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their contribution to the quality of the Journal's content is acknowledged.

Zagreb, 26th October 2012

Josip Stepanić

INDECS AWARD

Dear authors of articles published in Vol. 9 of the journal INDECS,

the contest for the INDECS award, INDECSA 2012, choosing of the best article published in INDECS during 2012, i.e. in Vol. 10, is opened.

You, the authors of articles published in INDECS Vol. 9, i.e. in 2011, and the members of the INDECS' Editorial Board, are the voters. Each and every one of you contributes with one vote.

Propositions for the INDECSA are available from the web site of INDECSA, http://indecs.eu/index.php?s=indecsa.

I would like to ask you to give your vote to the article which you consider to be the best among the articles published in the year 2011.

The votes will be collected till 10th January 2012 and the results will be presented in INDECS 11(1).

Cordially,

Zagreb, 26th October 2012 Josip Stepanić

EDITORIAL

Dear readers,

we are very pleased to announce our first INDECS CogSci issue. It is dedicated to the open questions concerning the integration of the first- and third-person approaches to the investigation of mental phenomena. The articles come from different fields of cognitive science and tackle theoretical, methodological and research problems connected to the first- and third-person perspectives.

The first article by Olga Markič offers a general overview of the problems of integration of first- and third-person approaches. Outlining the main philosophical issues related to the problem, her article serves as a useful general introduction to the issue. Markič's paper is followed by another overview: Urban Kordeš attempts to highlight some of the reasons for the renewed interest in study of experience, especially within the broader field of cognitive science. Kordeš describes the relation between the (relatively young) area of the first-person research and other areas of the study of human mind, especially cognitive neuroscience. The title of the article, "Thinking of experience, experiencing thinking", reflects the example the author uses to illustrate the importance of systematic study of experience and some open questions arising from such an enterprise.

The rest of the issue consists of articles concerned with specific questions, areas and/or applications within the area of cognitive science that agree to the utmost importance of studying both perspectives: first- and third-person. A great example is Michael Glanznig's article, which focuses on the field of human-computer interaction. The author presents and compares the quantitative, statistics- based approach with the qualitative methodology, based on phenomenal data. An overview of the two opposing views is presented together with the critical discussion of both, and the consideration of the possibility of a unified approach.

In the article "Semantics of distinguishing criteria: from subjective to intersubjective" Martin Takáč and Ján Šefránek tackle the problem of subjectivity from the angle of cognitive semantics. Based on the embodied cognition paradigm and studies of the autonomous agents, authors provide a possible account of moving from the primarily subjectively grounding meanings to intersubjective meanings via the observable behaviour and feedback.

The next article by Natalija Ćurković critically examines the old psychological assumption of different levels of cognitive processing. Her article "Using of structural equation modelling techniques in cognitive levels validation" examines the possibility of confirmation of the existence of such levels and underlines the importance of the interdisciplinary approach and triangulation of different perspectives. The content of the author's work shows the importance of the questions raised in the area of education as well as within the broader scope of cognitive science.

The philosophical reflection by Toma Strle, entitled "Metacognition and decision making: between first and third person perspective" completes the current issue of INDECS. The article starts by examining the importance of metacognitive monitoring, control and meta-knowledge in guiding decision making. It also raises some important questions concerning the validity of metacognition studies and by doing so illustrates the value of understanding experiential perspective of decision making.

We hope that reading this issue will help to improve the understanding of the first- and third-person integration problem and offer new ideas for further research.

Cordially,

Ljubljana, 26th October 2012

CogSci-issue Editors
Prof. Olga Markič
Prof. Urban Kordeš

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FIRST- AND THIRD-PERSON APPROACHES: THE PROBLEM OF INTEGRATION

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Regular article

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ABSTRACT

The author discusses the problem of integration of first- and third-person approaches in studying the human mind. She critically evaluates and compares various methodologies for studying and explaining conscious experience. Common strategies that apply reductive explanation seem to be unsatisfied for explaining experience and its subjective character. There were attempts to explain experience from the first-person point of view (introspectionism, philosophical phenomenology) but the results were not intersubjectively verifiable. Dennett proposed heterophenomenology as a scientifically viable alternative which supposed to bridge the gap between first- and third-person perspectives. The author critically evaluates his proposal and compares it to contemporary attempts to provide first-person methods.

KEY WORDS

cognitive science, heterophenomenology, consciousness, experience, explanation

CLASSIFICATION

APA: 2340, 2380
JEL: D83, D84, Z10

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INTRODUCTION

Cognitive science has a relatively short history, if compared to established scientific disciplines that are participating in this interdisciplinary science of the mind: neuroscience, psychology, computer science, linguistics, evolutionary biology, anthropology, educational sciences and philosophy. Josés Luiz Bermúdez stresses that "[T]he job of cognitive science is to provide a framework for bringing all these different perspectives together" [1; p.xviii]. This is far from being an easy job, and cognitive scientists from different disciplinary backgrounds are dealing with concrete questions on how to combine different approaches and methodologies in their research. David Marr [2] famously proposed three levels of analysis (computational level, algorithmic/representational level and physical level) with the corresponding methods, and thus suggested the model of integration in classical cognitive science. Later approaches to cognitive modelling (connectionism, neural networks) and the much more important role of neuroscience reopens the problem of how to build coherent interdisciplinary theories. Valery Hardcastle in her book *How to Build a Theory in Cognitive Science* suggested that the answer to this conundrum revolves "around the common explanatory patterns one finds in cognitive science" and the shared interest in explaining how information is processed [3; p.9]. She is aware that what counts as information and how different scientists explain it is not uniform across disciplines composing cognitive science. But it seems to me that if we stick with Bermúdez and his "short, but accurate, definition of cognitive science: Cognitive science is the science of the mind" [2; p.1], the problems of integration are much harder. Namely, many philosophers of mind and cognitive science (e.g. Nagel [4], Chalmers [5], Varela [6, 7]) have pointed out that cognitive scientists, if they really want to explain the mental, they have to find the way how to deal with the experience and subjective aspects of consciousness. They emphasize that cognitive science has been neglecting the experiential.

