HADTUDOMÁNYI SZEMLE

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Human Factor in Information Operations: The Weakest Link?

Humán faktor az információs műveletekben: A leggyengébb láncszem?

Abstract

The large amount and various kinds of information produced by All-Source Analysis Systems (ASAS) can provide a serious advantage; however entails the responsibility of the final decision making on a relatively small group of top commanders. The burden of information on these commanders' shoulder approaches the limits of human information processing abilities. This study – based on the results of cognitive psychology – examines what factors obstruct human decision making processes, and what advantages human information computing methods still have compared to decision making systems based on artificial intelligence.

Keywords: Information Operations, cognitive psychology, cognitive scheme, artificial intelligence

Absztrakt

Az összadatforrású felderítő rendszerek által szolgáltatott információtömeg alapján viszonylag kisszámú vezetőre hárul a döntéshozás felelőssége. Az információs műveletekben részt vevő katonai csúcsvezetők információs leterheltsége az emberi teljesítőképesség határait feszegeti. A tanulmány a kognitív pszichológia eredményei alapján vizsgálja, hogy mely tényezők segítik, mely tényezők gátolják e szakmai döntéshozatali folyamatot és mi az a plusz, amit a humán információ feldolgozás a mesterséges intelligencián alapuló döntésekkel szemben képes felmutatni.

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HADTUDOMÁNYI SZEMLE

2016. IX. évfolyam 1. szám

Kulcsszavak: Információs Műveletek, kognitív pszichológia, kognitív séma, mesterséges intelligencia

INTRODUCTORY THOUGHTS ON THE EVOLUTION OF WAR AND HUMAN INTELLECT

The history of mankind was followed by wars. Nowadays, in the developed world the same principles and factors determine the outcome of combats as in the case of the prehistoric fights of the ancient herds: the attributes of the territory, the size, desperation, faith and the routine of the fighting troops, the abilities, the knowledge and the physical conditions of the warriors, the smoothness of supply, the modernity of the weapons and finally the abilities of the leaders, the quality of commanding. As the army have become more and more institutionalized these last two factors have an increasing significance in success.

Over the course of the millennia societies have become increasingly differentiated, the division of labor is at a high level by now, complex systems of institutes, compound rules have emerged and a rapid development of the technical environment has been carried out apace in every aspect of life. Under these conditions information overload of humans has raised while the role of knowledge and learning has become more valuable. In connection with these changes there are several questions to be answered: Were users able to keep pace with all of these challenges? How could the development of our nervous systems and our information processing strategies adapt to these serious changes? Can we make these perplexingly complex systems work faultlessly on clearly rational bases? Can a commander be able to compute all the relevant information properly under pressure in a stressful situation? Can fully automatized, artificial intelligence based systems be created, and can they minimalize or even exclude the possibility of human errors and mistakes? If we create such systems, will we be able to keep them under control, can we entrust them to decide about the question of war and peace instead of us? Would a decision making mechanism based on clearly rational computing increase or decrease the probability of the initiation of armed conflicts? In war situation do commanders' motivations, emotions, urges and needs increase or decrease the effectiveness of their judgements and decisions? Can we do without military supreme commanders? Can any human being take the responsibility of decisions that can lead to the death of millions and determine the fate of entire countries? Should we let machines decide about these instead?

The aim of this study is to examine human factors of decision making processes carried out by supreme commanders which fundamentally determine the final success of the entire military force. In my essay – on the grounds of cognitive psychology – I would like to take a stand on the debate whether it is an art or a science what outstanding military strategists of our history do?[2] We analyze the possibilities of entrusting fully automatized, artificial intelli-

[2] Nagy, L.: *A hadtudomány tárgyának kibővülése – új kutatási területek.* In.: „Napjaink Hadtudománya", Az MHTT konferenciája a 21. századi hadtudomány irányvonalairól. 26th February 2009

gence based systems to make decisions in taut situations in order to exclude the possibility of human errors.

