

doc. Mgr. Ing. David Ullrich, Ph.D., MBA

Faculty of Military Leadership, the University of Defence in Brno

Department of Leadership

Ing. Jan Kyselák, Ph.D.

Faculty of Logistics and Crisis Management, Tomas Bata University in Zlín

Department of Population Protection

Mgr. František Vaněček

Physical Training and Sport Centre

The University of Defence in Brno

Response of the body to stress due to an emergency

A number of up-to-date studies point to the ever-decreasing physical condition of today's youth. Studies, evaluating psychophysical, mental or professional skills (fitness) not only of the youth but of the whole age spectrum of the population, to cope with the emergence of extraordinary events or crisis situations, i.e. with the burden, are basically absent. Co-authors have dealt for several times with this issue and, in the background of the experiment, they have verified and assessed these skills in a partial way.

Experiment Objective and Conditions

Experiment Objective

The objective of the experiment was to verify the ability of the population aged 20-25 years of a particular group of students of the economic-managerial field of the University of Defense, to execute a two-phase pedestrian evacuation on a 15.4 km (15 km plain, 400 m assault course - see below) with the evacuation bag. Such a scenario has been deliberately modeled to achieve very difficult, almost extreme conditions, for a „sample of the chosen age category of the population“ to verify the psychophysical, mental or professional abilities of a population sample.

The evaluation of the experiment (as well as measurements in the course of it) was aimed at:

A) Verification of:

- psychophysical;
- mental and
- the professional fitness of the participants.

(Note: In this particular case, we can define the psychophysical fitness of the trainees as the balance and harmony of the individual's inner environment, the mental condition as a cognitive and decision-making optimum of an individual for dealing in different situational contexts and types of tasks. Professional experience means the theoretical knowledge and practical experience required to perform a particular work or set of work activities, here - in this particular case - for handling and dealing with emergencies and crisis situations.)

- B) Determination of the reactions of individuals to a specific situation (to model load) and coping with it, i.e. relationship of:
- personality;
 - physiological and
 - performance indicators.

The Course and Basic Conditions of the Experiment Realization

- *Experimentalists*

The implementation of the experiment was carried out by the Department of Leadership (represented by the expert of kinanthropology), and the Department of Crisis Management of the University of Defense (represented by the expert of population protection and crisis management), the Center for Physical Education and Sport of the University of Defense (represented by the expert of a special physical training for survival in distress) and an external psychologist (the expert in the field of psychology of the survival), as the University of Defense has not currently had such a psychologist with the necessary focus and level.

- *Experimental group*

These were civilian students of the Security Management of the University, who were only familiar with the date and time of the experiment, not with its scenario. Military students were excluded from the experiment because there was a theoretical assumption of higher physical fitness of theirs and better coping with the experiment.

- *Experiment course*

15:00-21:00, month – October

The season and time were deliberately chosen so that the beginning of the experiment was realized in daylight and its end in the dark, and to avoid extreme temperatures.

- *Weather conditions*

12°C, drizzle

- *Evacuation bag*

The choice of the type of evacuation bag and its contents was left up to the participants of the experiment. The only condition to follow was the weight of the bag – 20 % of the participant's weight. It was different for each individual.

- *Terrain*

The experiment was carried out in two phases. The first part represented a transfer with the luggage carried at a distance of 15 km across the plane. This distance was made up of 1 km laps. The second phase consisted of moving over a standardized 100m assault course, primarily used for training and testing soldiers (simulation of transfer in extreme terrain conditions). The transfer along the assault course with the evacuation bag was realized 2 times.

The basic diagram of the assault course with individual obstacles is shown in Figure 1.