Let me elaborate a bit on the philosophy of psychology from the historical and theoretical perspective. Elisabeth Valentine compares different frameworks in psychology with respect to three different aspects: the subject matter, the methods prescribed and the preferred theoretical analysis [8; p.128]. She suggests that the subject matter – conscious experience, behaviour and physiology - provide three different types of data and further determine the methods and theoretical analysis. She points out that the famous question "how to get inside the head" can be answered by three different methods roughly associated with three subject matters: *asking* (introspection) with *conscious experience*, *guessing* (inferences from behaviour) with *behaviour* and *looking* (neuroscience) with *physiology* [8; pp.128-129]. Both behaviourism and cognitive science (classical and connectionist) are dealing with explaining behaviour, but they use different methods and theoretical analyses. Behaviourism is studying behaviour through objective observation and experiments using functional analysis in terms of stimulus-response relations. Classical and connectionist cognitive science study systems governing behaviour and use the computational model of mind, applying functional analysis and describing mental processes in terms of information processing [8; p.131]. Valentine, with a very broad brush, suggests that "there are three main psychological approaches to explain mental phenomena: the experiential, the behavioural and the neurophysiological" [8; p.137]. The experiential approach includes traditions of *Verstehen*, phenomenology, folk psychology and introspectionism. They tend to adopt a subjective and an individualistic approach with the focus on the subject's (first-person) perspective and explanation in terms of beliefs, desires, and reasons. The behavioural approach encompasses both behaviourism and cognitive psychology. It is based on the functionalist theory of mind and attempts to provide a causal analysis of the processes in the system. In contrast to the previous one, this approach is objective and general, as is the next, neurophysiological approach. At the level of neuroscience the task is to provide explanations in terms of physical embodiment.

Daniel Dennett describes three different stances: *intentional* stance, *design* stance and *physical* stance [2], that roughly correspond to the division above. He argues that these stances help us explain and predict behaviour at different levels of abstraction, the physical stance at the most concrete level and intentional stance at the most abstract level, corresponding to folk psychology. He also suggests that with the method of *heterophenomenology* he is able to provide a scientifically respectable approach to conscious experience. Heterophenomenology has provoked a lot of discussion and disagreement, but before focusing on his method let us briefly look at Nagel's and Chalmers' understanding of conscious experience and the possible science of consciousness.

NAGEL AND CHALMERS ON CONSCIOUS EXPERIENCE

David Chalmers opens his paper "Facing Up the Problem of Consciousness" with the following observation: "Consciousness poses the most baffling problems in the science of the mind. There is nothing that we know more intimately than conscious experience, but there is nothing that is harder to explain. All sorts of mental phenomena have yielded to scientific investigation in recent years, but consciousness has stubbornly resisted" [9; p.200]. What he sees as the most perplexing problem – famously hailed as "the hard problem of consciousness" – is the problem of *experience*, the subjective aspect of mental processes. He argues that in contrast to the "easy problems of consciousness" (e.g. the reportability of mental states, the focus of attention, the deliberate control of behaviour etc.) which concern the explanation of cognitive abilities and functions, the hard problem is not a problem about the performance of functions. Easy problems may be solvable by the methods of cognitive science and neuroscience, but even if one manages to successfully explain the performance of cognitive or behavioural functions (e.g. verbal report, perceptual discrimination), Chalmers feels it will still be unclear as to why exactly the performance of these functions should be accompanied by experience [9]. Or, in Thomas Nagel's words, "the fact that an organism has conscious experience *at all* means, basically, that there is something it is like to *be* that organism" [4; p.166]. Nagel stresses the subjective character of conscious experience. Only creatures that undergo similar experiences can understand this "what is like to be" in an empathetic sense. So, famously, because of a differences in sensory apparatus and consequently in perception, there is no reason to believe that we can feel what is like to be a bat. Nagel argues that facts about consciousness can be only incompletely understood from an outside, third-person perspective. Knowledge gained from the external, objective, third-person perspective of the natural sciences or cognitive sciences would thus, according to Nagel, not suffice to understand what the bat can understand of its own experience from its internal first-person subjective point of view. This epistemic form of subjectivity is associated with limits on the knowability and understandability about conscious experience [10].

We see that both authors emphasize the *subjectivity* of conscious experience and are concerned especially with the *qualitative* character of consciousness or *qualia*, sometimes also called *phenomenal consciousness* [11]. According to Block, phenomenal consciousness properties include the experiential properties of sensations, feelings, perceptions, and also thoughts, wants and emotions. He maintains that these properties differ from any cognitive, intentional, or functional property belonging to what he calls *access consciousness*. Nagel, Chalmers and Block stress that feelings escape functional explanations of cognitive science. In the words of Joe Levine, there is the so-called "explanatory gap" [12] between causal explanation from the third-person perspective and the first-person experience of how it feels.

Nagel and Chalmers deny the possibility of a reductive explanation of conscious experience because reductive theories lack resources to give an answer to “what is like to be” [4] or the “hard problem” [9]. But they both speculate about the possible solution. Chalmers argues that to account for conscious experience we would need “an extra ingredient” in the explanation. His suggestion is that we have to take experience as the fundamental feature of the world and construct a theory of experience with the aid of new psychophysical principles that will supplement physical theory. He further speculates about the double-aspect of information as the basic principle that might underlie and explain the emergence of experience from the physical. According to the double-aspect hypothesis, experience arises by virtue of its phenomenal aspect, while physical aspect is embodied in physical processing [9]. Nagel ends his seminal paper “What Is It Like to be a Bat?" with the following speculative proposal: “It may be possible to approach the gap between subjective and objective from another direction. Setting aside temporarily the relation between the mind and the brain, we can pursue a more objective understanding of the mental in its own right. At present we are completely unequipped to think about the subjective character of experience without relying on the imagination - without taking up the point of view of the experiential subject. This should be regarded as a challenge to form new concepts and devise a new method - an objective phenomenology not dependent on empathy or imagination..... Apart from its own interest, a phenomenology that is in this sense objective may permit questions about the physical basis of experience to assume a more intelligible form. Aspects of subjective experience that admitted this kind of objective description might be better candidates for objective explanations of a more familiar sort” [4; pp.178-179].

METHODOLOGIES FOR STUDYING CONSCIOUS EXPERIENCE

So, are there any concrete proposals on how to scientifically study conscious experience and integrate the first- and third-person perspectives? Is it possible to improve the standard methods used in science or do we have to develop new ones? How are new attempts connected to the more traditional approaches to studying experience?