THE ROLE OF HUMANS IN INFORMATION OPERATIONS

The 20th century is generally called 'the century of technics' while the 21th century is apostrophized as 'the century of information technology'. In every facet of our everyday lives we are witnesses of an extremely rapid IT boom, the significance of using information technology, computer controlled electronic devices has increased in the past few decades. Among Critical Infrastructures the operability of informatics systems and networks of public administration, public utilities, economy and telecommunications are of vital significance. In case of any attack or the collapse of these systems entire regions can be cut out from the 21th century, minimizing their chances to defense or survive in a war conflict.[3]

The modern tactics, the mainstream of military research and development strives for making the most of the possibilities given by information technology and telecommunications. Artificer officers of our age do not concentrate on the mere physical devastating power of hard kill weapons; they are getting focused on the chances of electronic warfare. Blocking the information systems of the enemy and ensuring the effectiveness of our similar systems creates an advantageous position. In addition, the aim is to deploy complex military communications and decision-making systems that combine high-tech solutions with modern methods of management science in the sake of obtaining both information and leading vantage.[4]

C4I Systems handle the aspects of Command, Control, Communication, Computer and Intelligence within an integrated framework. The first lines of All-Source Analysis Systems (ASAS) are human secret agents and technical sensors that provide real-time information about the measure, localization, movement of the opponent forces through protected communications systems. The various kinds and forms of data are selected, analyzed and evaluated by a processing subsystem which finally organizes them into a database where uniform interpretation of data becomes possible; they become accessible, tangible, and can be versatilely browsed and filtered.[5] All of this makes sense only if appropriate decisions are made, applicable and effective commands, actions and provisions are passed to the executive troops based on them. Although these systems are fully programmable and can be optimized along specific preferred parameters to produce possible alternatives of decisions adjusted to the characteristics of the certain situations, they can provide only a preparation of the decision. Final decisions are always made and responsibility is always taken by commanders on the top of the 'cognitive hierarchy'. That is why human factor could not have been substituted or excluded from the entire process so far.

[3] Haig, Zs., Várhegyi, I.: *Információs műveletek.* Vol. 1. Egyetemi jegyzet. Budapest. 2004. p 125-126.
[4] Haig, Zs., Várhegyi, I.: *Információs műveletek.* Vol. 2.. Egyetemi jegyzet. Budapest. 2004. p 7-52.
[5] Haig, Zs., Várhegyi, I.: *Információs műveletek.* Vol. 2.. Egyetemi jegyzet. Budapest. 2004. p 144-155.

HADTUDOMÁNYI SZEMLE

2016. IX. évfolyam 1. szám

THE APPEARANCE OF GENERAL ATTRIBUTES OF HUMAN INFORMATION PROCESSING WITHIN HIGHER COMMAND

According to the point of view of cognitive psychology human intellect is based on a series of information processing steps, during which input information from the environment becomes the object of internal mental operations that finally results in a reaction, a behavioral output.[6] In pursuance of the generally appreciated works of the Swiss psychologist, Jean Piaget cognitive development of the individual is basically determined by sensomotoric experiences. During their interactions with the world children begin to map the consequences and experiences of their own actions in the forms of cognitive schemes. This procedure is called interiorization. These schemes are dynamically changing elements of cognition. If it is possible we match the new experience to our existing schemes (assimilation), if not we have to alter our existing knowledge to reality and change our schemes (accommodation). Cognitive achievements of children start to grow spectacularly when they become able to execute mental operations based on their existing schemes. During our cognitive development mental processes are getting more and more independent from any physical simulation and by the age of 12, in the stage of 'formal mental operations' an abstract, systematic-logical way of thinking becomes possible.[7]

The success of our accommodation to the world is determined by the appropriateness of our mental schemes, cognitive maps, internal models and representations of reality that – through correct information processing – finally leads to adaptive behavioral output. These elementary parts of our knowledge in common parlance can be an expression, an experience, a practical method, a technicality, a theory but always some kind of an internal representation of a part of reality. How can a military experts represent the relevant factors of a martial situation within their minds, how can they execute mental operations on these internal schemes, how can they plan adequate steps based on them? Is this a clearly rational process, mere data storing and computation?

According to the current theories this mental representation involves not only the most developed, human specific regions of our brains such as the pre-frontal region and the neocortex but the whole nervous system including more ancient, subcortical regions and the brain-stem itself. In his work titled 'Descartes' Error' Antonio R. Damasio[8] – based on his career as a clinical researcher – argues that rationality paradoxically could not be imagined without the integration of emotional components transmitted continuously by the whole nervous system. In his concept the function of emotions is to inform the regions of the brain that are responsible for rational decisions about visceral feelings in connection with the situations one has to cope with through the signals of peripheral nervous system, so they actually contribute to the final reaction with a preliminary classification.