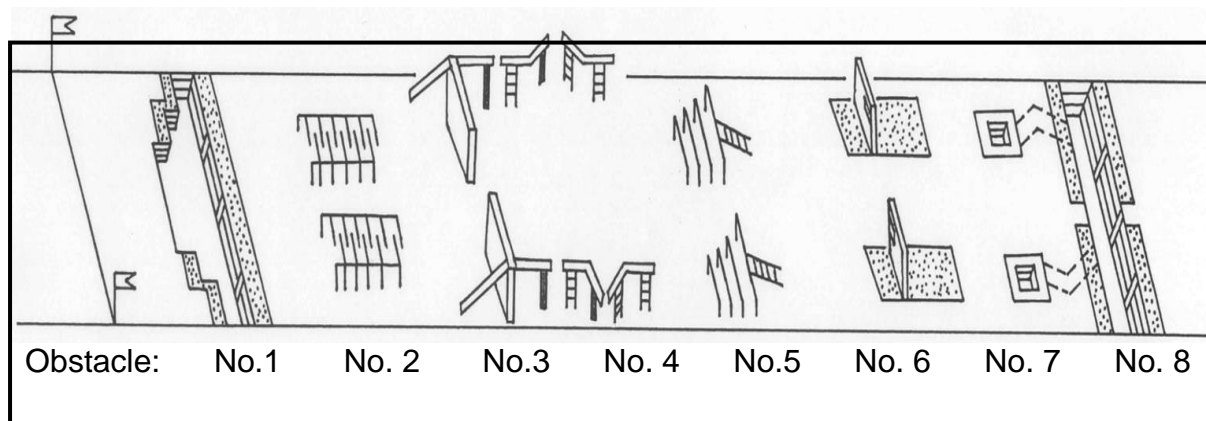


Fig. 1 Assault Course Diagram

A brief description of each obstacle of the assault course is given in Table 1.

Table 1 Assault Course Obstacle Description

Obstacle No.	Obstacle Description
1	a trench of a 1m depth
2	a labyrinth of 6 m long steel tubes
3	a perpendicular wooden wall with a height of 2 m
4	a wooden beam at a height of 2 m divided into three sections (squared timbers of 0.2 m × 0.2 m) with 1 m spacing
5	a wooden beam staircase with a width of 2 m, a height of individual steps 0.8 m, 1.2 m, 1.5 m and 1.8 m and 1.2 m distance between them
6	a concrete wall with a height of 1.1 m with a hole of 0.5 m (width) and 0.6 m (height) with a lower edge of 0.35 m above the ground
7	a trench with a ground plan of 1.0 m × 1.0 m and a depth of 1.5 m connected underground with a trench with a depth of 1.5 m and a total length of 8 m with a trench - obstacle No. 8
8	a trench across the entire length of the track at a depth of 1.5 m and a width of 1.0 m

Note: Taking into account the weather conditions (drizzle), obstacle 3 and obstacle 4 were omitted for safety reasons (load carried in combination with the slippery wooden surface of some obstacles). In the obstacle 5 the participants passed only the first two steps.

Monitored Sample, Procedures, and Methods Used in the Course of the Experiment

Monitored Sample

The monitored sample of the experiment consisted of 22 participants. These were 13 women in the range of 20-23 years (average age of 22.6 ± 0.9 years) and 9 men in the range of 20-25 years (average age of 22.9 ± 1.92 years).

Procedures and Methods used in the Course of the Experiment

Participants were subjected to physical fitness tests (Ruffier Test) and Attention Tests (ČO-Numerical Rectangle Test, DRT, RČS-Decision-making under Time Pressure, d2-Attention Test) at the beginning and at the end of the experiment. The

difference in the values obtained at the beginning and end of the experiment supported the assessment of the selected qualities and capabilities to handle this form of strain.

Ruffier Test

This standardized test is a physical fitness test [1]. It is based on the assumption that a trained and physically fit person has a lower increase in the heart rate after exercise [2], and that during his rest after the strain his pulse rate decreases more rapidly than in case of the less trained and less physically fit person. The calculated Ruffier Index of Fitness (IZ) expresses the fitness of the person tested and which can be classified into five levels - from excellent to below-average [3].

Numerical Rectangle (ČO)

The test is primarily focused on detecting optical observations, selectivity and distraction in conditions requiring a high rate of activity. The visual observation is determined by the internal factors, i.e. the state and quality of the nervous system, the degree of concentration, the focus and the oscillation of the attention, the level of visual perception and the memory. The external influences relate to the size of the observed field, the number of shapes in it, colors, shape, size, etc. [4].

DRT Test (Disjunctive Reaction Time)

The test is focused on measuring perceptual readiness, speed, and accuracy of responses to visual stimuli.

