DECISION MAKING: BETWEEN RATIONALITY AND REALITY

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ABSTRACT

Almost by definition decision-making is typical human activity, and therefore important psychological subject. The starting point of its classical conception within psychology could be traced back to economy and mathematic, with ideas of human as rational economic being, and conceptualising decision making as choice between two or more alternatives, and as such being a separate event in space and time. Already in fifties Herbert Simon challenged such a view with his concept of bounded rationality, emerging from the joint effect of internal limitations of the human mind, and the structure of external environments in which the mind operates. During the last decades with the shift to the real word situations where decisions are embedded in larger tasks, becoming so part of the study of action, the lost rational human appeared again as efficient creature in the complex environment. Gigerenzer showed how heuristics help in this process.

KEY WORDS

CLASSIFICATION

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INTRODUCTORY OVERVIEW

Decisions are regular part of human everyday life and they strongly influence either life of individuals, or even the lives of many others, depending on the position of decision maker. Understanding of the decision-making processes could help us in preventing bad decisions and in stimulating the good ones. Nevertheless there are many factors that influence decisions and we do not know each one or the totality of their relationships. At the same time decision-making processes are – due to their complexity – approached from different points of view, even inside particular science. Therefore this presentation will be incomplete. It will be focused mainly on the contemporary decision making theories appearing inside psychology, as they are offering quite different view of the matter in comparison with the classical ones. Their understanding of decision-making is more realistic, they are not demanding humans to be either a computer or incompetent irrational creature. Yet development is traceable, from concept of economic rational being, through bounded rationality to the theories of naturalistic decision making.

Montague (after [6; p.72]) believe that moving organisms need inner model of the world regarding value attribution, to be able to choose and classify the goals. To decide about relevant behaviour nervous system must assess value of every possible action, transform them into joint scale and based on it decide about activity. The question is only if assessment of *every* action is really necessary, what argues classical approaches but reject some of the naturalistic approaches, following that joint scale is also disputable. Is therefore only one mechanism for the assessment of different kinds of stimuli necessary, and if it is, how it is working?

Although research work on decision-making has long history in economy and philosophy, thorough research work is connected to the end of the Second World War, when in statistics and economy influential theories about rational decision-making appeared. Classical decision theories were based on the principle of *optimization* developed by well known mathematician and pioneer of modern computer science John von Neumann and economist Oskar Morgenstern in the book *Game theory and economic behaviour*. Psychology took over these economic and mathematical theories of decision making and based on them formed its decision-making models, and tested them experimentally. As an empirical science, it could not take them for granted. Very soon it appeared that regarding the criteria of these models humans are very bad decision makers. But let us overview the main phases in the development of psychological views on decision-making. After Collyer and Malecki [7; p.6] in the development of decision-making theories we could distinguish three periods:

- *rational decision making models.* Models based on rational choice and behaviour, (e.g. SEU, multiattribute utility theory, Bayesian inference models) prevailed during the period between 1955 and 1975. Within these approaches decision problems were decomposed into their elements so that the choices, the uncertainties and the outcomes were explicitly given,

- *descriptive models.* Stemming from the rational models descriptive ones argue that humans usually do not make decisions in this way and regarded deviations from the prescribed procedures as *heuristics* and deviations from the correct responses as *biases*. This approach was compelling during the period between 1965 and 1985. Herbert Simon [1] with his influential concept of *bounded rationality* was pioneer of this way of thinking,

- *decision models in natural settings.* This approach starting in 1980s is offering quite different emphasizes, and moved research from laboratory into dynamic natural settings, from naive to the expert decision makers and from the decision events to the real processes, to the greater tasks of which decisions are part. Decision-making is not devoted

to itself but is serving achievement of a wider goal. Therefore studying decision-making means studying the activity and not studying the choice.

Also the contemporary findings about *situation awareness* (SA) as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" [8; p.5] should be taken into account. All these approaches by their very nature emphasize the meaning of expertise. During the last years the field of naturalistic decision making and related concepts were classified under the concept of macro *cognition* [9], presenting a broader frame for macro operational situations characterised by the need for decision making during the tasks, like setting the goals, fault management, and planning, i.e. the role of cognition in real tasks, in interaction with the environment. As Schraagen et al. [9; p.9] believe, it is about 'the study of cognitive adaptations to complexity'. And really, the failure of classical decision making models stem from their neglect of complexity on one side, and emphasize of abstract rationality on the other.