[6] Bower, G. H., Hilgard E. R.: *Theories of Learning,* 5th ed, Englewood Cliffs, NJ: Prentice Hall, 1981
[7] Piaget, J.: *The Origins of Intelligence in Children.* New York: International University Press, 1952
[8] Damasio, A. R... *Descartes' Error – Emotion, Reason and the Human Brain.* Avon Books. New York, 1994, p 11-19

HADTUDOMÁNYI SZEMLE

2016. IX. évfolyam 1. szám

This 'visceral reaction' can contain either inherent components or can be an imprint of previous experiences; leastwise it is an important part of the internal representations of situations, since it has a fundamental orientating role. The fastest judgement about a particular situation is determined by our so called 'primary emotions' that help us to decide whether we should approach or leave, whether the situation will be useful or harmful for us. This fast, automatized orientation serves our survival. 'Secondary emotional reactions' in which rational analysis of the situation already takes part are based on them, but these would not be launched without the primary process.[9]

According to it the entire body is involved in forming internal representations of situations: „…the body, as represented in the brain, may constitute the indispensable frame of reference for the neural processes that we experience as the mind…" [10] As we can see not only the incredibly complex human brain, which involves every phylogenetic and ontogenetic grades of its development, but eventually the entire body takes part in the information processing. So we know not only with our brains, but – in accordance with Jean Piaget's theory – our entire being has been taking part in cognition through practical, sensomotoric experiences.

Some of the internal representations in our nervous system are originated from personal experiences but a plenty of them stem from our social environment and we adopt them without real personal involvement. We form mental representations about these indirect experiences during a process in which we connect these elements of knowledge that we obtain in the forms of verbal codes and symbols via either a verbal or a written communication channel with our own personal experiences that are associated to these words. The disadvantage of these indirect impressions is that they are not connected with either visceral or sensational experiences so the final map of reality within our minds reflects only personal connotations conditioned to these specific words not direct impressions about the object itself. According to the researches of Osgood on semantic differential scales personal shades of meaning of each expression can be surprisingly heterogeneous. For example the word 'dog' can mobilize different elements of knowledge, might induce various feelings, emotions, motivations, reactions in every individual since our personal experiences conditioned to this series of letters are obviously different.[11] The knowledge transmitted via symbols that we get from our social environment can be a well based and useful pack of information or a biased belief, stereotype, prejudice as well. In these cases we accept the representations of the communicator believing that they are exact and right so this process is based on a kind of faith or trust. Acquiring knowledge at a theoretical course therefore cannot entirely substitute practical, experience-based learning, direct forms of

[9] Damasio, A. R... *Descartes' Error – Emotion, Reason and the Human Brain.* Avon Books. New York, 1994, p 131-139

[10] Damasio, A. R... Descartes' Error – Emotion, Reason and the Human Brain. Avon Books. New York, 1994, p 16

[11] Snider, J. G., Osgood, C. E.: *Semantic Differential Technique: A Sourcebook.* Chichago: Aldine. 1969

internal representation making. Accordingly it is important to provide as much personal, practical experience as possible during the education of military leaders in forms of foreign missions, professional simulators and mimic warfare.

Generally speaking we can state that the more numerous and complex schemes an individual has in connection with a given topic (for example a science or profession), the more successful they can be in it. [12] It is true for those who are occupied with military sciences, too.

As mentioned earlier, schemes are dynamic elements; they can be changed and also can affect each other. We try to organize our internal map of the world to a coherent whole. If we succeed, it might give us the convenient feeling of security, but on the other hand sometimes we have to sacrifice reality on the altar of the sense of this coherence. As a series of scientific experiments prove, our schemes determine the entire information processing procedure. At the very beginning of this process our attention is strongly affected by our schemes. They determine which part of the whirl of information is filtered out or selected for further processing. We perceive information that is in concordance with our knowledge rather than those that are in contradiction with our internal representations, so our attention is selective; we try to maintain the coherence of our schemes.

