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The Author's Summary
of his Doctoral (PHD) Thesis
about

The Possible Use of an Artificial-Intelligence-Based Computer-Aided Expert System at the Aptitude Tests of Military and Police Personnel

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I. Formulation and timeliness of the scientific problem

Hungary's obligations arising from their NATO membership as well as factors that threaten international public safety justify the establishment of military formations that are capable of efficient operations and can be usefully deployed for crisis management, in defence or within the framework of our international alliance. The army in the future will be a competency-based military force, built up based on pre-defined principles, procedures and doctrines, meeting both national and international challenges, whose duties, organisational structure, equipment and armament as well as staff and their level of training constitute a cohesive system.

The current changed environment sets a requirement that the staff's preparations for crisis-response operations provide, besides military knowledge and skills, preparation for the foreseeable (and personally experienced) conflict and stress effects together with psychological knowledge that, if they are missing, would impose additional psychical burden on, and thus hinder the efficiency of, the personnel assuming a by all means uncommon and risky duty. Today's battles require today's soldiers to be open to information, to correctly assess it, and to execute their determination in the form of complex deeds while bearing the said burdens, which makes it crucial for them to be able to resist to the exhaustive psychical impacts entailed in their activities (Szternák, 2004)[1].

Scientifically studying all those new challenges, those long-lasting, enhanced and extreme physical and psychical burden is an important pre-condition for achieving the above goals. To develop a personnel selection expert system (aptitude and functional tests) as per the changing system of criteria, and to provide training, from the basic ones to the staff up to the ones delivered to members of special task forces so as to develop and/or sustain their skill levels, such scientific results from the research of stress burden and the elaboration of new testing methods are essential that can be adopted successfully in practice (Hullám, 2005)[2].

Enhanced physical and psychical burdens exert an extremely complex effect on human performance. The effect can be noticed both in the qualitative and quantitative changes in human output. A soldier's physical and psychical capabilities will change in response to

[1]Szternák, Gy.: Thoughts on the problems of armed fights. Handwritten notes about unitversity lectures. ZMNE. Budapest, 2004.

[2]Hullám, I.: Multifactorial examination and analysis of the mental consequences of extreme burdens: applicability of results int he development of aptitude testing expert systems. Ph.D. thesis. ZMNE. Budapest, 2005.

enhanced and extreme burden. In other worlds, it may cause the individuals and groups' performing capabilities to decrease and their exposure to danger to increase.

In their 35 articles and book on battlefield stress, Michel and Solick (1983) stated that neither the accurate extent of output decrease nor the signs of the nature or origin of that decrease can be established from the literature[3]. Furthermore, other studies on the subject (Végh, 2004)[4] pointed out that in combat situation only 10 to 15% of soldiers sustain their capacity to act, 70 to 80% of them will have very limited capacity, while 10 to 50% of them will become entirely paralysed in extreme stress situations. Certain research work unveils that 25 to 35% of the fatalities that occur at special military and police forces in the course of action are caused by what is called neuro-psychiatric injuries deriving from the lack of mental preparedness (Noy, 1987)[5]. At the same time some assessments suggest that not less than 50% of injuries in warfare are attributable to battlefield exhaustion. (Abraham, 1982; Mareth and Booker, 1982).

From the viewpoint of their content, military activities varies in a very wide range from simple, general, routine operations to the execution of complex tasks requiring special knowledge, physical and mental skills and competencies. To achieve the output level generated during the most versatile duties with respect to their durations, complexities and the required physical and mental efforts (burdens), soldiers have to be much more burden-bearing than the average in their psychical and physical functioning. An essential question is what functions are in the forefront from the perspective of military performance, and it is vital that, during staff selection, the most psychologically burden-bearing soldiers are assigned to a given task.