SOME HISTORICAL REMARKS

The majority of the classical decision making theories stemmed from economy, statistics and philosophy. Psychologists only adopted them as long as they did not make theories of their own. Therefore these first theories reflected the economic perspective. Between early decision making models prevailed model of economic human, assuming that decision makers are (after [10; p.481]) (1) fully informed regarding all possible options for their decisions and of all possible outcomes of their decision options, (2) infinitely sensitive to the subtle distinctions among decision options, and (3) fully rational in regard to their choice of options. Very soon deficiencies of this approach became evident and correction in the form of Subjective *Expected Utility* (SEU) appeared, taking into account psychological aspects too. The goal of human activity is the search for pleasure and avoidance of pain. During decision-making people try to maximize satisfaction (positive utility) and minimize dissatisfaction (negative utility). In this process they apply *subjective utility* (based on individual judgment of utility and not on objective criteria) and *subjective probability* (based on individual judgment of probability and not on objective calculations). People then calculate subjective probability of each subjective positive utility for each option and subtract subjective probability of each subjective negative utility and make decision on this base. The prediction of the optimal decision for the given individual is based on the belief that people want to make rational decision taking into account all known options, using maximal quantity of available information, careful, although subjective, weighting of the potential costs and benefits, careful, although subjective, calculation of the probability of different outcomes, and the maximum degree of sound reasoning. Although SEU is taking into account subjective variables as well, human decision making is much more complex, and people are not deciding like computers, measuring and weighting different utilities and probabilities either objectively or subjectively.

Nevertheless already in 1950s some psychologists challenge the concept of unbounded rationality. American psychologist and economist Herbert Simon in his papers published in 1955 and 1956 introduced the concept of bounded *rationality* [6, 10]. He believed that people are not necessary irrational, but they show bounded rationality. Namely our world is too complex to be understood in its totality, and therefore people form its simplified model, and behave according to it, using heuristics as a kind of mental shortcuts. According to Simon people use strategy of *satisficing*. They do not take into account all options and do not calculate which ones will give the greatest benefit and the smallest loss. They consider options one after the other and choose the first one that satisfies, i.e. meets the lowest level of acceptability. They consider the smaller number of options in forming the decision.

Simon (after [11; p.4]) uses the metaphor of a pair of scissors, where one blade represents cognitive limitations of actual humans and the other the structure of the environment. Bounded minds can nevertheless be successful using structures in the environment, or in Simon's words (after [11; p.4]) "a great deal can be learned about rational decision making... by taking account of the fact that the environments to which it must adapt possess properties that permit further simplification of its choice mechanisms". The model, believe Gigerenzer, describes how the decision is reached (heuristic processes) and not only its outcomes and the class of environments in which these heuristics will be un/successful. Bounded rationality is neither optimization, neither optimization under constraints or irrationality. As Gigerenzer and Selten [11; p.8] believe, the bounded rationality is about 'step-by-step rules that function well under the constraints of limited search, knowledge, and time, whether or not an optimal procedure is available'. The repertoire of these rules or heuristics they called 'adaptive toolbox', which is (1) collection of rules (heuristics) and not general-purpose decision-making algorithm, (2) heuristics are fast, frugal, and computationally cheap, rather than consistent, coherent, and general, (3) heuristics are adapted to particular environments, where this *ecological rationality*, i.e. match between the structure of a heuristic and the structure of an environment allows just mentioned characteristics of heuristics, and (4) the bundle of heuristics in the adaptive toolbox is coordinated by some not well understood mechanism reflecting the importance of conflicting motivations and goals.