Our existing schemes organize and sometimes distort our memory functions, too. If we cannot recall the details of an event that happened earlier we build up our afterimage using associating mental models that had been formed in connection with similar situations in the past. This psychological phenomenon is called the 'constructive memory'.[13] That is why a false or outworn cognitive scheme can restrict or even distort our thinking for a long time, and clogs adequate handling of reality. It is especially true nowadays, in our extraordinarily fast-changing environment.

During our primary socialization we adopt several basic pre-made schemes such as the general view of life, stereotypes, concepts of human being, common believes, customs, rites, etc. According to Benjamin Whorf's linguistic relativity concept the language itself basically determines how we process information, in what dimensions we perceive reality, what categories we use while thinking. Since our left hemisphere that mainly underlies our conscious operations uses a verbal code system, the structure and elaboration of the language we use (for example the differentiation of possible tenses) during our socialization confines the possibilities of mapping reality. Learning the jargon of a job, the differentiation of linguistic codes within a profession is an important aspect of occupational development.[14] Via acquiring the official terminology of military sciences communication based on the mutual knowledge of the parties becomes economic, concise and strict. Through the

[12] Mérő, L.:*Észjárások – Remix.* Budapest. Tercium Kiadó. 2008. p 151-166.
[13] Loftus, G. R., Loftus, E. F.: *Human Memos: The processing of Information.* New York: Hallstead Press. 1975
[14] Whorf, B. L.: Science and Linguistics. In. J.B Carroll (Ed.): Language, Thought and Reality: Selected Writings of Benjemin Lee Whorf. Cambridge, MA: MIT Press

function of internal speech learning of jargon makes differentiated thinking, learning, recalling and problem solving possible.

Next, based on Peter Scharle's study, we apply the connections of the number of cognitive schemes one possesses and the level of education to a military career.[15] At the 'beginner level', when we start to learn military sciences, technicalities, strategy and tactics, we know only a few dozens of simple professional schemes. We try to handle problems based on our habitual civil solutions, but most of the problems remain unperceived due to the lack of adequate knowledge. At the 'advanced level' possessing a few hundreds of professional schemes with conscious concentration we can apply methods developed by others to specific problems, but sometimes they interfere with our amateur schemes therefore the result can be an incoherent or illogical solution. Further years of diligent study can lead to the 'candidate level' of military sciences. This level is approximately equivalent to MSc level of higher education that means a few thousands of partly compound professional schemes. At this level following the logics of the profession, using professional jargon adequately autonomous problem solving becomes possible, we own a conscious knowledge; we can explain our decisions step by step and give countenance to them.

To the next grade, the 'master level' the way is not that straight. To reach this level talent, devotion and at least ten years of practice is required. A 'Master' has ten thousands of complex professional schemes. A military leader educated on this high level (minimum Ph.D. degree) approaches to professional problems in a different manner than those on minor levels of knowledge. Knowing the internal nature and logics, the underlying principles of military strategy and tactics a kind of a synthesis and specialization of this knowledge appears, professional thinking is based on analogues, and intuitive forms of decision-making start to dominate. The Master is able to anticipate possible steps, outcomes and consequences several moves earlier, recognizes the possibilities of errors or corrections. Conscious deduce or explanation appears only after the solution; during work time-saving, heuristic decision-making strategies prevail. Conscious processes of information collecting and mental testing of the possible methods in the preparation stage are followed by an incubation period and finally in the so called illumination stage suddenly unique, creative solutions would appear as a result of the combination of possessed professional schemes. At this point 'military science' turns into an 'art of military'. Unexpected, new combinations of that kind can surprise and confuse enemy and create a new paradigm where the leading party obtains the point of vantage. This is what artificial intelligence will not be able to achieve within reasonable time: to create new algorithms based on intuition.

[15] Scharle, P: A kognitív pszichológia sémafogalma és a többciklusú felsőoktatási képzés szintjei. Magyar Tudomány. 2004/67. p 743.

HADTUDOMÁNYI SZEMLE

2016. IX. évfolyam 1. szám

Having not discussed artificial intelligence systems yet, the arguments of this study seem to lead to a conclusion that human factor can add something irreplaceable quality to military decisions what ensures its place within the Information Operations. At this point we have to take into consideration that psychological researchers have found several examples to the vulnerability and fallibility of these human information processing procedures. Several psychological effects can spoil the quality of military decisions.