Test of Decision-making under Time Pressure (RČS)

It is a method of mapping the complex performance of an individual in stressful conditions, in which several types of strain can be found: situation load (environment, testing, the person of psychologist), power motivation (presented and perceived target of testing, method of responding to the load), the test itself (reading, knowledge, length and clarity of items) and time load. Specification of the partial capabilities identified by the test includes, for example, attention, perception, differentiation and comparison, visual short-term memory, flexibility, concentration and resilience to interference, decision speed, etc. The speed of the solution, correctly solved, misplaced and omitted items are monitored [5].

d2 Attention Test

This test enables to determine individual performance in the area of attention and mental concentration. It represents a standardized innovation of the so-called tick-tests. It measures the pace and accuracy of work performance in distinguishing similar visual stimuli (when discriminating the details), thus providing the assessment of individual attention and concentration. The test assumes the recognition of the three components of performance, which represent the speed or amount of work done, the quality of the work performed and the ratio of speed and accuracy of the work performed [6].

In addition to these tests, other methods of scientific research were applied in the course of the experiment as follows:

Questionnaire Survey

During the experiment and at the conclusion of the experiment, the participants completed a questionnaire in order to get the feedback on the course of the transfer or

overnight, as well as the whole experiment. The questions were focused on obtaining both quantitative and qualitative data. They focused on the evacuation bag content, monitoring of previous pedestrian activities of the experiment participants, health condition, etc. The basic descriptive statistics were used for evaluation.

Observation

Another method used in the experiment was an observation, carried out as obvious and non-standardized, by a representative of the Department of Crisis Management. It was focused on the behavior of the individual participants as well as the whole team, the response to the course of the experiment, the weather, the mental and health problems etc.

Group Interview

This method was used by all experimentators, at the beginning, during and at the end of the experiment. The aim of this interview was to gain attitudes and opinions within the group concerning the level of the prepared experiment, the course of the experiment, the chosen scenario, the problems that occurred etc.

A photographic record was taken from the entire experiment, which was retrospectively used to evaluate on details that were not detected during the experiment itself.

Results and discussion

As mentioned above, the entire experiment was aimed at verifying psychophysical, mental and professional indicators reflecting the decision-making process and abilities of the population of the tested age range to cope with the mock-up burden, as well as verifying the body's response to stress caused by this burden. This also corresponds to the above-mentioned procedures and methods used in the course of the experiment to verify these indicators.

Partial Indicators of Physical, Psychophysical and Mental Fitness

Physical Fitness Measurement

The transfer time of 15 km was in the male group 2 hrs 41 mins \pm 5 mins, in the female group 2 hrs 43 mins \pm 3 mins. During the transfer, the male had a minimum heart rate (HR) of 115 \pm 12 rp min⁻¹, an average HR of 141 \pm 10 rp min⁻¹ and a maximum HR of 165 \pm 11 rp min⁻¹. For the monitored group of female an HR of minimum of 117 \pm 10 rp min⁻¹, an average HR of 140 \pm 11 rp min⁻¹ and a maximum HR of 159 \pm 9 rp min⁻¹ was measured during a 15 km transfer.

The transfer time on the assault course was in the male group 13 mins 10 s \pm 2 mins 32 s, in the female group 15 mins 18 s \pm 2 mins 5 s. The minimum male HR was 135 \pm 10 rp min⁻¹, an average HR of 163 \pm 12 rp min⁻¹ and a maximum HR of 179 \pm 11 rp min⁻¹. For the monitored group of female a minimum HR of 129 \pm 15 rp min⁻¹, an average HR of 157 \pm 12 rp min⁻¹ and a maximum HR of 175 \pm 11 rp min⁻¹.

The test results for the current physical fitness assessment of the participants by **Ruffier Test** are given in Table 1.

Table 1 **Physical Fitness Test**

Male [n _i]	IZ 1	IZ 2
1	12.9	22.4
2	14.2	15.6
3	9	16
4	17.9	20.6
5	14.6	15.2
6	10.9	16.6
7	12.4	12
8	18.2	23.2
9	17.8	27.1

Female [n _i]	IZ 1	IZ 2
10	10.7	18.1
11	15.6	16.6
12	18.7	20.6
13	15.1	18.1
14	12.9	13.2
15	17.7	19
16	11	16.2
17	15.1	18.1
18	23.9	24.5
19	13	9.2
20	19.8	17.8
21	15.2	16.9
22	16.5	20.2

Source: Own data processing.