The psychological testing methods currently used in the military, among other things IQ tests, concentration tests by instrument or by paper and pencil, personality questionnaires, examining a capability required for a special position, career motivation questionnaire, biography indicator, anamnesis, exploration, are fundamentally suitable to meet the changed aspects of selection. However, there are stronger and stronger special expectations for the personnel of armed forces, e.g. stress resistance need to be identified as precisely as possible, that can be studied more efficiently with unconventional methods; and there is also a need for such special testing procedures that properly supplement the already existing means of competency and capability measurement. What can meet the arising needs include the projective personality testing methods (*inter alia* projective drawing tests) that have not or

[3] Driskell, J.E., Salas E.: Stress and Human Performance. Lawrence Erlbaum Associates. Mahwah, 1996, 89.p.
[4] Végh, J.: Principles, methods and practical experiences of psychical training. New Military Review, 8. 1996.
[5] Belenky, G. L.: Contemporary studies in combat psychiatry. Greenwood Press. Westport, 1987.

scarcely been used so far, along with the expert systems developed to evaluate, interpret and objectivise them.

In psychology, projection is mostly connected to the psycho-analytical approach that interprets it in the following way: „… *an operation in the course of which one excludes from himself the attributes, emotions, desires and perhaps „objects" that he has not recognised or has rejected, and places them into another person or thing."* (Laplanche and Pontalis, 1994, pp. 387.)[6] According to Laplanche and Pontalis, Sigmund Freud first published his ideas about projection in 1895, then associating it as a primary defence mechanism with paranoia. But he also repeatedly mentioned that he found projection as a normal mechanism that can be captured e.g. in superstition, animism and mythology. Results of modern biological and Gestalt-psychological research also support that projection is a generally typical operation of human beings. Accordingly, living beings select from their fields of perception such stimuli only that are relevant to them while characteristic features of a personality, particularly in less structured situations where the stimuli are not fully unambiguous, are manifested in behaviour. That is the phenomenon projective testing methods are based on.

The key importance of the problems related to the aptitude tests of military and police personnel as set forth above inspired me to look scientifically at the crew of special armed forces (e.g. special police services, soldiers performing missions in war zones abroad, etc.) who are exposed to enhanced and extreme physical and psychical stress for a longer period of time, and to elaborate a special testing methodology that can be conducive to selecting personnel with strong stress coping capabilities.

II. Directions of research, goals, hypotheses and methods

In my research I basically set the goal of developing a computer-aided psychological expert system, based on artificial intelligence, which can be used to indicate and measure stress resistance and coping capabilities. For that, I use an already existing projective drawing test procedure as the testing tool. The procedure generates a stressful condition in the subjects of the experiment, which makes it useful achieving the set goal.

I performed the projective test evaluation and interpretation with such a further developed version of „ESPD" (*Expert System for Projective Drawings,* Vass, 2000a, 2000b, 2001a,

[6]Laplanche, J., Pontalis, J. B.: Dictionary of psychoanalysis. Akadémia Publishing House. Budapest, 1994. 387. o.

2001c, 2002, 2004a, 2004b, 2005, 2006, 2007)[7] expert system that can assist as a complex expert module in the selection process of soldiers and policemen to be deployed in special missions (e.g. surveillance, commando action, peacekeeping, disaster management, special fire-fighting as well as combat, guarding, law enforcement and transportation duties).

The goals of the research based on the above are:-

(a) to develop a new projective method for the selection of individuals capable of managing (extreme) stress at military and law enforcement services;
(b) to complete the comparative significance study between the contents of an existing test used to measure psychological immunity and stress-bearing capability (Psychological Immune System Questionnaire (Hungarian acronym: PIK) Oláh, 1996)[8] and of the projective drawing test I use, in order to better distinguish the drawing signs characteristic of people with better coping capabilities; and
(c) to create a new computer-aided expert system for the evaluation of MDZT (the Multi-Dimensional Drawing Test, or *Mehrdimensionale Zeichentest,* that I used in my research; Bloch, 1968, 1971, 1973)[9], based on the ESPD expert system, that is suitable to indicate the stress-bearing or coping capabilities of the personnel at armed forces, particularly in positions involving high stress levels such as combat units, foreign military missions, action forces of law enforcement agencies, to interpret the products of drawing tests, and to generate textual expert views on stress resistance and coping capabilities.