Let me start with Dennett’s illustration of two opposing teams tackling the problem of explaining experience. Dennett starts off with the two questions, posed by his colleague James Conant [13; p.1]:

> Descartes: How is it possible for me to tell whether a thought of mine is true or false, perception or dream?
>
> Kant: How is it possible for something even to be a thought (of mine)? What are the conditions for the possibility of experience (veridical or illusory) at all?
>
> Dennett adds a third version of the question:
>
> Turing: How could we make a robot that had thoughts, that learned from “experience” (interacting with the world) and used what it learned the way we can do?

Dennett suggests there are two main reactions to Turing’s proposal to trade in Kant’s question for him:

(A) Cool! Turing has found a way to actually answer Kant’s question!

(B) Aaaargh! Don’t fall for it! You’re leaving out . . . experience!

Dennett declares himself as a captain of the A team (together with Quine, Rorty, Hofstadter, the Churchlands, Andy Clark and others), while Chalmers is a supposed captain of the B team. He thinks that his team will win, but admits that it will not be an easy task. It will take “a rather remarkable exercise of the imagination to see how it might even be possible”, but following Turing's insight on how to recast Kant's question as an "engineering question" he thinks it will be possible to "trade in the first-person perspective of Descartes and Kant for the third-person perspective of the natural sciences and *answer all the questions*–without philosophically significant residue" [13; p.1]. On the other side, Chalmers, together with Nagel, Searle, Levine and others, insists that he just knows that A team leaves out consciousness and does not address the hard problem.

So, let us look first at Dennett's heterophenomenology, and then turn to first person methods in the science of consciousness.

HETEROPHENOMENOLOGY

Dennett develops heterophenomenology as a method for studying consciousness and describes it in the 4th chapter of *Consciousness Explained* as "the *neutral* path leading from objective physical science and its insistence on the third-person point of view, to a method of phenomenological description that can (in principle) do justice to the most private and ineffable subjective experiences, while never abandoning the methodological principles of science" [8; p.72]. In his later paper, he characterized it as "a bridge – the bridge – between the subjectivity of human consciousness and the natural sciences" [14; p.249]. He thinks that heterophenomenology preserves the point of view of the subject (first-person perspective) and then conveys it to science (third-person perspective). He argues that it takes the subjects seriously, but without granting them infallibility, in contrast to the Cartesian tradition which he calls a "lone-wolf autophenomenology". The distinguishing character of the method is neutrality, a kind of agnosticism, "a deliberate bracketing of the issue of whether what they are saying is literally true, metaphorically true, true under-an-imposed-interpretation, or systematically-false-in-a-way-we-must-explain" [14; p.252] that is contrary to what we are used to in our everyday interpersonal communication.

The investigator starts the research by extracting verbal utterances that are transcribed and function as verbal reports. The method, however, is not limited solely to verbal reports, but may also include other types of data, such as behavioral reactions, visceral reactions, hormonal reactions, and other changes in physical states that are detectable by objective means. Dennett points out that the investigator has to be particularly cautious with verbal reports, since they require interpretation and assessment of speech acts as expressions of beliefs about a subject's subjective state. Verbal reports represent the most critical part and require the employment of the intentional stance as well as the move from raw data to interpreted data - subject's heterophenomenological word [13]. Dennett stresses that his fictional world is populated with all the images, events, sounds, smells, hunches, presentiments, and feelings that the subject (apparently) sincerely believes to exist in his or her (or its) stream of consciousness. Maximally extended, it is a neutral portrayal of exactly *what it is like to be* that subject–in the subject's own terms, given the best interpretation we can muster" [2; p.98].

Dennett suggests that heterophenomenologists can, by carefully designing their investigations, bring data from the first-person point of view to objective science. He feels he has not discovered a new method, but has merely described and explained it. He considers it to be a "good old 3rd-person scientific method applied to the particular phenomena of human (and animal) consciousness" [13]. Scientists in various disciplines (e.g. psychophysicists, cognitive psychologists) that intend to study consciousness in a scientific way have already used it. Heterophenomenology also takes some features from philosophical phenomenological tradition (Brentano, Husserl) but in a *naturalized* variant. What is the exact relationship between Dennett's heterophenomenology and classical philosophical phenomenology is the topic of much heated discussion [15]. But before that, let us give a word to the members of the team B who believe that heterophenomenologists leave out what they need to explain – the subjective experience.

FIRST PERSON METHODS

On the first sight Chalmers has radically different views about possible methods for the science of consciousness then Dennett. He argues that the job of a science of consciousness is to connect first-person data to third-person data [16]. The latter are obtained by investigating processes like behaviour, brain processes and environmental interactions that are accessible by known scientific methods. First person data are about conscious experience an include those concerning visual experience (e.g. the experience of colour), other perceptual experiences (e.g. auditory, tactile), bodily experience (e.g. pain), mental imagery (e.g. recalled visual images), emotional experience (e.g. happiness, fear), and concurrent thought (e.g. the experience of deciding) [17]. Chalmers takes for granted that there are first-person data – it is a fact about our minds, and that "our direct knowledge of subjective experiences stems from our first-person access to them" [16]. He has argued that reductive strategies to explain conscious experiences are doomed to fail [5, 9]. Even if scientist find out the complete functional explanation there will still remain the question why is this functioning associated with the particular subjective experience. First-person data are not data about objective functioning. Scientists are thus facing the problem to find good methodologies for collecting the data (both first-and third-person), express them in suitable language and find connecting principles. Chalmers' goal is to find "fundamental theory of consciousness", i.e. formulate simple and universal laws that underlie these connecting principles [16, 17]. In order to possibly achieve the goal scientists have to develop methods in both domains.

There was a fascinating development of methods in psychology and especially in neuroscience (e.g. brain imaging, single cell studies) in last few decades, as well as improvement in expressing data (e.g. computational models, statistics). It therefore seems that science about the third-person domain is well equipped. But what about the first-person domain? Do we have well developed methods for gathering first-person data? There were traditions in the experiential approach, especially introspectionism and philosophical phenomenology that nearly disappear from scientific investigation of the mind. But they are now coming back, transformed and accompanied with many new first-person approaches to the study of consciousness, including those, based on a Eastern meditative tradition [18]. Nevertheless we have to take into account the well known obstacles: the lack of incorrigible access to experience, the changing of experience while we self-observe and the difficulties with expressing in language.