IZ 1-2 expresses measurements at a time. IZ 1 are the quiescent values before the experiment start and IZ 2 immediately after the finishing of the experiment. Red-colored values show an insufficient level of physical fitness with the simultaneous negative trend over time. On the contrary, green-colored values show a good level of physical fitness with the simultaneous positive development trend within the experiment.

Psychophysical and Mental Fitness Measurement

The results of the **Numerical Rectangle Test** for the observation, selectivity, and attention rate under time deprivation conditions are shown in Table 2.

Table 2 **Numerical Rectangle Test**

Male [n _i]	NR 1	NR 2
1	13	9
2	21	22
3	18	14
4	19	19
5	9	12
6	21	20
7	22	21
8	17	18
9	19	20

Female [n _i]	NR 1	NR 2
10	22	20
11	23	23
12	18	16
13	18	19
14	19	18
15	23	21
16	18	14
17	20	19
18	18	17
19	22	23
20	13	14
21	15	13
22	14	19

Source: Own data processing.

NR (Numerical Rectangle) 1-2 expresses measurements at a time. NR 1 are the quiescent values before the experiment start and NR 2 immediately after the finishing of the experiment. Red-colored values show a very low value in the test with the simultaneous negative trend over time. On the contrary, green-colored values show a high value in the test with the simultaneous positive development trend within the experiment.

Evaluation of the **DRT test** to determine the observation, speed, accuracy, and attention rate under time deprivation conditions is shown in Table 3.

Table3 **DRT Test (Disjunctive Reaction Time)**

Male [n _i]	DRT 1	DRT 2	Female [n _i]	DRT 1	DRT 2
1	33	34	10	11	8
2	41	43	11	25	28
3	40	44	12	41	42
4	23	22	13	18	25
5	33	31	14	30	32
6	43	47	15	42	49
7	40	45	16	30	40
8	43	50	17	30	31
9	47	52	18	38	44
			19	19	40
			20	21	30
			21	20	27
			22	26	33

Source: Own data processing.

DRT (Disjunctive Reaction Time) 1-2 expresses measurements at a time. DRT 1 are the quiescent values before the experiment start and DRT 2 immediately after the finishing of the experiment. Red-colored values show a very low value in the test with the simultaneous negative trend over time. On the contrary, green-colored values show a high value in the test with the simultaneous positive development trend within the experiment.

The (**RČS - Decision-making under Time Pressure**) monitored the performance of the individual in stress conditions, the accuracy of the solution, the speed and the error rate in the test. The results are shown in Table 4.

Table 4 **Decision-making under Time Pressure Test**

Male [n _i]	D 1	D 2	Female [n _i]	D 1	D 2
1	14	19	10	15	23
2	14	15	11	24	28
3	18	27	12	19	23
4	23	22	13	18	21
5	21	25	14	24	18

6	21	22
7	24	28
8	16	20
9	27	24

15	19	20
16	26	27
17	21	25
18	16	24
19	24	28
20	17	21
21	9	13
22	17	18

Source: Own data processing.

D (Decision) 1-2 expresses measurements at a time. D1 are the quiescent values before the experiment start and D2 immediately after the finishing of the experiment. Red-colored values show a very low value in the test with the simultaneous negative trend over time. On the contrary, green-colored values show a high value in the test with the simultaneous positive development trend within the experiment.

d2 Attention Test monitored the area of attention and mental concentration. The results are shown in Table 5.

Table 5 **d2 Attention Test**

Male [n _i]	d2 1	d2 2
1	99	148
2	136	157
3	117	151
4	120	139
5	137	147
6	147	184
7	166	235
8	88	211
9	210	245

Female [n _i]	d2 1	d2 2
10	135	150
11	186	218
12	152	182
13	99	119
14	111	108
15	189	248
16	148	210
17	166	188
18	115	155
19	175	238
20	90	104
21	129	163
22	115	144

Source: Own data processing.

d2 1-2 variable expresses measurements at a time. d2 1 are the quiescent values before the experiment start and d2 2 immediately after the finishing of the experiment. Red-colored values show a very low value in the test with the simultaneous high error rate. On the contrary, green-colored values show a high value in the test with the simultaneous low error rate in the frame of measurement.