Hypotheses in the research:

(1) From the viewpoint of stress resistance the people in the *experiment group* (members of military and police personnel who are exposed to significant stress burden) and in the *control group* (civilians) produce significantly different drawing behaviours with regards to the traditional and behavioural MDZT variables, i.e. the testing method I use is suitable to distinguish between people with different stress bearing capabilities and coping strategies;

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[7] Vass, Z.: Psychodiagnostic foundation of drawing tests. Flaccus Publishing House. Budapest, 2006.
[8] Oláh, A.: Personality factors of coping: The psychological immune system and a method to measure it. ELTE. Budapest, 1996.
[9] Bloch, R.: Der mehrdimensionale Zeichentest als Hilfsmittel in der Psychotherapie. Zeitschrift für Psychotherapie und medizinische Psychologie, 23. 1973. 24-35. o.

(2) Based on the differences mapped out, a mathematical procedure can be elaborated that will make meritorious contribution to the selection of a target personnel with developed stress resistance to be deployed in special military or law enforcement duties;
(3) Applying the elaborated mathematical procedures, a psychological computer-aided expert system can be created that is suitable to distinguish between the tested people on the basis of their levels of stress resistance.

Methods of research:

(a) presenting the theories describing stress and coping functions, based on the relevant publications of national and international literature;
(b) Presenting the theoretical background of the projective personality testing procedures and of the artificial-intelligence-based computer-aided expert system.
(c) A preliminary validity check of the Multi-Dimensional Drawing Test as a projective procedure for the stress resistance and coping functions of the personnel of armed forces.
(d) Studying an experiment group and a control group, both set up under a pre-defined set of criteria, by using the projective drawing test and the Psychological Immune System Questionnaire.
(e) Supplementing the MDZT with actual genetic reactions which I made a list of, and definitions for, in the course of the research.
(f) Incorporating the elaborated mathematical procedure into the computer-aided expert system.

III. Presenting the structure of the study

In the *Introduction* I formulated the factors inspiring the choice of the topic of research, my scientific objectives, and the methods chosen to achieve my scientific goals. The study is developed in four chapters. *Chapter one* presents the specific stress situations the personnel of armed forces are exposed to, the typical stressors, and the sources for a personality to successfully cope with and manage stress. The effect of enhanced physical and psychical burden and of extreme environmental factors on soldiers' physiological and psychical functions is described. Within the topic, a number of relevant publications studying the impact of extreme burdens, climatic conditions and irregular rhythms of the parts of day on mental performance are presented. *Chapter two* summarises the psychical, physical and medical

aptitude testing procedures used at armed forces, as well as the projective testing methods, touching upon in particular the potential application of projective drawing tests, and the theoretical background of artificial-intelligence-based computer-aided expert systems and their possible use in the configuration analysis of projective tests. The ESPD: *2008* system, its version extended with a special module, the MDZT expert system that I developed are presented in the chapter. In *Chapter three* of the paper that contains an empirical study I perform an evaluation and interpretation of the research done. By using a projective testing procedure, I verify the significant difference between the stress resistance of the experiment and control groups, and analyse the results by statistical procedures and with the help of the ESPD: *2008* expert system. *Chapter four* concludes the thesis by summarising the results of the scientific research and by presenting the possible application of the developed system.

IV. Summary of the accomplished scientific activity. New scientific results, verification of the hypotheses, recommendation, potential usages in practice

As a conclusion of the research results I can state that MDZT (as a stress-generating projective drawing test procedure) can make a meritorious contribution to distinguishing groups of tested people from the viewpoint of their stress-bearing capabilities. Although no test in itself is sufficient to support complex decisions, MDZT will enhance the certainty of decisions to a large extent. I developed a mathematical procedure (regression functions) that is capable of distinguishing the drawing tests of members of an experiment group and a control group in 80% of the cases if, besides looking at the drawings themselves, we also record and analyse the subject's involuntary, consciously uncontrolled drawing behaviour, i.e. their actual-genetic signs.