Kahneman and Tversky [12] – following Herbert Simon – link attitudes toward risk with the nature of outcomes (gain or loss) and the size of probability. Their *prospect theory* represent psychological variant of the SEU theory [6]. Decision-making begins with structuring of the decision problem, which simplifies subsequent evaluation and choice. Coding of possible outcomes as gains or losses relative to some reference point (usually status quo, but also an expectation or an aspiration) is important. The nature of the reference point, i.e. evaluation of the outcome, is affected also by the description of the problem, subsumed under the concept of *framing*. Value function is different for gains and for losses (Figure 1).
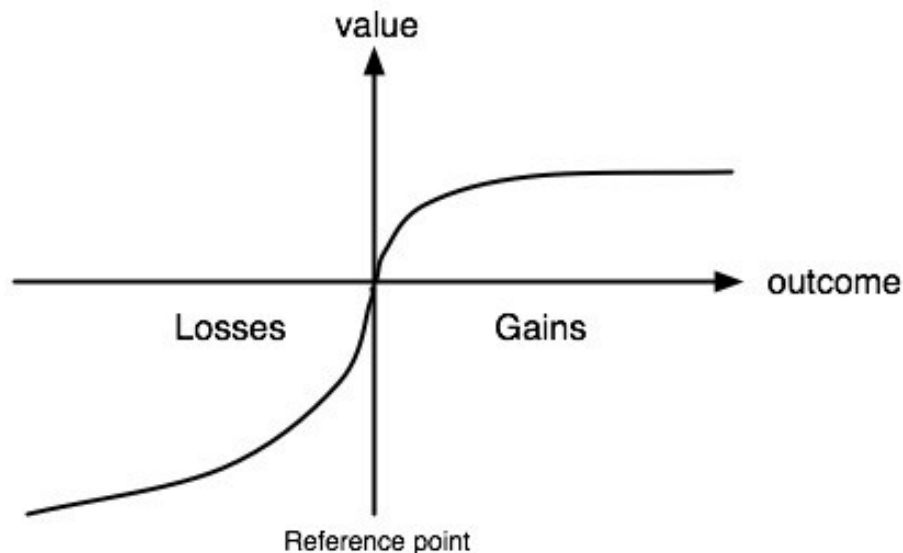
Figure 1. Hypothetical value function as proposed by Kahneman and Tversky prospect theory. Function is convex and relatively steep for losses and concave and gradual for gains (taken from http://en.wikipedia.org/wiki/File:Valuefun.jpg, after [13]). Value is similar to utility, only it is evaluated regarding the reference point.

Decision problem is determined with acts or choices, their possible outcomes or consequences and links or conditional probabilities that connect outcomes with acts. *Decision frame* is about decision-makers conceptualization of the acts, outcomes, and dependencies connected with particular choice [13]. This is the context of choice or different possible models of the world in the Simon's sense. The frame is determined on one side with the formulation of the problem, and on the other with norms, habits, and personal characteristics of the decision maker. This means that particular decision problem could be framed in different ways. Different frames reminds on different views of the scene. Reliable perception demands that relative heights of two neighbouring trees would not change depending on direction of viewing. Similar demand holds also for the rational choice: choice preference should not change with the frame change. But with people – because of the imperfection of the senses and decision processes – both is occurring. With the change of the acts, links or outcome frames, we could systematically change their preferences.

Decision context does not influence only the values of choices, but also the values of outcomes, e.g. the amounts expressed as gains or losses. If choices are framed in such a way that reference point is low on the scale of values, the gain will be greater in comparison with high positioned reference point. Fifty Euros is a lot for poor and a little for rich.

Framing effect contradict the invariance axiom of the utility theory, which demands that wording should not influence deciding, because preferences should be defined only with outcomes and connected probabilities, while because of framing effect different coding of outcomes (as gains or losses) change the outcomes assessment. This is evident in the famous Kahneman and Tversky task regarding efficacy of the health programmes expressed either as a number of survivors or as a number of victims. It seems that negative frames demand greater degree of cognitive processing and have longer response times [6].

