INDICATORS OF THE PSYCHOPHYSICAL CONDITION OF AN INDIVIDUAL FOR COPING WITH CHALLENGING CONDITIONS OF SECURITY ENVIRONMENT

[a] DAVID ULLRICH, [b] EVA AMBROZOVÁ, [c] VRATISLAV POKORNÝ, [d] FRANTIŠEK MILICHOVSKÝ, [e] KAREL KUBA

[a,b] Brno University of Defence, Faculty of Military Leadership, Kounicova 65, 662 10 Brno, Czech Republic
[c] Newton college, a.s., Rašínova 2, 60200 Brno, Czech Republic
[d] Brno University of Technology, Faculty of Business and Management, Department of management, Kolejní 2906/4, 612 00 Brno, Czech Republic
[e] Pan-European University, Faculty of Economics and Entrepreneurship, Tematínska 10, 851 05 Bratislava, Slovakia
email: [a]david.ullrich@unob.cz; [b]eva.ambrozova@unob.cz; [c]vratislav.pokorny@newetoncollege.cz; [d]milichovsky@fbm.vutbr.cz; [e]karel.kuba@peuni.cz

Abstract: The actual corporate environment, reflecting the concept of Industry 4.0, requires managers and leaders with specific leadership qualities. These qualities capture importance in a security environment, especially in the army. Paper deals with the topic of psychophysical condition identification of individual applicants in solving stress situations of the security environment. Research of the psychophysical condition was done in the simulated situation of increased psychophysical stress during courses with X-tream methodology application. X-tream methodology helps to monitor the qualities and potentials of individuals in hard and dangerous contexts. The research sample consists of 286 of course participants, working on managerial and commander positions. The main aim of the paper is to define an indicator of the psychophysical condition by the usage of objective pacification parameters and organism regeneration. Due application of factor analysis two factors with the calming-down trend after physical drain were gained. From both factors, only one reached an acceptable value of Cronbach's alpha ratio. Monitoring and evaluation of the relationship between change trends of the psychophysical condition and human activities in stress situations could serve as a base for choice, preparing and personal development.

Keywords: psychophysical condition, X-tream methodology, cognitive management, army leadership, professionalism, development of leader.

1 Introduction

The current environment, known as Industry 4.0, requires managers and leaders who have specific qualities for leadership (Bennis, 2007). These qualities are becoming increasingly important in security and military environments (Bujak, Śliwa, 2016). Military commanders and leaders face countless challenges and shifting strategic priorities (Morath, Leonard, Zaccaro, 2011).

In addition to the professional knowledge and skills of the leaders, a big emphasis is put on the professionalism in terms of, e.g., personal mastery and systemic thinking (Senge, 2007), conceptual and complex thinking (Robbins, Coulter, 2004; Hroník, 2008), mental maturity and personal fitness (Ullrich, Pokorný, 2012; Kiyosaki, 2016) or specific personality potentials and qualities of security professionals in security environment (Mikulka, Nekvapilová, Pospíšil, 2017; Mikulka, Nekvapilová, Fedorková, 2018; Ullrich, Sládek, 2018). To explore these qualities, it seems useful to use an environment that is close to real demanding and dangerous conditions, for example, a virtual environment (Pallavicini et al., 2016). Related to this are questions that are still topical: “What precisely is leadership in dangerous environments?”, and “What distinguishes effective leadership in dangerous contexts?” (Campbell, Hannah, Matthews, 2010).

In the context of Cognitive Management (Ambrozová et al., 2016), we perceive professionalism as a mature, comprehensive competence of an individual. It is based on an individual set of potentials, abilities, and skills, which is manifested both concerning the external professional and systemic environment and the internal environment of the individual. Professionalism reflects the level of mental, personality, psychophysical, and social condition, for example in terms of acceptance of change and proactive adaptation to its consequences, as well as useful coping with stressful situations, especially in decision making, in difficult conditions of military and security environment (Ambrozová, Pokorný, Knap-Stefaniuk, 2019). Professionalism is related to the potentials for critical, creative, and systemic thinking and to the ability to change models of cognition for decision-making, taking action, commanding and leadership (Ullrich, Pokorný, Sládek, 2018). These qualities of professional managers, commanders, and leaders are of long-term interest.