The analysis of actual-genesis in the test is of key importance because MDZT as a projective drawing test procedure can ultimately be considered as a manifestation of expressive behaviour. A significant element of the test procedure is that, in addition to the drawing, the related behaviour is also analysed to draw conclusions regarding the personality. At the same time, the graphic product is also indispensable to understand the drawing person's behaviour as such a product does not only reserves and documents the movements but also enlarges such features of movements that can be hardly seen by eyesight; it simultaneously shows the series of movements fractioned over time; and a drawing in the process of creation also represents a stimulus that the tested person responds to. As the data about the creation process can only be recorded during the test situation, the person leading the test will have to make preliminary

preparation for it in order to possess a set of aspects and criteria that focuses his/ her attention to the diagnostically relevant phenomena. This thesis has elaborated that set of aspects and criteria.

The research looked at both the graphic characteristics of a drawing and the actual-genetic features of test behaviours at the same time. The results suggest that the two approaches together can be applied the best.

To use a drawing as a self-expression form closely related to human onto- and philogenesis for psycho-diagnostic and selection purposes appears to be useful in itself because it is a universal activity familiar to everyone. Unlike other testing methods (e.g. forced selection paper and pencil tests), drawing as a situation is not unknown which makes it a relatively safe situation for testing. Consequently, it triggers less resistance than, for instance, a stress interview or instrumented measurements, it often dissolves a tested person's anxiety, helps in making rapport, and can provide voluminous information even about adults who are otherwise difficult to open up. Its non-verbal nature prevents even more reserved and resistant people from balking at it. Another important factor is that they are less able to keep a drawing in process (i.e. an image evolving about themselves) under conscious control.

A positive feature of MDZT is that it is a cost-saving but less time-consuming procedure. The central element of a test is that the time pressure in the course of recording the test imposes a psychological burden on a tested person, partially converting the otherwise informal, associative, projective test situation into a performance-driven situation. A tested person can react to the 'stress' in many ways (which I examined in part). The reason for time pressure is psychologically acceptable: shortening the time for thinking helps enlightening the individual features of the person's thinking and association process, enhances the dynamics of image flow, and forces defence mechanisms to become activated. An interesting and positive feature of multi-dimensional drawing tests is that it offers such a tool for analysing the form and content of free drawings that results in quantified indicators. Taking into account the tools of projective drawing tests, one will see it unique for its feature that it is capable of quantifying the analysis of a free drawing.

It is exactly that feature that my research utilised to study stress-bearing capability. The analyses performed with multiple variables resulted in functions that help in selecting apt personnel for roles that require enhanced stress resistance and psychological coping potential. I calculated two functions in my research, and I recommend using the one that resulted from stricter professional criteria. That version is virtually as accurate as the other version but also reserves its validity when it comes to studying new cases. I incorporated the function into the

special version of ESPD expert system that I developed, which, immediately after recording a drawing, tells you with what percentage a candidate can be recommended for a job requiring extreme stress-bearing capabilities.

Verification of the hypotheses

Out of the hypotheses of my study, I ***verified the first hypothesis,*** i.e. it was proven statistically that the drawing behaviours of the two examined groups are significantly different with regards to the traditional and behavioural MDZT variables. It means that the members of the experiment and control groups have different stress-bearing capabilities and apply different coping strategies, or in other words the soldiers and policemen who work in positions involving significant psychic burden (task forces, combat units) have remarkably better stress resistance than the members of the control group. The reason for that can be a proper selection of personnel and/or the experiences, skills gained in the course of their work and training events. At the same time the study filtered out people who I put into the control group because some criteria for placing them into the experiment group were not met, but who, based on their test results, produced the same stress-searing capability as the members of the experiment group. From the viewpoint of the testing method, it is a very important conclusion because the studied projective drawing test procedure along with the developed expert system can in the future be used in the selection of people who meet the criteria to become members of the control group (civilians, policemen and soldiers working in stress-free or extreme-stress-free circumstances) for jobs and positions involving high stress level.
The ***second hypothesis was*** also ***proven*** in the study because, using the differences mapped out, I developed a mathematical procedure that makes meritorious contribution to the selection of target personnel (regression functions).
I verified the third hypothesis because a new computer-aided system, i.e. the MDZT expert system, was prepared as a result of my research. Further data collection can be done directly by the expert system, which significantly accelerates the research. As a result of the current study, further development of the MDZT expert system has also become possible. The upgraded program makes textual and quantified analysis, and calculates in every individual case the logistical regression function that was produced as a result of the current study during the mathematical statistical analysis of the experiment and control groups. The program compares the gained values with the theoretically foreseeable ones and, based on his/her

reactions, indicates which group the currently tested individual should be placed into. The results can be saved both in textual and numeric forms.
The further developed program also offers a special option for research purposes that collects data about an optional number of cases and exports them in a format that modern statistical software programs (e.g. SPSS, ROPstat) can retrieve and open, allowing further statistical analysis to be carried out.