Capability of Evacuation on Foot

This capability was in addition to the above-mentioned testing and its evaluation (see above) assessed on the basis of the results of the questionnaire survey, observation and group interviews.

The monitored areas can be summarized as follows:

Evacuation Bag

All participants of the experiment decided on the evacuation bag carried on the back (a backpack), which in this case was a very good choice.

Food

The choice and quantity of food were very limited, basically corresponding to the expected duration of the experiment. In some cases, the food was not consumed by all - no appetite to eat during the experiment.

Drinks

The average amount of drinks prepared for the transfer was 1.5 l. Expecting the expected weather, tea was dominated in vacuum flasks, then mineral water (sparkling and non-sparkling) and water from the tap. This amount can be considered appropriate due to weather conditions. All participants evaluated the prepared amounts of both food and drinks as appropriate.

Footwear and Clothing

Most participants chose appropriate footwear and clothing according to the weather and the expected nature of the field. Even so, in rare cases, there have been problems with the non-waterproof garment (jackets, caps).

Health and Mental Aspects

The health problems that occurred with almost all participants were back pain caused by carrying the bag (participants not being used to such a load), in some cases calluses and blistering. In rare cases, those who had not followed the guidelines in the second phase of the transfer and jumped with the bag from the obstacles suffered a painful back bruise. According to the participants a major negative impact on the mental condition had the selection of the route of the first phase of the transfer (15 km transfer was intentionally formed by tracks of one kilometer), then the weather and last but not least (especially in case of female participants in the second phase of the transfer) the obstacles that led to the underground and where the dead animals were placed. Due to both physical and mental exhaustion, there was a sudden, nervously controlled oral excretion at the very end of the experiment in case of a female participant.

Additional Comments

The participants rated the experiment as interesting. They emphasized the necessity of a suitable clothing in such situations, then shoes, drink, and food. The clothing was logically put at the first place- because of the prevailing bad weather (cold, drizzle), the food, because of the short duration of the experiment, was the last one in this case.

Results Discussion

The experiment has brought both pros and cons worth mentioning.

The pros of the experiment include:

- A. Practical verification of the ability of a given age group to respond adequately to the occurrence of an emergency or crisis situation under harsh conditions.
- B. Most participants were able to cope with the experiment very well, despite having just basic and little information about it.
- C. Unlike previous experiments, the participation was not based on volunteers who were interested in the experiment, but one of the learning groups was targeted on purpose. Results and conclusions can, therefore, be more objective.
- D. The effectiveness of education in this area has shifted within the group of participants to the very top of the learning pyramid.
- E. Experiment with zero financial subsidies.

The cons of the experiment to mention are:

- A. The experiment did not involve any disabled person who could influence the experiment and its results in a very negative way, especially concerning the time.
- B. There was no representation of marginal age categories (children, the elderly) in which we can assume a lower physical fitness and thus a lower ability to cope successfully with the experiment with these parameters and, of course, also with a possible real-life situation in extraordinary events or crisis situations.
- C. Breach of guidelines in case of some participants that could result in serious injury.
- D. The students were familiar with the weather conditions in advance and could make use of the information in the choice of clothing, footwear, quantity and type of food and drinks.

Some of the above-mentioned facts can misinterpret the measured value. In a real-life situation - under similarly difficult conditions, they would probably be worse.

Within the Czech Republic, it was not possible to trace a methodology that would include standards for the population to implement planned tools for protecting the population under the difficult conditions set in the experiment. Since the strain caused by this kind of evacuation is influenced by a number of factors, it would be advisable to think over the elaboration of such a methodology. Even the ability of individuals to cope, for example, with this kind of evacuation is an important factor deserving a detailed examination, especially for two reasons. The first is that it is possible to predict the specific burden of a certain level related an evacuation on foot in most of the population (except for the obvious exceptions - children, old and disabled people), but the reality may vary. The second reason is that once a specific burden, a strain is sufficiently coped with - both physically and mentally (even under less stressful conditions), such experience can create a potential to handle any similar burden in a satisfactory way.

On the basis of the partial results, it is also confirmed that individuals with a higher level of quality of subtle skills [7], which are skills for cognition, decision making and handling situation solving and fulfilling tasks in complex, dynamically changing conditions (about 15 % of the population) achieve better results in the quality of

decision-making and handling challenging situations than lower-level individuals and show a more dynamic shift in personal careers [8]. The results are apparent in n_i 7 a n_i 19.