In our research work, we focus on the detection, identification, evaluation, and development of personality potentials of professionals working in demanding conditions of the military and security environment. We apply a Connatural Management approach that focuses on an individual´s natural potentials which form a background of abilities, skills, and functions and are useful and needed for cognition, decision-making, taking action and leadership. They relate to subtle skills, which are a part of the three-dimensional skill model (hard, soft, and subtle skills) of a professional leader. Natural potentials of people significantly influence personal fitness, which is a statement about the current state and balance of the individual's internal environment (Koleňák, Ambrozová, Pokorný, 2016). They are related to the issue of hardiness, which is discussed in the military environment in frame of selection and preparation of individuals e.g. for special and extreme tasks (Maddi, 2006, 2010; Clemmer, 2017) self-efficacy, coping self-efficacy and appraisal emotions (Delahaij, Van Dam, 2017), and emotional intelligence (Wildermuth, Vaughan, Christo-Baker, 2013; Zhang et al., 2018; Kozáková, Saliger, 2019; Krishnakumar et al., 2019).

In the pilot research, we focused on identifying personality qualities that relate to the psychophysical fitness of an individual, which is an important indicator for coping with challenging conditions, situations, and specific tasks of the military and security environment (Halpin, 2011). The psychophysical fitness is the result of the interaction of physical and mental processes, states and phenomena. It is related to the balance and harmony of the individual's internal environment. It is about an individual's ability to work with change, manage emotionally tense situations (Krishnakumar et al., 2019), strain and stress (Bartone, 2006; Mallak, 2016). A low level of psychophysical condition may negatively influence decision-making (Starcke, Wolf, Markowitsch, 2008), operating memory, or overall individual performance (Chiesa, Serreti, 2009; Gamble et al., 2018). In this context, there are interesting outcomes concerning, for example, the study of sleep deprivation (Nindl et al., 2002), functional magnetic resonance imaging (fMRI), and psychophysiological measurements in the process of decision-making (Wong, Xue, Bechara, 2011). Psychophysical fitness is related to emotional resilience (Paulík, 2017), which is based on how quickly an individual can regenerate after increased stress, anxiety, etc. It is therefore related to the ability of an individual to adapt to a stress stimulus. Subjective perception of the level of tiredness caused by increased stress, as well as the subjective perception of recovery / regeneration plays an important role (Heidari et al., 2019). Some studies point to personality traits concerning coping with increased strain and stress (Spector, O'Connell, 1994; Leys et al., 2018). It is essential to take into account the multiple demands individuals encounter, the meta-cognitive and emotive processes that affect the resilience-stress relationship, and the conceptual distinction between resilience and coping (Fletcher, Sarkar, 2013).

1.1 Context of psychophysical fitness

The relationship between regeneration and tiredness and its impact on individual performance attracts the interest of professionals involved in education and training processes for these challenging and specific environments (Bouchard et al., 2010; Casey, 2011; Cornum, Matthews, Seligman, 2011; Courtney, 2015).

In the context of psychophysical fitness, it is necessary to consider other parameters that may provide relevant data on the

individual's condition. A possible indicator of the organism's adaptation to strain and stress is, for example, nutritional status (Santana et al., 2012). Physical and body composition play an important role too (physical fitness and body composition characteristics) (Pihlainen et al., 2018).

Another indicator of body adaptation to stress and change is Heart Rate Variability (Kim et al., 2018), which is an indicator of psychophysiological reactivity to stress (Rubaltelli et al., 2018). The issue of Heart Rate Variability (HRV) is an important topic in sports physiology, e.g. monitoring HRV in relation to training intensity and improving body physiology (Dong, 2016), at the same time HRV may be an indicator of possible levels of psychophysical fitness and flexibility (Appelhans, Luecken, 2006; Thayer, Lane, 2009). Measurement of heart rate variability during the night can serve as an interesting indicator of both psychophysical fitness and the degree of excitement of homeostasis after a hard workout (Hynynen et al., 2011).

An important indicator is the value of the morning heart rate, which is relatively stable, because during the day the values may vary depending on mental and physical stress, weather and other variables (Hynynen et al., 2006). Morning frequency depends on the physical and mental fitness of an individual, health condition, age and healthy lifestyle (Soumar, Soulek, Kučera, 2000). In addition, the morning heart rate is a very important indicator of the current state of the body after a demanding previous strain, when its increase by more than 8-10 pulses compared to normal values can be considered as insufficient regeneration from the previous day (Bartůňková, 2014; Weippert et al., 2018). Morning heart rate is related to the issue of useful, optimal strain and the individual's ability to cope with these situations. It is also related to the ability of the organism to regenerate (Ambrozová et al., 2016). Adequate balance between stress (caused by training, professional strain and other specific requirements of the military or security environment) and regeneration is a prerequisite for achieving sustained quality performance (Kellmann et al., 2018).