I find it as a new scientific achievement:

- I was the first to use a projective testing tool (the MDZT projective drawing test) to analyse stress resistance at armed forces. I verified with the new testing procedure that the coping potential of the members of special armed services (combat units, police intervention units) is, in vast majority, significantly different from civilian individuals' stress resistance.
- I elaborated a computer-aided evaluation method for interpreting MDZT results, thus extending the circle of projective testing procedures useable at military aptitude tests (currently an option). Thus the testing tool I examined has become suitable to select the personnel for special armed services entailing high stress level.
- In the course of my study, I developed a mathematical procedure (regression functions) that makes fundamental contribution to the distinction between people with different stress coping potentials, and provided a theoretical foundation for the creation of the expert system software.
- I created an artificial-intelligence-based computer-aided expert system (MDTZ – expert system) that is capable of analysing and interpreting the results of the projective drawing test procedure (MDTZ – drawing test), and indicate a test person's stress-bearing potential, which can make it an up-to-date, easy-to-use, fast and efficient testing tool at the aptitude tests of military and police organisations in the near future.

Recommendations, practical applicability

- I recommend implementing the MDZT expert system developed during the study as a pilot supplementary aptitude testing procedure for the selection of the personnel of armed forces who can be deployed in jobs and positions entailing high stress levels

(combat units of the military, members of foreign missions, intervention units of law enforcement agencies, members of anti-terror services, etc.).

- I recommend further testing the MDZT system, particularly in selecting the staff for foreign missions and in examining how well they function in their roles, in order to finalise the mathematical procedures (regression functions) regulating the operation of the expert system software and to reinforce the reliability of the expert system. The final objective is to develop a reliable expert system, based on the projective procedure that indicates with high level of certainty a given individual's coping and stress resistance potential.
- Furthermore, I recommend extending the ESPD: *2008* expert system with additional expert modules to filter out such personality features (e.g. aggression, impulse control) of the applicants to, and personnel working at, armed forces, which are more difficult to measure with traditional testing methods.

V. Curriculum Vitae

Academic Achievements

NAME: Attila KIRÁDY

DATE OF BIRTH: 27 February 1970

EDUCATION AND QUALIFICATIONS:

- **ZRÍNYI MIKLÓS UNIVERSITY OF NATIONAL DEFENSE,** Doctoral School of Military Sciences (HDI), **Department of Military Psychology:** "Development of expert system based on the application of artificial intelligence in military aptitude test*"*
- **UNIVERSITY OF SZEGED,** Faculty of Arts, *Department of Psychology* (2006) – psychologist specialized in clinical psychology
- **UNIVERSITY OF SZEGED**, Faculty of Arts, *Department of Communication* (2001) – graduate degree in communication sciences
- **KODOLÁNYI JÁNOS COLLEGE** (KJF), *Department of English and Communications* (1997) – expert of communication sciences

LANGUAGE SKILLS:

1. ENGLISH – INTERMEDIATE LEVEL (WRITTEN AND ORAL)

2. ESPERANTO – ELEMENTARY LEVEL (WRITTEN AND ORAL)

POSITIONS HELD AS INSTRUCTOR:

- **KODOLÁNYI JÁNOS COLLEGE (KJF)** – ASSOCIATE PROFESSOR

  1. DEPARTMENT OF CULTURAL STUDIES
  2. INSTITUTE OF PSYCHOLOGY AND PEDAGOGY, DEPARTMENT OF PSYCHOLOGY
  3. DEPARTMENT OF COMMUNICATION AN MEDIA SCIENCES