These professionals (about 15% of the population) can be considered as the „golden“ core of human potential who have a higher level of fine skill quality and are suitable for leading people in dynamically changing conditions.

Conclusion

The experiment was evaluated by the participants in a very positive way. The experiment was carried out within the framework of a timetable, i.e. within the field of the study of the Security Management – the subject of Communication under Risks. Each participant could verify his / her psychophysical, mental and professional fitness to handle similar situations, i.e. ability to react in difficult conditions. The participants were provided with a detailed expert evaluation of the experiment. The experiment undoubtedly belonged to very demanding and that in a real-life situation the population would probably face such difficult conditions (situations) only in extreme cases.

Experiment organizers - authors of the article, welcome any information about other similar experiments. They would also appreciate any national and international cooperation in the field.

Literature

1. *Zátěžové testy s dřepy - ruffierova zkouška*. Ústí nad Labem: Pedagogická fakulta UJEP, 2016. [online]. [cit. 2017-08-16]. Dostupné z: <https://pf.ujep.cz/~pysnad/fyziologie/drepy.htm>.
2. TONHAJZEROVÁ, Ingrid. *Mentálna aktivita a variabilita frekvencie srdca. Variabilita frekvencie srdca: mechanizmy, hodnotenie, klinické využitie*. Martin: Vydavateľstvo Osveta, 2008, s. 96-100. ISBN 978-80-8063-269-4.
3. Závěrečná zpráva: *Analýza životního stylu a zdraví mládeže v kraji Vysočina*. [online]. [cit. 2017-08-17]. Dostupné z: http://www.szu.cz/uploads/documents/czsp/zdravi_mladych/Analiza_mladez_Vysočina_kon.verze.pdf.
4. DOLEŽAL, Jan at al. *Číselný obdĺžnik (ČO)*. Bratislava: Psychodiagnostika Bratislava, 1992.
5. KOMÁRKOVÁ, Eva a Liduška OSECKÁ. *Rozhodování v časovém stresu*. Brno: Středisko psychologických služeb, 1993.
6. BRICKENKAMP, Rolf a Eric ZILLNER. *Test pozornosti - d2*. Překlad Karel Balcar. 1. české vyd. Praha: Testcentrum, 2000. ISBN 80-86471-00-4.
7. AMBROZOVÁ, Eva, Jiří KOLEŇÁK, David ULLRICH a Vratislav POKORNÝ. *Kognitivní management*. Brno: Key Publishing, 2016. ISBN 978-80-7418-254-9.
8. ULLRICH, David a Vratislav POKORNÝ. The possibilities of comprehensive approach and the specifics of the training managers to fulfill tasks in the challenging environment and crisis management. In: *Recent advances in Energy, Environment and Economic Development*. France. Paris: WSEAS, 2012, s. 309-314. ISSN 2227-4588.

R E S U M É

Mimořádné události spojené s potřebou aktivace havarijních plánů provázejí v posledních letech naší společnost dosti často. Tato aktivace se samozřejmě nezřídka dotýká i obyvatelstva. Spoluautoři proto čtenářům časopisu na základě realizovaného experimentu a zmapování psychofyzické, mentální a odborné kondice, nabízejí pohled na schopnosti vybrané kategorie obyvatelstva vyrovnat se za specifických podmínek se zátěží, která byla modelována prostřednictvím pěší evakuace. Nabízejí rovněž pohled na reakci organismu na stres vyvolaný touto modelací mimořádné události.

Klíčová slova: Bezpečnost, experiment, leadership, ochrana obyvatelstva, pěší evakuace, překážky, psychofyzická, mentální a odborná kondice, zátěž.

S U M M A R Y

The extraordinary events associated with the need to activate emergency plans have been accompanying our society quite often in recent years. Of course, this activation often affects the population as well. The co-authors, therefore, on the basis of the experiment and the psychophysical, mental and professional condition offer a view of the abilities of a selected group of the population to cope with specific conditions with the burden that was modeled by the evacuation on foot. They also offer a view of the body's response to the stress caused by this extraordinary event modeling.

Keywords: Evacuation on foot, experiment, obstacle, leadership, load, mental and professional conditions, population protection, psychophysical, safety.