The issue of HRV is also an important topic in the preparation of military professionals. The effects of prolonged physical activity on resting HRV are studied (Jouanin et al., 2004), sleep quality and chronic stress are addressed (Trousselard et al., 2014). Research activities are also focused on the relationship between physical fitness, HRV and cognitive functions (Hansen et al., 2004). Thayer et al. (2009) draw attention to the important relationship between cognitive performance, HRV, and prefrontal cortex functions.

Programs that focus directly on the Stress Resilience Training System (SRTS) are an integral part of the preparation process. Training app can provide an effective individualized method for mitigating the negative effects of situational and mission-related stress, at the same time eliciting potentially positive effects on performance (de Visser et al., 2016).

The need to monitor the psychophysical state of military professionals is pointed out by Stacey, Hill, Woods (2018), who directly propose the use of wearable physiological monitoring devices. Examples include software that accurately and continuously analyzes a soldier's HRV, updating results at intervals of 10 to 30 seconds. Directly in a combat situation, it can help the field commanders determine who needs immediate medical attention or evacuation (MRI, 2006).

Our work aimed at identifying indicators of the psychophysical fitness of an individual for coping with challenging conditions of the security environment, in the form of objective indicators of the ability to calm and regenerate the organism. These indicators, in the form of indices, reflect the psychophysical fitness of the individual. The research was carried out under simulated conditions of increased complex load, in the environment of courses with the applied X-tream methodology, which allows monitoring the qualities and potentials of individuals in difficult and dangerous situational contexts and conditions.

1.2 Framework of X-tream methodology

The X-tream methodology represents an environment with a sophisticated multidisciplinary methodology of strain variability and testing the quantity and quality level of an individual's performance during changes in their fitness in multiple dimensions and different situations of tasks. It enables the creation of conditions for multiparametric detection and evaluation of indicators related to individual performance and how he or she handles the different demands of task situations. In this sense, the methodology itself and the courses created on it are multidimensional. Although the methods of psychophysical diagnostics require standard conditions for testing, in the context of the X-tream model, the non-standard, natural conditions are targeted (Ambrozová et al., 2015; 2016). The diagnosis is carried out in three phases - before the start of the course - in a sleep mode (1st measurement), during the course (2nd, 3rd and 4th day) and at the end of the course (5th day of the course). To determine objective indicators of the ability to calm and regenerate the body, we used continuous monitoring of heart rate changes and their trends, using the Polar Team System. For statistical data processing, data on trends in heart rate changes, concerning exercise and post-exercise recovery, in a standardized fitness test were used.

The standardized X-tream fitness test consists of three consecutive standardized tests: sit-up, push-up, and the Burpee test. The sit-up test is performed for one minute. Execution: lying with legs apart in the width of the hips (thighs and calves forming an angle of 90°) - crouching from the inside out (hands at the back of the head) bent stretched arms upwards from the inside (hands at the back of the head) – forward bend sit astride, elbows on knees and back to lying position, the backs of hands situated at the back of the head touching the mat in the low position. The legs are fixed with feet on the mat during the test. The push-up is performed for 30 seconds. Execution: starting position – front-support (upright head, hands in the width of the shoulders, trunk, and legs in a straight line, legs touching, max. distance of inner ankles 20 cm) – downward movement (the chest touches the mat) – an upward movement to the front-support. During the exercise the body should be kept firm – upright head, hands in the width of the shoulders, trunk, and legs in a straight line, legs touching. The Burpee test includes the following positions. Starting position – narrow straddle, push-up in squatting position, push-up in lying position (upright head, hands in the width of the shoulders, trunk and legs in a straight line, touching legs, max. distance of the inner ankles 20 cm), push-up in squatting position, and back to narrow straddle. The cycle repeats 20 times. The time is measured in seconds. There is a one-minute interval between the tests. Only complete and correctly performed exercises are included (Ministerstvo obrany ČR, 2011).

Trends for each day are calculated from the TF0 and TF1 heart rate values for an individual day after standardized X-tream fitness tests. TF0 represents the heart rate value immediately after exercise and TF1 represents the heart rate value 1 minute after exercise when an individual performs activities to regain the utmost calm and concentration. Trends for individual days comprised of $= \frac{(TF_0 - TF_1)}{TF_0}$.

2 Materials and Methods

The main aim of the paper is to define an indicator of the psychophysical condition by the usage of objective pacification parameters and organism regeneration. The sample consisted of 286 respondents, participants of courses with applied X-tream methodology - men and women aged 21-34 years, working in a secure environment. For statistical data processing, 236 participants were selected. The main selection criterion was the successful completion of the entire course (due to the need for a complete set of data obtained by measuring and testing participants at each stage of the course). All gained data were processed by SPSS Statistics 25 within factor analysis.