What I find perplexing is how two approaches, introspectionism and phenomenology are sometimes merged in new first person methods. I think the names phenomenal consciousness and phenomenal properties may provoke some misunderstanding by conflating qualitative and phenomenal structure [10]. According to phenomenologists from Brentano on, the phenomenal structure of experience is much more then raw feels and covers the domain of the world as it appears to us. It involves not only sensory qualities but also intentionality. Introspection was introduced by Wilhelm Wundt as a psychological method where "one attends carefully to one's own sensation and reports them as objectively as possible" [19, p.103]. This means that one describes the felt sensation and not the stimulus that provoke it. In a way, the introspectionists were studying the elements of sensation and looking for the basic constituents of mental states. On the other hand, for Brentano, the early phenomenologist, psychology starts with the mind–an active, creative entity which has intentions, for it implies and demands an object. The true subject matter of psychology is the mental act–such as judging, sensing, imagining, or hearing, each of which reflects a sense of direction and purpose. One cannot simply *see*; one must see *something*; and the *act* of seeing something is psychological or mental. Given this viewpoint, the task of empirical psychology is to study the mind of the agent at work, dealing with objects, purposes, and goals. ... one cannot conceive of thoughts and judgement, let alone study them, except by taking into account one's inner phenomenal experience. And this can be accessed not by prompted introspection – for one cannot observe at the same time that one experiences–but rather by simple phenomenal experience of one's inner mental life" [19; pp.101-102].

We can clearly see the difference between bottom-up approach of introspectionism and top-down phenomenological approach of Brentano. As Howard Gardner has pointed out, his top-down concerns are emerging in different forms, also in the view of the computer as an agent with plans, intentions, and goals [19; p.102]. On the other side, we can understand why with the more accurate measurements of brain activity neuroscientists are interested in more fine-grained descriptions of experience that can be linked to neural correlates. As Nahmias reflects: "Given the new tools we have to test and correlate the conscious experiences reported by subjects, should we shake off the shackles of behaviorism and reconsider some of the introspectionists' methods and goals? Specifically, might it be worthwhile (1) to try to train subjects to attend more closely to their experiences and describe them more fully and accurately; (2) to try to develop a more precise language with which subjects can report the contents of conscious experience; and ultimately, (3) to try to map out the internal structure of conscious experience to better understand its relations to neural processes" [20; p.12].

Let me illustrate the idea of correlating subjective experience and neural state with an experiment done by neuroscientist Antonio Damasio and his colleagues [21, 22] . They set about to study the neurobiological substrates of feelings by connecting first-person experiences with third-person data obtained by modern imaging techniques. First, he and his team made sure that they were actually capable of triggering emotions in their test subjects. They asked them to recall a certain emotional situation in which they experienced one of the four feelings: joy, sorrow, fear or anger, and then to re-experience this emotion as vividly as possible. The experiment was then taken to the second room where test subjects were placed in a PET scanner. They were asked to imagine the past experience again and then signal with their hands when the required emotion was experienced. At that point the activity of their brains was recorded with the PET scanner, which eventually provided appropriate brain correlates for certain emotive states. The obtained results corroborated their hypothesis that in experiencing emotions there was high neural activity in the somatosensory parts of the brain (cingulate cortes, insula and SII, hypothalamus and several nuclei in the brain stem tegmentum), and at the same time activation/deactivation patterns for different feelings differed substantially. So, just as we can perceive that our bodies are in different states when we experience fear or joy, Damasio and his colleagues successfully showed that brain maps corresponding to these feelings also differ.

But is this approach really so different from Dennett's heterophenomenology? I think that Dennett would accept experiments like Damasio's without problems. The important difference between hetrophenomenology and first person methodologies described by Varela and Shear [18] is in the preparation of persons that are doing first person research. Persons doing introspection or phenomenological inquiry are trained to do this (see also Kordeš, this issue), while Dennett rely on ordinary people. He thus suggests that "if some of your conscious experiences occur unbeknownst to you (if they are experiences about which you have no beliefs, and hence can make no "verbal judgments"), then they are just as inaccessible to your first-person point of view as they are to heterophenomenology. *Ex hypothesi*, you don't even suspect you have them – if you did, you could verbally express those suspicions. So heterophenomenology's list of primary data doesn't leave out any conscious experiences you know of, or even have any first-person inklings about" [13]. On the other side at least some first person methods are concerned with pre-reflexive experience and see the role of introspection in explicating what was only implicitly present. Since this part of our knowledge is non-conscious and thus difficult to get at, Pierre Vermersch and Claire Petitmengin-Peugeot propose the explication session with an interviewer. Interviewer guides the subject through three stages: gathering descriptions of experiences, analysis and modelling of the descriptions and comparing the established models. The accessing the experience can be relieving a past experience or living the experience 'in the present [23, 24; p.46]. In seems that guidance and help from well trained interviewer – second-person, is crucial for such an investigation and that "naive" introspection will not lead to interesting results. But who wants to stick to naïve introspection if there are better methods.

CONCLUSION

Common strategy in science is to apply reductive explanation but it is highly problematic if the same strategy can be used also in cognitive science, particularly in science of consciousness. Nagel and Chalmers have argued that because of the special qualitative character that accompany experience which is always subjective and from first-person perspective, strategies for explaining experiences must be different. We know from the beginning of psychology that there were attempts for a scientific approach to explain experience (introspectionism, philosophical phenomenology). Because the results were not intersubjectively verifiable scientist were highly sceptical about such methods. Dennett proposed heterophenomenology as a scientifically viable alternative, which supposed to be a bridge between first-and third- person perspectives. I think this method is quite similar to some new introspective methods although the ideology behind often points otherwise. I understand all of them more pragmatically as tools for obtaining more systematic and deeper knowledge of our mental life that can be possibly correlated with the functioning neural system but I doubt that any of the proposed methods can help Chalmers to solve the hard problem.

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PERSPEKTIVE PRVOG I TREĆEG LICA: PROBLEM INTEGRACIJE

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SAŽETAK

Autorica diskutira o problemu integracije perspektiva prvog i trećeg lica u proučavanju ludskog uma. Ona kritički procjenjuje i uspoređuje različite metodologije proučavanja i objašnjavanja iskustva svijesti. Uobičajena strategija, primjena redukcionističkog objašnjenja, nije zadovoljavajuća za objašnjavanje iskustva i njegovog subjektivnog karaktera. Pokušaji objašnjavanja iskustva iz perspektive prvog lica (introspekcionizam, filozofska fenomenologija) ne mogu se intersubjektivno verificirati. Dennett je predložio heterofenomenologiju kao znanstveno prihvatljivu alternativu koja je trebala premostiti procijep između perspektiva prvog i trećeg lica. Autorica kritički razmatra njegov prijedlog i uspoređuje ga sa suvremenim pokušajima za formuliranje metoda temeljenog na prvom licu.