NATURALISTIC DECISION MAKING

Main research work in the field of the so called *naturalistic decision making* was going on mainly in the frame of the crisis events and radically change the view of the nature of crisis decision making. It is not by chance, that US Army devoted a lot of resources and time to the study of these questions, e.g. in the project TADMUS (*Tactical Decision Making Under Stress*). Many bad decisions whose outcomes count in human lives demand this. Up to then decision-making researches study only one segment of the decision-making, the decision event. Main part of the decision making should be going on when decision maker (usually one person) overview known and defined set of choices, weight probable consequences of particular choice and then select one, depending on his goals and values, which should be stable and known. Researchers focused on the selection process of the best alternative. Involved participants were usually inexperienced, e.g. students. But then psychology went out of the laboratory in the real life, joined firemen, police officers, medical staff, etc. that is experienced participants. Quite different image of the decision making appeared. Classical decision-making models were not adequately describing the situation. Decision makers focused on the definition of the situation, and on the base of their experience in similar previous events, while taking into account constraints of the given situation, choose the most adequate response. Possible responses were assessed on the base of the projection of their possible consequences into the future and search for the possible unwanted effects. If unwanted effects were not predicted, the response was selected. This new approach differs at least in three ways from the classical one, which emphasizes simultaneous assessment of a number of alternatives, being based on analytical methods of values and probabilities connection, and was searching for the optimal solution [3]:

- decision maker pays his attention mostly to *situation assessment* or to the discovering of the nature of the problem,

- particular alternatives are judged successively with the help of *mental simulation* of outcomes, and

- alternative is accepted if it is satisfying (not necessary optimal).

Fundamental difference lie in the fact that in everyday situations *decisions are the part of the larger tasks*, which decision maker try to accomplish. In the laboratories decision-making was going on outside the meaningful connections, while in reality it is the mean of achieving the wider goals. Decisions are the part of the broader tasks consisting of the problem definition, understanding of meaningful solutions, acting for goals achievement, and effects assessments. As one of the researchers said [2], studying decision-making in dynamic, real time context changes it into the part *of the study of action,* and not study of choice. Decision making is the matter of guiding and maintaining the continuous flow of behaviour directed toward the set of goals and not the set of separated events of choice dilemmas. Decision-making in reality is a joint function of two factors [3]:

- task characteristics, and

- individual's knowledge and experience relevant for the task.

Decision-making is often going on in stressful conditions. Stress is caused mainly by the following characteristics of the situations, called stressors [14]:

- multiple information sources,

- incomplete, conflicting information,

- rapidly changing, evolving scenarios,

- requirements for team coordination,

- adverse physical conditions,

- performance pressure,

- time pressure,

- high work/information load,

- auditory overload/interference,

- threat.

They represent important factors and conditions in decision-making, which often determine the nature of decision, consequent behaviours and their outcomes.

SITUATION AWARENESS (SA)

Mica Endsley [15], leading expert in planning, developing and assessing systems in support of SA and decision-making, is discovering new ways and understanding of human decision-making and action. Evidently field has SA and decision-making in natural environments complement and stimulate each other. Behind their development stand also Herbert Simon's conceptions of bounded rationality, heuristics, etc. This is evident from the starting idea that contemporary technical systems offer more information than is needed and that the needed one is hard to discover (Figure 2). Therefore, the system is too complex and should be simplified to be able to master it.

Data Produced

Information Needed

Find   Sort

Integrate   Process
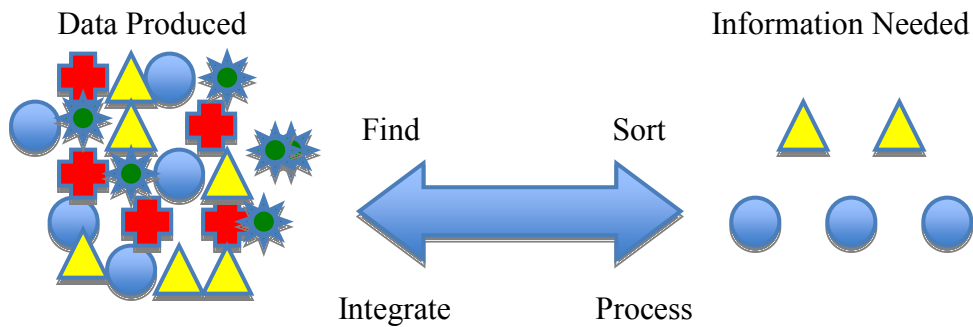
More Data ≠ More Information

Figure 2. The Information Gap [8].

Need for the solution of practical decision problems leads to this development. Contemporary systems should not only provide needed information but it must be cognitively and physically usable. SA simply means that we know what is going on around us, and are able to select important information from the surrounding, what enable somebody to make decisions. SA depends on tasks and goals demanded by certain work or activity.

