 2; ^ Significantly ($p<0.01$) different from Day1

correction error in the 50%max task was significantly higher already after the first night of training compared with the pre-training state [12]. Handgrip force differentiation may thus serve as a criterion of selection to special military units.

A high degree of motor adaptation capacity is of great assistance to soldiers performing diverse activities, e.g. running, sudden changing the running direction, crawling and stealthy approach, driving a vehicle or participation in direct combats. Only on the third day of activities combined with a sleepless night and an about 35-km orienteering march, the motor adaptation of soldiers significantly decreased. In contrast, physical education students participating in survival training achieved worse results of 15-m sprint already after only several hours, other components of the motor adaptation test being unaffected [12].

Moderate prolonged physical exertion combined with sleep deprivation affected adversely movement coordination as reflected in worsened body balance disturbation tolerance skills, a component of motor coordination, on Day 4. Similar results were reported also by Mikulski et al. [4] who applied 36-h moderate survival training combined with sleep deprivation in summer season with the use of posturography, and by Avni et al. [13] and Ma et al. [30] who applied sleep deprivation under sedentary conditions. Probably the long-lasting military training brings about more serious disorders to the dynamic body balance than to the static one. It seems that the future direction of research should concern the biochemical changes in the soldiers involved in survival training, similar like athletes and other people taking extreme challenges [31, 32].

Conclusion

The tree-day survival training combined with sleep deprivation negative affected on the coordination motor performance (handgrip differentiation, body balance disturbation tolerance skills and running velocities) but not the divided attention. This could have been due to an uneven adaptation to adrenergic stimulation associated with central and peripheral fatigue.