KLJUČNE RIJEČI

kognitivna znanost, heterofenomenologija, svijest, iskustvo, objašnjenje

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THINKING OF EXPERIENCE, EXPERIENCING THINKING

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ABSTRACT

The article briefly describes the relatively young field of cognitive science dedicated to the research of lived human experience – the so-called phenomenological inquiry (or first-person research). It enumerates the reasons for the renewed interest in the study of experience and outlines the field's relation to the rest of cognitive science. With the help of an example (phenomenology of thinking), the article attempts to illustrate the importance of systematic study of experience and addresses some open questions emerging from such an enterprise.

KEY WORDS

phenomenological inquiry, first-person perspective, experience, thoughts

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INTRODUCTION

Tremendous progress of cognitive neuroscience has recently virtually overshadowed the endeavours of other disciplines engaging in the research of cognition. Many researchers in the field feel that a path has been opened to understanding the functioning of the brain in a way similar to understanding the ‘functioning’ of the physical world. The descriptions of the dynamics, biochemistry and functionality of neural networks are becoming more and more accurate and through that, it does appear that claims that soon reason will be able to explain the functioning of reason are not too far fetched. Of course we have not yet reached that stage. Cognitive neuroscientists still have much to learn using the trial-and-error principle. Nevertheless, a theory of mind in the sense of naturalistic theories explaining the functioning of inanimate nature appears to be possible.

However, a look into the history of attempts to explain the human mind quickly curbs such enthusiasm: a couple of disciplines have cherished similar high hopes during the past century and before. The enthusiasm of today’s neuroscientists is similar to the conviction of artificial intelligence experts some twenty years ago about their abilities to model the human mind. And – in even more distant past – we can observe similar unfulfilled hopes in the fields of psychology, cybernetics and, of course, philosophy.

Searle [1; pp.30-31] describes this sequence of unsuccessful attempts to explain the mind: “... The theory in question has left out the mind; it has left out some essential features of the mind, such as ‘consciousness’ or ‘qualia’ or semantic content....[Thus] if we were to think of the philosophy of mind as a single individual we would say of that person that he is compulsive neurotic, and his neurosis takes the form of repeating the same pattern of behaviour over and over.”

A number of cognitive scientists agree with Searle’s diagnosis (perhaps most notably Varela [2]): by leaving direct human experience – i.e. the most intimate and omni-present part of cognition – out of the equation, we necessarily fail to gain a full-fledged understanding of mind. For some philosophers this realization shows that there will never be a complete theory of mind, because “the very fact of subjectivity, which we were trying to observe, makes such an observation impossible” [1; p.97]. Some try to include experience in their models, and some (to be mentioned later) argue that the human experience should be taken as irreducible ground by which other layers of cognition are layered.

There is another, more practical reason why subjective experience research became the latest addition to cognitive science. A big part of neuroscience (and also Artificial Intelligence (AI)) cannot go on without understanding what they are studying. The task of cognitive neuroscience is supposed to be understanding the neural correlates of human experience. The question is how it can attain that goal without understanding experience in the first place? One could even argue that neuroscience’s (and AI’s and psychology’s etc.) failure to provide a full-fledged theory of mind is the consequence of their taking the understanding of human experience as self-evident: for a long time nobody (within the scope of cognitive science) bothered to doubt everyday intuitions about the structure of our experiential world. Similarly, the isomorphic relation between events in the brain and experience (or between behaviour and experience) was rarely questioned, at least outside pure philosophic speculations.

However, such assumptions have been shattered in recent decades by a new (or renewed) research field dealing with the systematic inquiry of lived human experience. The following text aims at describing this research field and its relation to the rest of cognitive science. With the help of an example, it also attempts to open some of the hard questions that emerge from such an enterprise.

EXPLORING EXPERIENCE

Contemporary empirical research of experience is, as mentioned above, a fairly young discipline, even though it relates to several older scientific experiments. The idea that inquiring into the direct experiential world is (at least) as important as the study of physical reality is by no means a new invention. Its most elaborate theoretical exposition can be found in the work of Edmund Husserl, but even before that, in the beginning of XVIII. century, there existed a research programme based on the primary role of human experience developed by Johan Wolfgang Goethe [3]. At the beginning of XX. century there was a strong surge of new approaches aimed at the research of the subjective. Beside Husserl, German introspection flourished at the time, as well as the field of the so-called Graz school of experimental phenomenology, which emerged just a few years later [4].

Each of the above-mentioned schools soon met with virtually insurmountable problems. Consequently, none of them had any major influence on the research of human psyche in the framework of cognitive science in the 70s. But during that period (also under the influence of the progress of neuroscience, as stated in the introduction), the urgent need to understand experience emerged, as can be seen in several areas. Thus a wide array of diverse research approaches has been developed recently, directed at the lived human experience [5]. In the last 30 years a considerable number of methods and perspectives of how to study our experiential world have been proposed: everything from strictly quantitative methods measuring chiefly the frequency of the occurrence of a given type of experience, to qualitative dialogical methods which endeavour to preserve the inner wealth of participants' experiential worlds.

The common denominator in all of these approaches is the insistence on studying experience as 'it shows itself', without endulging in metaphysical or theoretical speculation. Researchers in this area emphasize the importance of trusting the participants' experiential reports. Inquiries focus more on how participants experience in different situations and lees on why it is so – theoretical grounding, judgements and explanations are 'bracketed' in favour of observing lived experience. All of these basic research assumptions have been formulated by the philosopher and mathematician Edmund Husserl [6], who realised the simple truth that primary human experience is, in fact, all we have at our disposition – there is no way to escape it. His motto 'Back to things themselves' is an appeal symbolically marking the birth of one of the most powerful philosophical currents of XX. century: phenomenology. Husserl himself was well learned in the procedures of natural sciences, but he found it unacceptable that direct, lived experience be neglected on account of the fixation on theoretical explanations. He formulated phenomenology as a rigorous science which should systematically study experience, i.e. things (or rather phenomena) as they show themselves to us (instead of searching for hidden truths and background mechanisms explored by other sciences).