Factor analysis as a statistical method work within the correlation of individual variables. The correlation coefficients represent the variable distance within others as the linear dependence of individual variables. The correlation of two chosen variables illustrates their similarity in situations where the other variables are assumed to be constant. If it is possible to explain the dependence of variables using common factors, the partial correlation coefficients are close to zero.

To verify the eligibility of factor analysis, two coefficients must meet the required values. As first, Kaiser–Meier–Olkin (KMO) represents the value is calculated by the rate of squares sum of correlation coefficients and squares sum of correlation and partial coefficients. The value of KMO can move in an acceptable interval ⟨0.5; 1) – more suitable values are close to 1. If the KMO value is under 0.5, factor analysis couldn't be employed. The second is Bartlett's test, which helps to test a null hypothesis. If the null hypothesis is rejected, factor analysis could be used for defined variables (Řezanková, 2010). The value of Bartlett's test must be to 0.05 as an acceptable 5% error. For verification of factor analysis, Cronbach's alpha indicator must be used. This indicator is seen as a reliability coefficient, which is used as a kind of analog of the correlation coefficient. It is possible to reach values in the interval (0;1), where zero is a value explaining the unsuitable correlation of variables. The value closed to 1 describes a higher degree of conformity is reported (Řezanková, 2010; Cronbach, 1951).

3 Results

According to requirements of factor analysis, the KMO test and Bartlett's test of sphericity were applied. The KMO measure for the psychophysical dimension is 0.609. The value of Bartlet's test of sphericity is 0.043 and confirms the usefulness of factor analysis.

Five variables were defined from the performed factor analysis, including complete variables. These are the results obtained by extracting the main components. Of these five variables, the strongest factors were then determined according to the chosen key. The key is to achieve an intrinsic value of at least 1, which is the overall variety of each factor. The first two factors explain almost 68% of the variance. The result of the factor analysis is a rotated matrix, which indicates the strength of individual variables, saturating the identified individual factors. To qualify rotating factor loads as a saturating (supporting) factor, they must be greater than 0.5. To determine the value of the Cronbach alpha indicator, the variables that saturate the factor were taken. However, only a factor that contains at least two positive variables is acceptable (see Table 1).

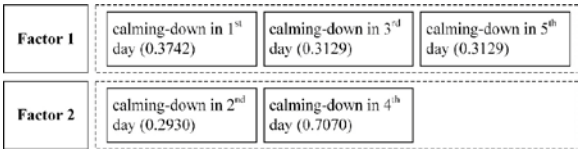
Table 1 Factor loadings of physical stress in individual days

Variable	Factor 1	Factor 2
Physical trend of 1st day	0.830	0.126
Physical trend of 2nd day	0.441	0.771
Physical trend of 3rd day	0.787	-0.007
Physical trend of 4th day	-0.044	0.941
Physical trend of 5th day	0.537	0.296
Cronbach alpha	0.425	0.634

Source: own work by authors

Based on the performed factor analysis, two indices for the psychophysical dimension were defined - the factor of the calming trend in 1st, 3rd, 5th day (F1), and the factor of the calming trend 2nd, 4th (F2). Both factors are showed in Figure 1). Although the value of the Cronbach alpha index for the F1 is 0.425 (the acceptable value is 0.5), for the pilot examination it seems to be taken into account, especially because of the so-called trends on individual days and result trends in individual tests. In the case of factor, for F2 Cronbach alpha ratio reaches value 0.634, which could be valued as the middle one (see Table 1).

Figure 1. Factors of psychophysical dimension



Source: own work by authors

Factors of the calming trend affect the relationship between trends in changes in heart rate levels about an individual's workload. Speed and direction after the end of the activity - the trend of calming, or recovery of the body after physical exercise.

For both indices, the sum of the factor scores used represents the weights of the variables. Therefore, their sum must be equal to 1. For the indices ascertained, it is important to establish basic statistical indicators that represent limit values when comparing the results of individual course participants (see Table 2).

Table 2. Descriptive statistics of factors for the psychophysical condition

Variable	Factor 1	Factor 2
Mean	2.241	2.151
Median	2	2
Standard deviation	0.407	0.494
Variance	0.166	0.244

Source: own work by authors

The mean value describes the mean value of the whole research sample. The median sets a threshold where one-half of the participants reached a lower value and the other half reached a higher value. The indices obtained show sensitivity to trend changes in individuals. In addition to specific data on the individual's current heart rate level in a given situation, the change in heart rate, speed, and direction after the termination of activity is significant. It can be considered as a trend of calming, or regeneration of the body after physical stress (see Table 2). The trend range is then in three values: (0;0.1), (0.1;0.2), (0.2;0.3). Table 3 shows the scaling of heart rate trends.