References

1. Kalina RM, Chodała A, Tomczak A: O sportach ekstremalnych z perspektywy kryteriów współczesnego treningu militarnego i antyterrorystycznego oraz efektywnego funkcjonowania służb ratowniczych. In: Rakowski A, Chodała A, Kalina RM, editors. Sporty ekstremalne w przygotowaniu żołnierzy i formacji antyterrorystycznych. Warszawa: PTNKF, Tom 6, 2003; 7-12 [in Polish]
2. Rintamäki H, Oksa J, Rissanen S et al : Effects of 12 days military winter operation on soldiers` cardiorespiratory fitness. [serial online] 2005; Available from: http://www.rto.nsto.int/abstracts.asp/
3. Rissanen S, Oksa J, Kyröläinen H et al: Effects of 12 days military winter operation on neuromuscular performance. In: Hakkinen K, Kyröläinen H, editors. Proceedings of the 1st International congress on soldiers` physical performance, 2005 May; 18-22; Jyväskylä, Finland; 2005
4. Mikulski T, Tomczak A, Lejk P et al: Influence of ultra long exercise and sleep deprivation on physical performance of healthy men. Med Sport 2006; 10 (4): 98-101
5. Hoyot RW, Opstad PK, Haugen AH: Negative energy balance in male and female rangers: effects of 7 days of sustained exercise and food deprivation. Am J Clin Nutr 2006; 83:1068-75
6. Tharion WJ, Lieberman HR, Montain SJ: Total energy expenditure in men and women during 54 h of exercise and caloric deprivation. Med Sci Sports Exerc 2006; 38:894-900
7. Oliver SJ, Wilson S, Laing SJ et al: The effects of a 48 hours of fluid, calorie or combined fluid and calorie restrictions on 30 minute treadmill time trial performance. In: Hakkinen K, Kyröläinen H, editors. Proceedings of the 1st International congress on soldiers` physical performance, 2005 May 18-22; Jyväskylä, Finland; 2005
8. Vuorimnaa T, Vasankari T: The effect of a 2 days march with ingestion of carbohydrate and caffeine on physical performance, oxidative stress and antioxidant capacity in well trained soldiers. In: Hakkinen K, Kyröläinen H, editors. Proceedings of the 1st International congress on soldiers` physical performance, 2005 May 18-22; Jyväskylä, Finland; 2005
9. Leyk D, Rohde U, Erley O et al. Recovery of hand grip strength and hand steadiness after exhausting manual stretcher carriage. Eur J Appl Physiol 2006; 96: 593-599
10. Tomczak A, Kalina RM: Appraisal of soldiers` acquired skills for surviving in conditions of isolation. In: Sokołowski M, editor. Morphofunctional aspects of selection of soldiers for realization of tasks in the army formations. Polish Scientific Physical Education Association, Warsaw; 2007; (11) 84-100
11. Lakie M: The influence of muscle tremor on shooting performance. Exp Physiol 2009; 95(3):441-50
12. Tomczak A: Effects of winter survival training on selected motor indices. Biomed Hum Kinet 2010; 2, 62-65
13. Avni N, Avni I, Barenboim E: Brief posturografic test as an indicator of fatigue. Psychiatry Clin Neurosci 2006; 60 (3): 340-6
14. Liu Y, Higuchi S, Motohashi Y: Changes in postural sway during a period of sustained wakefulness in male adults. Occup Med 2006; 51:490-495
15. Kalina RM, Jagiełło W, Barczyński BJ: The method to evaluate the body balance disturbation tolerance skills – validation procedure of the 'Rotational Test'. Arch Budo. 2013; 9(1):59-69
16. Kruszewski A, Wiktorek P, Litwiniuk A et al: The ability of keeping body balance and lighting in man-to-man crash. In: Sadowski J, Niźnikowski T, editors. Coordination motor abilities in scientific research. Biała Podlaska; 2008; 216-222
17. Chmura J, Krzysztofiak H, Ziemba AW et al: Psychomotor performance during prolonged exercise above and below the blood lactate threshold. Eur J Appl Physiol Occup Physiol 1998;77(1-2):77-80
18. Ziemba AW, Chmura J, Kaciuba-Uscilko H et al. Ginseng treatment improves psychomotor performance at rest and during graded exercise in young athletes. Int J Sport Nutr 1999; 9(4):371-7
19. Mikulski T, Ziemba A, Chmura J et al: The effect of supplementation with branched chain amino acids (BCAA) on psychomotor performance during graded exercise in human subjects. Biol Sport 2002; 19(4): 295-301
20. Chmura J, Nazar K: Parallel changes in the onset of blood lactate accumulation (OBLA) and threshold of psychomotor performance deterioration during incremental exercise after training in athletes. Int J Psychophysiol 2010;75(3):287-90
21. Reilly T, Lewis W: Effects of carbohydrate feeding on mental function during sustained physical work. In: Brown ID, Goldsmith R, Coombes K, Sinclairs MA, editors. Ergonomics International, Taylor and Francis, London; 1985; 700-702
22. Collardeau M, Brisswalter J, Vercruyssen F et al: Single and choice reaction time during prolonged exercise in trained subjects: influence of carbohydrate availability. Eur J Appl Physiol 2001; 86(2):150-6
23. Grego F, Vallier JM, Collardeau M et al: Effects of long duration exercise on cognitive function, blood glucose and counter regulatory hormones in male cyclists. Neurosci Lett 2004;364(2):76-80
24. Lucas SJ, Anson JG, Palmer CD et al: The impact of 100 hours of exercise and sleep deprivation on cognitive function and physical capacities. J Sports Sci 2009; 27(7):719-28
25. Lieberman HR, Bathalon GP, Falco ChM et al: Severe decrements in cognition function and mood induced by sleep loss, heat, dehydration, and under nutrition during simulated combat. Biol Psychiatry 2005; 15;57(4):422-9
26. Waśkiewicz Z: The influence of anaerobic efforts on chosen aspects of motor control. Katowice; 2002 [in Polish]
27. Juras G, Waśkiewicz Z: Time, space and dynamic aspects of coordinational motor abilities. Katowice; 1998 [in Polish]
28. Klocek T, Spieszny M, Szczepanik M: Computer tests of coordination capacity, Warszawa; 2002 [in Polish]
29. Lieberman HR, Bathalon GP, Falco CM et al: The fog of war: decrements in cognitive performance and mood associated with combat-like stress. Aviat Space Environ Med 2005; 76 (7): C7-14
30. Ma J, Yao YJ, Ma RM et al. Effects of sleep deprivation on human postural control, subjective fatigue assessment and psychomotor performance. J Int Med Res 2009; 37(5):1311-20
31. Kormanovski A, Harasymowicz J: Survival adaptation in Everest: Metabolic response during acclimatization in lowlander and sherpa climbers. Arch Budo 2010; (6) 2: 83-89
32. Opara J, Socha T, Bidzan M et al: Stress urine incontinence especially in elite women athletes extremely practicing sports. Arch Budo 2011; (7) 4: 227-231

Cite this article as: Tomczak A.: Effects of a 3–day survival training on selected coordination motor skills of special unit soldiers. Arch Budo, 2013; 3: 168–172.