Since most of the basic concepts pertaining to the research area dealing with the empirical inquiry into experience come from Husserl, this field was given the name phenomenological inquiry. As the research in question is in effect empirical, several purist philosophers of phenomenological provenience have been opposing this designation. Some of them have suggested the term phenomenography, which however never caught on. Another name for this research project is also first-person research, a designation bringing another set of problems: while the issue in question is indeed the first-person perspective (as opposed to the third-person perspective dealing with behaviour and neurophysiology), it is also true that it is dealt with in the manner of third-person research – one does not study one's own experience, but rather the experience of the participants of the research.

Be that as it may, in the rest of the article I intend to stick to the term phenomenological inquiry, while sometimes using also the term first-person research.

WHAT EXACTLY IS THAT WHICH WE ARE STUDYING?

If science is supposed to be the study of the properties of the world which we live in, it should be clear that a new scientific discipline is formed once we become aware of a new, hitherto unexplored area of the world (or once we gain the tools to research an area which we were up to that moment unable to consider in a scientific way). In this section I would like to discuss which part of the world - or rather which level of reality – should be dealt with in phenomenological inquiry. Which area does it actually study and what kind of data does it operate with?

EXPERIENCE

The area of our inquiry is experience, i.e. everything that happens in the scope of individual consciousness. Husserl [6] in fact did not differentiate between the two - that which we today commonly designate as experience was referred to by him as consciousness. Indeed, such an equation actually makes sense, since differentiating between consciousness and experience does appear to be somewhat artificial: experience is basically the entire gestalt of being conscious.

The question which part of reality is dealt with in phenomenological inquiry is impossible to answer in the same way as in the case of other sciences. Phenomenological inquiry is concerned with a part of the world which is the most intimate and directly accessible one, the world as 'it shows itself' to us. Physical world, human behaviour, social world ... all of these are merely different systematisations of the experiential world - and all of them are less existentially direct. It was because of this fact that Husserl believed that the science of experience should be the basic science, rising above and over all other sciences due to its fundamental nature. At this level, there is no difference between that which shows itself to us and our perception. It is impossible to separate between the screen onto which experience is to be projected and the projection itself. Even the very notion of a reality which is 'out there', being projected into our consciousness (i.e. the world as studied by most of the sciences), has no place at this level of direct access. Experience is the entirety of existence in a given moment.

Perhaps our area of research was best highlighted by the philosopher Nagel in his article entitled 'What Is it Like to Be a Bat?' [7]. It is extremely hard to answer the question what is experience by reducing it to other psychological notions; it cannot be described as this and that. When we speak about the gestalt of experiencing, we are talking about what it is like to be that human being (in the chosen moment).

As stated by Varela and Shear: "In spite of the variety of terminology being used, a consensus seems to have emerged that Thomas Nagel's expression 'what it is like to be' succeeds in capturing well what is at stake. Clearly 'what it is like to be' a bat or a human being refers to how things (everything) looks when being a bat or a human being. In other words this is just another way of talking about what philosophers have called phenomenality since the Presocratics. A phenomenon, in the most original sense of the word, is an appearance and therefore something relational. It is what something is for something else; it is a being for by opposition to a being in itself independently of its apprehension by another entity" [8; p.3].

HOW TO OBSERVE EXPERIENCE?

Let us now ask the question what we can find out about experience and how can we find out anything about it at all. In considering the question how, we are immediately faced with the principle problem of phenomenological inquiry: the so-called excavation error, i.e. the fact that the act of observing essentially changes that which is observed. Searle offers the following description of this inconvenience: “The very fact of subjectivity, which we were trying to observe, makes such an observation impossible. Why? Because where conscious subjectivity is concerned, there is no distinction between the observed and the thing observed ... Any introspection I have of my own conscious state is itself that conscious state” [1; p.97].

Our intuitive opinion (shared by several important phenomenologists) is that human experience is intentional – it is always aimed at something. Thus when we embark on the observation of experience, this means that experience is actually observing itself. This is hard to fathom – it appears as though we would need to take a step back all the time in order to find a new position from which to observe. A position, that is, which is not a part of the observed.

At this point, Zen masters would disagree with us. According to them, unintentional observation, or rather, presence in which the field of awareness is being aware of its own entirety – and of the fact that it is aware of itself, is indeed viable. Who knows, perhaps such a state is in fact the ultimate method of phenomenological inquiry? It is definitely a subject worth elaborating upon, and even more worth trying out in practice. But that is not the aim of this article. Our goal is to present third-person phenomenological research methods, i.e. the kind that explores (also) experiential landscapes of others, and first and foremost one which yields results accessible to others.

FROM EXPERIENCE TO EXPERIENTIAL REPORTS (PHENOMENAL DATA)

Setting aside the possibility of direct observation of experience in the form of mindfulness, one must recognize that any perception of one’s own experience is in essence the perception of a memory of one’s experience.

The memory of experience is itself a new kind of experience, of course. But the crucial difference here is that memory is but a part of the entire domain of consciousness, thus allowing the observer to occupy a position outside of the area in question. Maintaining this position means that one is able to observe the memory of experience from a distance and can thus try to describe it. It is only at this point that scientific research becomes possible: descriptions of memories of experience are the closest we can come to describing what it is like to be.

All things considered, our position in the field of phenomenological research is not so much different from the position of other scientific areas. Physics, for example, is similarly unable to explore physical reality directly – at the quantum level one must accept observing merely the effects of the processes observed. In a way it could be said that this also involves the observation of memories, or rather traces, of past events.

The only data available to phenomenological research is thus the so-called phenomenal data - descriptions of memories of past experience.

THE CONSTRUCTIVE NATURE OF RETROSPECTION

The processes involved in making memories are of course highly problematic and unreliable. The fact that phenomenal data is actually a description of memories of past experience has resulted in the formation of two distinct schools of phenomenological inquiry, separated by their attitude towards retrospection: one of them tries to reduce retrospection to the minimum, while the other one strives to train the interviewer in the dialogical art of 'cleansing' constructions brought about by memory.

This school of phenomenological inquiry's first and foremost representatives are Pierre Vermersch and Claire Petitmengin. They are trying to perfect the art of interviewing to the level where it would become possible to approach even the memories which are no longer fresh, and get rid of the constructions which had piled up in the mean time. The method of interviewing used by the adherents of this school is called the explicative interview [9]. There are well documented cases of people who were able to remember incredible details after such seances (some of which can sometimes be verified).