Mica Endsley [8] believe that elements of SA differ depending on the field, but its nature and mechanisms could be described generically. Three levels of SA could be distinguished (Figure 3), the first one referring to the cues perception. Without perception of the important information our image of the situation would be incomplete or false. Endsley [8] indicate that 76 % of the pilot errors appeared because of the problems with perception of the important
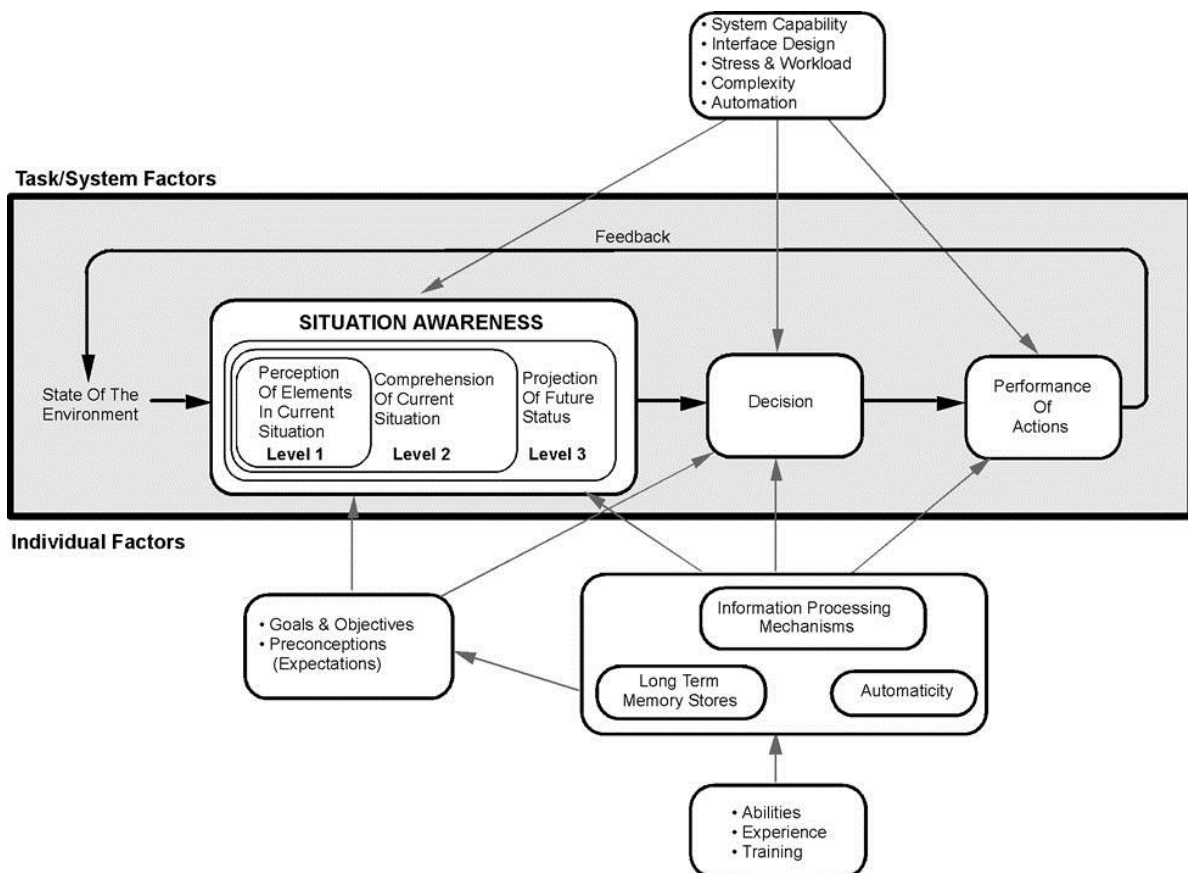
Figure 3. Model of Situation Awareness (SA) in Dynamic Decision Making [8].