As seen before All-Source Analysis Systems (ASAS) provide headquarters with converted and pre-selected information. It is important to ensure the professionalism of the pre-selection since the less qualified subordinates might neglect some important details that seem to be irrelevant if one lacks an appropriate set of professional schemes and does not know the context of the conception. These help to understand the significance and foresee the possible interferences of the specific data obtained from different sources. The chance of any errors or mistakes is especially high in a war situation, in the press of time, at a high level of responsibility when the level of stress becomes extremely high and has an unfavorable effect on achievement. In case of a complex task even a relatively small amount of stress can spoil cognitive performance of human especially at under-structured situations where well-drilled solutions are inefficient.[16] According to the model of Fiedler and Garcia at a high level of stress it is not the intelligence but the routine of the leader what is the main determinant of the final performance.[17]

Another important factor is fatigue. If a top commander is to make decisions for a long period of time, overload will inevitably result in being worn out; the nervous system itself will lose its effectiveness in a cellular level. Imbalance of homeostatic processes (for example hunger, thirst, lack of sleep, etc.) insensibly draws our attention from the subject, recalibrates its direction. All things considered how long is a top commander able to lead the troops at a stretch in a harsh situation? According to the study of the Hungarian work psychologist, Tibor Hódos, if the shift starts after a satisfying rest, the most optimal period of time for cognitive achievements takes about only 1,5-2 hours after a half an hour long warming up. With concentration the decrease of the quality of attention can be fully compensated for further 1-1,5 hours. Despite one's effort after 3-4 hours of work personal performance becomes unstable, mistakes and omissions appear. From the fifth-sixth hours gradually decreasing but with serious effort temporarily entirely compensable achievement can be measured. After 7-8 hours of hard, concentrated work the decline of attention and mental performance becomes less and less controllable. There are personal differences in the development of this fatigue process, as it depends on age, gender, practice, motiva-

[16] Hebb, D. O.: *Textbook of Psychology.* 3rd ed. Rhiladelphia: Saunders. 1972. Ch 11.
[17] Peter Warr (ed.). *Psychology at Work.* 4th ed. Ch. 9. Leadership and Management. Penguin Books. 1996. p 254-279.

HADTUDOMÁNYI SZEMLE

2016. IX. évfolyam 1. szám

tions, personal physical conditions, dispositions, personality traits, etc.[18] Decisions of artificial systems are unaffected by these factors.

It seems to be logical to ensure the presence of more top commanders in the headquarters at the same time so as to reduce personal responsibility and the effects of fatigue and stress. Researches of social psychology warn that group decisions are almost necessarily become polarized, move to the direction of extreme risk taking. This effect is amplified if the group is isolated, works under pressure and is hierarchical therefore leading teams of headquarters are definitely endangered. These groups often share the faith and illusion of infallibility, unquestionable higher morality, they evaluate any outgroup in a stereotype way. The members follow group norms without doubt; they do not bring up their contrary opinions especially when it is in contradiction with the leader's declarations. This 'group thinking' often leads to decisions that do not stand the test of reality and results in a failure.[19]

ARTIFICIAL INTELLIGENCE: THE IMPERFECTION OF PERFECTION

We analyze the principals of the research of artificial intelligence based on the study of the Hungarian mathematician and psychologist, László Mérő through the development of chess programs. This analogy to military sciences seems to be absolutely adequate since chess is basically a strategy game. In advance we have to mention that a chess program called 'Deep Blue' defeated Garry Kasparov, the contemporary world champion of human chess in a pair of six-game chess matches under tournament regulations in 1997. How could this 3½–2½ final result happen?