The other school of phenomenological research uses a different approach: it tries to reduce the time passing between an experience and its report and thus increase the reliability of memory. This method goes by the name of experience sampling. It is based on collecting random samples of experiential moments throughout the day. The method has one qualitative derivation (Descriptive Experience Sampling), elaborated by Russell Hurlburt [10], and also a quantitative one, in which subjects are being asked with the help of questionnaires about the presence of selected types of experience at randomly selected moments. The latter is frequently used in contemporary cognitive-neurophysiological research.

Both of these approaches are not incompatible, but rather complementary. Approaches such as DES are especially useful in 'drawing out' a map of everyday experience, while dialogical methods can delve deeper into its selected (pre-chosen) aspects. The methods developed from the starting-points of these basic approaches have since become quite sophisticated, thus objections like "Phenomenology has failed to find a single settled method that everyone could agree upon" [11; p.44], which have been stated by cognitive philosophers as recently as two decades ago, no longer apply.

NATURAL ATTITUDE

The (im)precision of memory is thus not the biggest problem of phenomenological inquiry. A much larger difficulty lies in the fact that our conscious attention is very poorly suited for observing experience: in our awareness we are oriented almost completely towards the content of experience at the expense of its structure. The so-called natural attitude of our experience is perhaps the most basic feature of our existence: it is almost impossible for us not to regulate, categorize, explain, make sense of and relate experiences into a whole. We are used to directing all our attention to the results of this process, so much so that there is no more of it left for the process itself.

That is why training is such an important part of the research of human experience. Many phenomenological researchers have noted that humans are very poorly acquainted with their direct experience (e.g. [8]), meaning that we are not good at 'bracketing' our natural attitude. In other words, we are not used to remembering our experience in a given moment, but rather merely its content.

In the following chapter I will present an example of experience research which will clearly demonstrate how little we are aware of the how? of our experiential world due to our overwhelming orientation towards the what? But before embarking on that, let me enumerate some of the basic methodological guidelines of experience research which aim to bypass our natural attitude and allow us to perceive phenomena as they show themselves to us. Most of these guidelines stem from Husserl's instructions for phenomenological reduction [6]:

- focusing on phenomena (things as they show themselves to us in our experience) and bracketing. Husserl suggests 'leaving the usual assumptions about things behind' (respectively, 'bracketing' them) and phenomenological reduction – the reduction of the observed onto phenomena as the only thing which is given in experience and thus certain,

- the rule: 'Do not explain, but describe!' It is the single most important methodological guideline of phenomenological inquiry. Simple as it might appear at first sight, its realization is a complex matter demanding a great deal of reflection and skill. Only once we try to merely describe experience in practice without classifying it, giving it theoretical grounds, explaining it etc., we become aware of the depth of our need to explain and how difficult it is to avoid it. Ihde [4] talks about the problems of differentiating between actual describable experience which is manifested solely in its directness, and non-experiential elements such as assumptions and prejudice. Explanation as understood here is any kind of theory, idea, notion or construction which is aimed at exposing the background of phenomena,
- abstinence from beliefs or rather from evaluating the 'reality' of observed phenomena. Without intersubjective verification (typical of the scientific method), it is impossible to separate between 'illusion' and 'reality'. From the point of view of direct primary experience such a distinction is just one of the ways in which to organize the experiential world (and as such of no bigger value than other possible distinctions). That is why Husserl recommends that even this – seemingly so basic a judgement – be bracketed in order to observe the field of experience as it shows itself, without judging it.

These guidelines are shared by all the approaches in the research of experience (especially by the qualitative, dialogical ones). But since Husserl was of the opinion that following only the afore-mentioned instructions one might get "lost in phenomena", he added a fourth guideline, which recommends the search for structure and constant properties of the observed phenomena. Husserl believed that this way it would be possible to bring forth a 'transcendental' science – i.e. a system surpassing the unique, ephemeral experience, which could extract its essential (transcendental) elements. This is the part where – in my opinion – one has to be very cautious. The following chapter will demonstrate the danger of presupposing a common experiential field shared by all.

THINKING – AN EXAMPLE OF AN UNEXPLORED LAND OF EXPERIENCE

In this section, the problems and possibilities of phenomenological research will be demonstrated with the help of an example. The principle aim of this is to emphasize two points mentioned in the theoretical introduction:

- human beings focus almost exclusively on the content of experience, consequently we are very poorly acquainted with its structure,
- many of the seemingly self-evident assumptions about experience are plainly and simply wrong.

For this purpose I have selected the phenomenon of thinking – probably one of the most common modalities of human experience.

WHAT IS THINKING?

We are intimately acquainted with it and yet (or perhaps, because of it), the phenomenon seems to be surprisingly poorly defined. In everyday conversation we use the term for a wide variety of experiences: from remembering something to trying to solve a problem. The situation is no more exact even within the scientific framework – modern cognitive neuroscience, for example, is quite broadminded in the use of the term thinking: one can find it in connection with abstract problem solving [12], argumentation [13], bringing forth memories of past events, associative processes, sense-making and meaning [14], appearance of intrusive mental images [15], etc.

The recent ‘discovery’ of default mode networks has focused scientific attention on the area of mind wandering [16], and via that, rekindled some questions about thinking. To be able to extract some research value from this concept, it is (again) becoming necessary to narrow down its definition. In this respect, most authors agree that thinking is some kind of a symbolical mental process, associated with processing of content – be it connected to a concrete object or event, or to an abstract idea.

HOW DO WE THINK?

Furthermore, despite the age-old philosophical argument about the relationship between thoughts and language, almost everybody today agrees that thinking is somehow connected to language. Most authors do not doubt the common intuition that thinking is actually inner talking, most prominently George H. Mead [17], who stated that thought is nothing but internalised conversation. This view has not changed much during the last century. Bernard Baars, a prominent cognitive scientist, confirms this: “Human beings talk to themselves every moment of the waking day. Most readers of this sentence are doing it now. It becomes a little clearer with difficult-to-say words, like ‘infundibulum’ or ‘methylparabine’. In fact, we talk to ourselves during dreams, and there is even evidence for inner speech during deep sleep, the most unconscious state we normally encounter. Overt speech takes up perhaps a tenth of the waking day; but inner speech goes on all the time” [18; p.106].