information. Yet SA construct exceeds mere perception and take into account how human combine, interpret, store and retain information. It is necessary to integrate multiple pieces of information and determine their relevance for the person's goals. But this is not the end of the story. On the highest level of SA, the ability to forecast future events and dynamics is taking place. Only this enables relevant decision-making. SA is certain internal model of the state of the environment and based on it humans decide what to do about the situation. SA depends on the limitations of the working memory and attention. Use of the attention in the complex environment offering multitude of competing cues is critical for determination of those aspects of the situation that will become the content of SA.
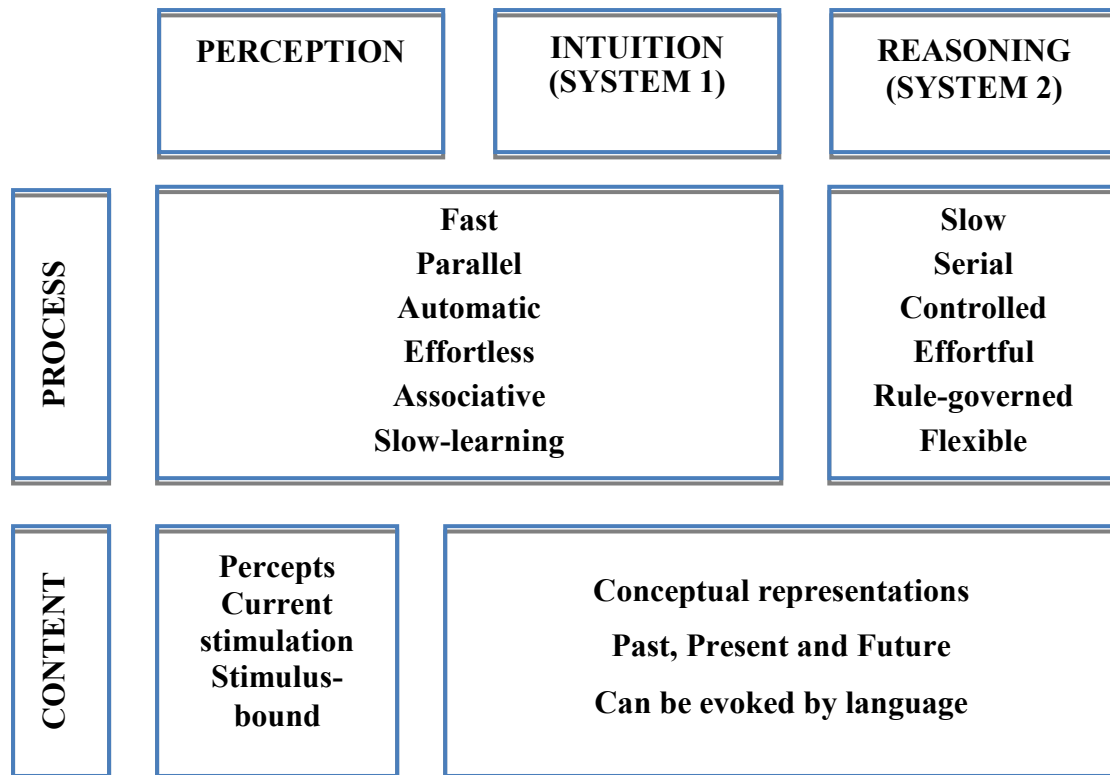
INTUITION: MIRACLE OR EXPERTISE

The term *intuition* (from lat. *intueri*, meaning *to look inside* or *to contemplate*) is quite often used in everyday life, but the majority of people would hardly define it precisely. We know something and believe that it is correct, that the consequential decision will be the right one, but we do not know neither why nor how. Corsini's [16] psychological dictionary define intuition as 'Immediate insight or perception as contrasted with reasoning or reflection. Intuitions appear to be products of feeling, minimal sense impressions, or unconscious forces rather than deliberate judgment.' Herbert Simon [1] uses the term in the sense of a belief, judgment or decision arrived at by the process of recognizing cues in the surrounding situation, and using them to access information already stored in long-term memory. It permits problem solving without awareness or with incomplete awareness of the solution process. Also contemporary considerations go in this direction. Without doubt intuition is mental process. Input into this process is given by the knowledge stored in the long-term memory, acquired mainly with associative learning. Input is processed automatically and unconsciously. Output of the process is the *feeling*, that could serve as the basis for the judgment and decision making [17]. Klein [4] too, is linking intuition with experience that enables humans' recognition of situation (judgment) and necessary reactions (decision making). Therefore decisions are fast and without conscious effort.