- **COLLEGE OF POLICE** (RTF) - ASSISTANT LECTURER

  1. DEPARTMENT OF PSYCHOLOGY AND LABORATORY

- **ZRÍNYI MIKLÓS UNIVERSITY OF NATIONAL DEFENSE (ZMNE)** – LECTURER

  1. DEPARTMENT OF SOCIOLOGY- PSYCHOLOGY AND PEDAGOGY
  2. STAFF COURSE- COMMUNICATION STUDIES

SUBJECTS, 1998-2008

MEDIA PSYCHOLOGY – LECTURE, SEMINAR
ADVERTISEMENT PSYCHOLOGY – LECTURE, SEMINAR
PSYCHOLOGY – LECTURE
PSYCHOLOGY OF TOURISM - LECTURE
FACT FINDING REPORT - SEMINAR
FIELD TRAINING IN THE RADIO – SEMINAR
TELEVISION SUDIES – LECTURE, SEMINAR
STYLISTIC STUDIES – SEMINAR
COMMUNICATION TRAINING – SEMINAR
INTRODUCTION TO PSYCHOLOGY – LECTURE, SEMINAR
PSYCHOLOGY OF HUMAN RELATIONS – LECTURE, SEMINAR
PSYCHOLOGY OF DISASTERS –LECTURE, SEMINAR
CRIMINAL PSYCHOLOGY–LECTURE, SEMINAR
PSYCHOPATHOLOGY -LECTURE

PROFESSIONAL ACTIVITY:

In the field of communication:

In the radio:	Vörösmarty Rádió, Székesfehérvár (host and editor)
	Reflex Rádió, Székesfehérvár (host and editor)

On television:	TV2, News programmes: Tények /Facts/, Morning news, Magazines, Shows (editor, editor-in-chief,), Jakupcsek Show (editor-in-chief), creative producer of TV2
Printed press:	Színes Vasárnap, national weekly (editor), Népszava (journalist, editor)

In the field of psychology:

- Articles, conferences and lectures on psychology
- Managing director of Institute of Stress and Crisis Psychology
- *Configuration analysis of projective drawings by schizophrenic patients* (6th National Congress of the Hungarian Psychiatric Association, 2006)
- Trainer and Researcher (Kodolányi János College, RTF, ZMNE)

In the field of military sciences:

- Trainer and Researcher (ZMNE)
- PhD programme

VI. List of publications

- **KIRADY, Attila (**2002)**:** Chernobyl Indictment (book), Alexandra Kiadó, Budapest, 5-239 p.
- **KIRADY, Attila:** Human Experiments, (book), Alexandra Kiadó, 5-241 p., 2006
- **KIRADY, Attila:** Human Experiments – revised publication (book), Alexandra Kiadó, 5-264 p., 2008
- **KIRADY, Attila:** Army in the Facts, *Humán Szemle*, 93-104 p., HM, 2006
- **KIRADY, Attila:** Configuration analysis of projective drawings by schizophrenic patients (6th National Congress of the Hungarian Psychiatric Association, 2006)
- **KIRADY, Attila:** Application of artificial intelligence in military aptitude test, *AARMS* (Academic and Applied Research in Military Science), 785-790, ZMNE, 2007
- **KIRADY, Attila:** Application of expert systems in armed forces, *Társadalom és Honvédelem*, 12-24 p., ZMNE, 2007
- **KIRADY, Attila:** Analysis of September 2006 riots from the aspect of mass psychology. ZMNE, Conference Publication, 2008

- **KIRADY, Attila:** Aggressive behaviour in disaster situations. In:Katasztrófapszichológia, college notes, RTF, Rejtjel Kiadó, 2008
- **KIRADY, Attila**: Forms of stress in the armed forces, *www.zmne.hu,* ZMNE, 2008
- **KIRADY, Attila, VARJU, Nóra**: Definition of stress resistance by analysis of projective drawings in the armed forces. MDTZ analysis in RTF, *www.zmne.hu,* ZMNE, 2008
- **KIRADY, Attila:** Group and team organization, in: Pszichológia, university notes (MA), RTF, before publication.