The number of chess related cognitive schemes can probably be measured in ten thousands in the case of Garry Kasparov; this number seems to be a general limit of complexity that human nervous system can approach. The chess 'Master' can rely on the combinations of these schemes that practically means that they have an almost endless set of possibilities to choose appropriate solutions from. Based on this huge set of schemes a human chess player can plan possible combinations and their probable outcomes of several different scenarios and evaluate their propitiousness. The problem is that human short term memory has a limit of 7±2 chunks.[20] These limitations restrain 'Masters', too, so they simply cannot take more schemes into account at one time. Their only advantage compared to 'Beginners' is that their schemes are more complex and deep, so they can take solutions out of a much wider pool of schemes. In contrast 'Deep Blue' works in a completely opposite manner. It calculates using only a few dozens of basic chess schemes but its algorithm of utility can compute a huge number of possible combinations at every step (up to 200 million per second). So artificial intelligence could defeat the human chess master using a

[18] Hódos, T..: *Munka és pszichés állapot*. Budapest. Universitas Kiadó. 1994. p 11-70.
[19] Janis, I. L.: Groupthink: Psychological Studies of Policy Decisions and Fiascoes. 2nd ed. Boston: Houghton Mifflin, 1982.
[20] Ericsson, K. A., Chase, W. G., Faloon, S.: *Acquisition of a Memory Skill. Science*, 208. p 1181-82.

HADTUDOMÁNYI SZEMLE

2016. IX. évfolyam 1. szám

modest knowledge of chess that was compensated by a tremendous amount of brut counting force.

Could it also happen in the practice of military sciences? In the ancient Chinese game named 'Go', artificial intelligence could not be as successful as in chess. This game is deeper, more complex, from 'Beginner' to 'Master' level it covers more classes than chess.[21] What about military sciences? To what extent is it complex, how many classes does it cover from Robin Hood to Clausewitz? Can artificial intelligence ever replace the 'Masters' of military sciences?

As mentioned before Antonio R. Damasio believes that human information processing procedures involve not only rational and logical neocortex with somatosensory and association areas but the whole process is infiltrated with emotional-motivational affects from subcortical areas and eventually the visceral experiences of the entire body. Artificial intelligence systems probably will not be able to exhibit this complex, shaded process within a reasonable time. Daniel Goleman improved the concept of Damasio and states that practically accomplishable, realistic, good decisions simply cannot be made without emotional intelligence (EQ).[22] In a war situation a mechanized command from the headquarters made by artificial intelligence can be perfect from a rational point of view; practical effectuation can yet be insufficient, since executive subordinates have to realize them in a martial context that is emotionally strongly saturated. According to a generally accepted computation in work and organization psychology the effectiveness of a decision equals its quality multiplied by the measure it is accepted by the people involved (De = Dq X Da).[23] Since in the case of a multiplication a zero generates a final result that is zero, this formula suggests that even a decision that is hundred percent perfect can be totally ineffective if the regular troops cannot accept it, if people cannot identify with it.

CONCLUSION

The processing of the huge amount of information carried by the complex technical apparatus of All-Source Analysis Systems (ASAS) and decision making about the way of application of military force is incumbent on supreme commanders. Human factor obviously have some attributes that make this process fallible but the unique action of human mind that integrates emotional, motivational and cognitive aspects – based on ten thousands of cognitive schemes – is still able to produce such unexpected combinations, creative solutions that dynamically developing artificial intelligence systems probably will never be able to. In virtue of this the expression 'art of military' seems to be more supportable than 'science of military'. Difficult military ethical problems would arise if artificial intelligence systems substituted human decision making in war because in this case the assertion of inter-

[21] Mérő L.: *Új észjárások*. Budapest. Terricum Kiadó. 2001.
[22] Goleman, D.: Emotional Intelligence: Why It Can Matter Nore Than IQ, Bantham Books. 1995.
[23] Zettisch N..: *Enterprise and Management*. University Course. 3rd lecture. Eötvös Loránd University, Faculty of Humanities, Psychology major. 1998.

ests would be degraded to a mere contest of the algorithms used and the capacities of computation. Identification with the aims and the values of the highly respected commanders is an important factor that increases the devotion of executive subordinates. Decisions of commanders can evoke this identification, while commands based on artificial algorithms will never be able to build up motivation in soldiers.

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16. Warr, P. (ed.). *Psychology at Work.* 4th ed. Ch. 9. Leadership and Management. Penguin Books. 1996. p 254-279.
17. Whorf, B. L.: *Science and Linguistics.* In. J.B Carroll (Ed.): *Language, Thought and Reality: Selected Writings of Benjemin Lee Whorf.* Cambridge, MA: MIT Press
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