Nobel prize winner for 2002 Daniel Kahneman in his prize lecture devoted a lot of attention just to intuition. In his paper, he said that he and his close co-worker Amos Tversky were guided by the idea, that intuitive judgments take place between the automatic operations of perception and deliberate operations of reasoning. Dual system approach distinguishes intuition from reasoning (Figure 4).

Working of the intuition is fast, automatic, effortless, associative and is hard to control or modificate. Reasoning is slow, serial, effortful and controlled, relatively flexible and rule-governed. Working characteristics of System 1 are very similar to perception. Working of both systems is not limited to stimuli processing. Intuitive judgments too are dealing with concepts as well as stimuli and could be evoked by language. Perception system and intuitive operations generate impressions of the objects of perception and thinking, which are not voluntary and explicitly verbal. Contrary to this, judgments are always explicit and deliberate, irrespective of explicitness of their expression. System 2 is included into all judgments irrespective of their source (from impressions or from deliberate reasoning). Intuition refers to judgments that directly express impressions, while System 2 is controlling the quality of both mental operations and behaviour. The control is not rigorous.

	PERCEPTION	INTUITION (SYSTEM 1)	REASONING (SYSTEM 2)
PROCESS		Fast Parallel Automatic Effortless Associative Slow-learning	Slow Serial Controlled Effortful Rule-governed Flexible
CONTENT	Percepts Current stimulation Stimulus-bound	Conceptual representations Past, Present and Future Can be evoked by language	

Figure 4. Kahneman and Tversky dual system view of cognition [18].

Therefore two kinds of cognition exist, intuitive and analytical, where the first is subconscious and the second conscious. Betch [17; p.4] believe that intuition is a process of thinking, the input to which is mostly knowledge stored in long-term memory and acquired mainly via associative learning. The input is processed automatically and subconsciously, thus differing from the deliberate processes of thinking. The output of the process is a feeling that can serve as a basis for judgments and decisions. Intuition is therefore based on previous knowledge and is not consequence of certain innate factors (is not instinct or reflex). Key difference between rehearsal and intuition is that the output of the former is a mental representation of an entity, whereas the latter is a feeling toward it, which serves as the basis for decision. While higher order processes of thinking determined with the limitations of attention and memory capacity and are focusing on information serially, the automatic processes are considering it simultaneously. Due to parallel processing intuition is capable of processing a great amount of data. Findings of the neuropsychological studies, especially of parallel distributed processing, support this possibility. Experience provides the organisms with a rich database on which intuition could reveal its power. Intuition could offer highly accurate judgments and decisions if the prior sample of experiences is representative for the current task [17]. It was already mentioned that Herbert Simon reveals the true nature of intuition, but close link between intuition and his concept of bounded rationality, otherwise related to conscious thinking, should be added. Within bounded rationality people help themselves with heuristics that simplify decision tasks. Betch [17] classify heuristics into the field of deliberate thinking that is into system 2 in Kahneman's [18] model, because they are mostly based on the reflection, and are therefore shortcuts to consideration and not intuitive strategies. Remember that Kahneman [18] linked availability heuristic with intuition. But both kinds of processes (automatic and deliberate) as a rule are acting simultaneously and jointly shape the thinking and acting. We could agree with Betch [17] that neither kind of thinking exists in pure form.

Deliberate, conscious processing does not enable fast and complete decisions, enabled by intuition. Epstein [19] goes even into more detailed picture of both ways of thinking, and connects them with his cognitive-experiential self-theory. People are using two cognitive systems, *experiential* system (nonverbal automatic learning system) and *rational* system (verbal system of reasoning), referring to intuition and conscious thinking.

Systems are equivalent and strengths of one are limitations of the other. Experiential system is directing everyday behaviour and can solve problems that are beyond the capacity of the rational system, because they required holistic and not analytic approach [19]. According to Epstein [19], people without experiential system would be like robots with computer in a head. Rational system understand experiential one, while the opposite does not hold. Because the experiential system is reacting faster, the starting response to the situation is experiential. If rational system recognize starting response tendency as inadequate it represses or adapts it.