Table 2. Descriptive statistics of factors for the psychophysical condition

	trend scaling
Stability or placid decrease	(0;0.1)
Fast decrease	(0.1;0.2)
Rapid decrease	(0.2;0.3)

Source: own work by authors

The achieved individual factor values can then be an indicator of the higher or lower frequency and intensity of the following aspects, such as the speed of getting into the situation, adaptation and acclimatization, resilience to tiredness and exhaustion, the degree of suggestibility and performance of an individual by change and standard stress.

For the identified factors, the sum of the factor scores used represents the weights of the variables. Therefore, their sum must be equal to 1. If some indicators are not included in the relevant factor, the individual coefficients must be recalculated. For the interpretation of the defined indices, it is important to use the basic statistical indicators, which represent limit values when comparing individual results.

4 Discussion

Based on statistical data processing formulas of two factors were obtained. The calming trend factors cover the relationship between trends in changes in heart rate levels concerning the individual's strain. Speed and direction after the end of the activity - the trend of calming, or recovery of the body after physical exercise.

Relationships between trends of heart rate changes on the first, third and fifth days of the course (Factor 1) and between trends on the second and fourth days of the courses (Factor 2) appear to be significant. Although factor 1 does not have acceptable validity, because the Cronbach alpha value is 0.425 (acceptable value is 0.5). In the context of the pilot investigation, it also appears to take this index into account, mainly because of working with the so-called trends. The trend was calculated as a calming trend on a given day.

The trend range is then in three intervals: (0;0.1), (0.1;0.2), (0.2;0.3). The maximum value of trends achieved by course participants is 0.30, the minimum value is 0.06. When the stability or slight decrease in heart rate is on a scale of (0;0.1). The rapid decline of (0.1;0.2). The rapid decrease of (0.2;0.3). The indices obtained show sensitivity to trend changes in individuals.

In addition to specific data on the individual's TF level in a given situation, the change in heart rate, speed, and direction after the termination of the activity appears to be significant. It can be considered as a trend of calming, or regeneration of the body after stress. This trend does not necessarily depend on the individual's level of training in terms of adaptation to physical stress. Individuals with a slow return to a resting position (mild and moderate decline) then exhibit more tiredness traits leading to exhaustion. Their ability to respond adequately to the task situation differs from individuals who are characterized by a rapid decline.

The factor is sensitive to the change that is reflected in the fourth day of the course. Individuals whose factor result is above the median value (0.166) and above mean (0.172), may have a higher frequency and intensity of the following aspects:

- Faster getting into the task situation, more effective adaptation and acclimatization.
- Resilience to tiredness and exhaustion.
- The lower suggestibility of an individual and his/her performance by change and standard workload.
- The lower vulnerability of an individual as a whole to stress, limit, and extreme stress.

Individuals whose factor result is below the median (0.166) and in particular below the mean (0.172) can be observed a higher frequency and intensity of the following aspects:

- The lower adaptation and acclimatization efficiency.
- Higher risk of tiredness and exhaustion requiring longer time or specific recovery and regeneration conditions.
- The suggestibility of the individual and his / her performance by change and standard workload.
- Increased sensitivity to change, strain and stress, with negative consequences on quantity and quality of performance and a higher potential risk of 'disease'.
- Higher vulnerability of the individual as a whole by stress, limit, and extreme strain, with devastating consequences for an individual, e.g. inability to continue to solve a task, perform the required activity or provide a function, tendency to fail as a whole (breakdown).

5 Conclusion

The X-tream methodology enables to identify individuals who possess not only the appropriate level of partial qualities but also their appropriate combination or organization. This combination allows personality potentials and qualities to be manifested, updated and applied in individual and situational contexts as professional leadership. At the same time, it is a necessary quality for the activities of managers, commanders, and leaders in the current military or security environment.

It turns out that identifying trends in heart rate changes can contribute to understanding the level of an individual's psychophysical fitness. Monitoring the relationships between trends in psychophysical fitness changes, identifying, deciding, and taking action in solving tasks and coping with situations and processes of change and strain in various conditions and environments provides important data for the selection, preparation, and development of people. These data not only identify the presence and level of the natural potential of an individual but also suggest their cultivation through personal development, as it is related to their psychophysical and mental fitness levels, for example in terms of acceptance of change and proactive adaptation to its consequences, and potentials of critical, creative, and systemic thinking, ability to change cognitive models for decision-making and taking action, etc., which form the basis of professional management and leadership mastery.

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Primary Paper Section: A

Secondary Paper Section: AE, ED, KA