Gary Klein's [4] understanding of intuition, relatively more concrete and connected to decision making in crisis will be presented too (Figure 5).
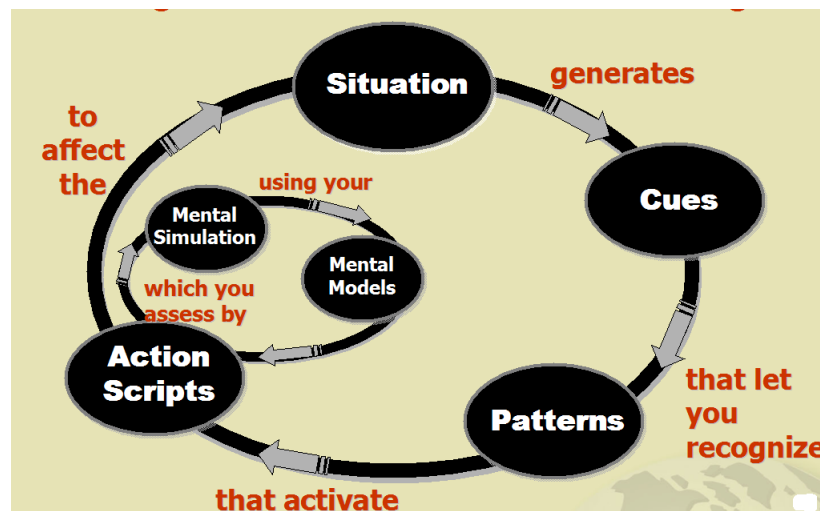

Figure 5. Klein's [4] model of recognition primed decision-making.

According to his theory expert decision makers judge the situation on the base of comparison with the similar, already experienced situations. In this way they choose relevant activity for the situation. Confronted with new situation, decision makers use memory of some previous situation and create trial representation of the new situation. The representations interpret perceived data, forms expectations about the future activities and define limitations of those situation characteristics that perhaps would not be perceived. Situation representation is constantly tested with the new data. Those in accordance with it are confirming it for the prediction of future events and for the reasoning about non-perceived event characteristics. Discordant data may either improve representation or show that it must be entirely changed. Klein [4] called this process *recognition primed decision-making*.

On the base of repeating experience intuition enable unconscious connection of the cues into pattern. Pattern is multitude of cues that usually appear together, so that if some are perceived, others could be expected. More patterns that we know, it is easier to connect the new situation with one of them. During the appearance, the new situation is recognized as known on the base of comparison with known patterns. Because pattern match is going on fast and without the conscious effort, people are not aware how they reach intuitive judgment.

CONCLUSION

Decision making as one of the most characteristic human mental activity is shown to us – or better studies and thinking about it are showing this – as a very complex phenomenon. The image of the human decision maker is circling between irrationality and bounded rationality. If classical models of rational (economic) human took him from time and space, and put him with his decision making, that should be rational, but was not, into certain abstract frozen space, with the development of knowledge he is gradually coming back, to find himself in the theories of naturalistic decision making. The image of the alive concrete human, adapted to his environment, is exchanging its artificial abstract image.

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ODLUČIVANJE: IZMEĐU RACIONALNOSTI I STVARNOSTI

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SAŽETAK

Gotovo prema definiciji, odlučivanje je tipična ljudska aktivnost, a time i značajna za psihologiju. Polazište njene klasične koncepcije u okviru psihologije može se pratiti do izvorišta u ekonomiji i matematici te pripadnim idejama o ljudima kao racionalnim ekonomskim bićima. Pritom, odlučivanje je konceptualizirano kao izbor između dvije ili više mogućnosti te je kao takvo izdvojeni događaj u prostoru i vremenu. Još u pedesetim godinama XX. stoljeća Herbert Simon je preispitivao takvo gledište sa stajališta svog koncepta vezane racionalnosti. Taj koncept izvire iz zajedničkog učinka unutarnjih ograničenja ljudske misli i strukture vanjske okoline u kojoj ljudska misao djeluje. Tijekom zadnjeg desetljeća i stavljenog težišta na situacije u stvarnom svijetu u kojemu su odluke uklopljene u veće zadatke, čime odlučivanje postaje dio proučavanja djelovanja, zagubljeni racionalni čovjek javlja se iznova kao učinkovito biće u kompleksnoj okolini. Gigerenzer je pokazao kako heuristika pomaže u tom procesu.

KLJUČNE RIJEČI

vezana racionalnost, odlučivanje, heuristika, makro kognicija, naturalističko odlučivanje