Leaning on this assumption, Matthew Botvinick from Princeton University summarises ‘the long-term goal’ of thought-related cognitive neuroscientific research as follows: “to translate [that] brain-activity pattern into the words that likely describe the original mental ‘subject matter’ ”[19].

It is interesting though, that Baars’ and Botvinick’s views are not universally accepted. John McWhorter, a prominent linguist, is convinced that we are not so much talking, but reading in our mind: “When we utter a word, we cannot help but mentally see an image of its written version. In our heads, what we have said is that sequence of written symbols. When we say ‘dog,’ a little picture of that word flashes through our minds, Sesame Street-style. Imagine saying ‘dog’ and only thinking of a canine, but not thinking of the written word. If you’re reading this book, it follows that you couldn’t pull this off even at gunpoint” [20; p.3].

So, is thinking inner talking or is it inner reading? It is really hard to assume that one’s own way of experiencing thinking might not be universal. This is probably one of the reasons why nobody thought of empirically testing the assumptions in the area of thoughts and thinking for quite a long time. The young field of phenomenological inquiry is attempting to bracket intuitions concerning our mind’s workings and instead gather empirical data about lived human experience. Let’s see what it has to say about thinking.

PHENOMENOLOGY OF THINKING

Russell Hurlburt, one of the prominent figures in contemporary empirical phenomenology, comments on above-mentioned descriptions: “I’m pretty sure that Baars and McWhorter are entirely mistaken. Maybe Baars talks to himself all the time, and maybe McWhorter himself sees images of written words while he talks (there’s reason to be sceptical of both claims), but I've investigated such things as carefully as I know how and become convinced that most people (let alone all people) do not do such things” [21].

Hurlburt is mostly known for his invention of afore-mentioned descriptive experience sampling method – one of the oldest (by now it has been around for more than 35 years) and most effective methods of collecting phenomenal data. In recent years, research of experience is gaining momentum. Many new methods are being developed, all having one thing in common: asking not what it is about, but how a particular modality (thought, feeling, sensory experience...) is experienced.

Execution of the afore-mentioned phenomenological methodological guidelines, i.e. phenomenological reduction (bracketing the content or the what of experience), is probably most difficult to do in the area of thinking: content is the very essence of thoughts. The predilection of our everyday experience (a natural attitude) makes us pay all our attention to the content of thoughts and none to its structure. We can easily remember what we were thinking, on the other hand, how this was experienced is rarely observed. Therefore, beside a well designed research method, a lot of exercise, determination and mindfulness is needed to explore experience, and especially the how of thinking.

The results are pretty surprising, though. In the area of thinking, Hurlburt et al. showed that the experiential modality of inner speech occurs in 26 % of all samples, with "large individual differences: some subjects never experienced inner speech; other subjects experienced inner speech in as many as 75 % of their samples. The median percentage across subjects was 20 %" [21].

Inner speech has been shown to be a robust phenomenon, but far from being the only way of how people think: "... some people talk to themselves a lot, some never, some occasionally" [21]. Furthermore, it seems that – behind the interface of well coordinated external communication – there is a vast variety of experiences, all called 'thinking'. Hurlburt reports on different other modalities of thought, one of which is, for example, the so called unsymbolised thinking, which is quite interesting in light of old philosophical debates about the possibility of such a way of thinking.

Many other modalities of thinking have been detected. I intend to dedicate the rest of this article to one of them: visual thinking.

VISUAL THINKING

This modality of experience is most clearly and convincingly reported in the works of Temple Grandin – publicist, academic and well known spokeswoman for people with the autistic spectrum disorder. At some point in her struggle to co-exist and communicate in 'normal' social surrounding, she discovered to her surprise that a great deal of her troubles originates in the fact, that – in order to be able to communicate – she has to constantly translate her way of experiencing the world. She found out that this seems to be a common problem of many people with autistic disorders. Following this observation, she started an inquiry that resulted in the articulation of three different specialized autistic/Asperger cognitive types: "(i) visual thinkers such as I who are often poor at algebra, (ii) pattern thinkers such as Daniel Tammet who excel in math and music but may have problems with reading or writing composition, and (iii) verbal specialists who are good at talking and writing but they lack visual skills" [22].

In her reports, Grandin offers a unique insight into the experience of a full-fledged visual thinker. She does not experience thinking as a linear (or consequential) affair. And she certainly does not think by talking to herself. Most of her experience consists of browsing through vivid recollections of pictures of (actual) things.

The simplest example is her report on deciphering words, describing generalized entities: "If you say the word 'butterfly', the first picture I see is butterflies in my childhood backyard. The next image is metal decorative butterflies that people decorate the outside of their houses with and the third image is some butterflies I painted on a piece of plywood when I was in graduate school. Then my mind gets off the subject and I see a butterfly cut of chicken that was served at a fancy restaurant approximately 3 days ago." [22].

It seems that she is not utterly unfamiliar with inner speech. But it only plays a role of a narrator, without having any power of abstraction or leading the argumentative process. Her experience handles what we know as logic and abstraction “with high-speed handling of hundreds of ‘graphics’ files”.

Grandin reports about her struggle to grasp the idea of abstraction: at first, whenever the certain non-actual thing was mentioned, a series of all pictures pertaining to it rushed through her experience. It took her decades to invent a way of dealing with this flood of actual memories. Today, she normally just chooses a couple of the last (or most prominent) images, as described in the ‘butterfly’ example, using it as a sort of representation of the whole class.

Still, she is unfamiliar with the experience of concept as something containing information about all the members. Her way of forming a concept is to sort the many specific photo-realistic pictures she has stored in her memory into categories. To form concepts “I sort pictures into categories similar to computer files. To form the concept of orange, I see many different orange objects, such as oranges, pumpkins, orange juice and marmalade” [22].

“When I was a child, I categorized dogs from cats by sorting the animals by size. All the dogs in our neighbourhood were large until our neighbours got a Dachshund. I remember looking at the small dog and trying to figure out why she was not a cat. I had to find a visual feature that she shared with big dogs. I had to create a new category in my mind to differentiate. All dogs, no matter how big or small, have the same nose shape. My concept is sensory based, not word based. Other ways of sensory-based categorization would be sound (barking or meowing) or smell.” [22].

THE ENCOUNTER OF FIRST- AND THIRD-PERSON PERSPECTIVES

It is not the aim of this article to explore visual thinking in further detail. I hope this short overview managed to point at the vast and mostly unexplored territory of human experience. It appears that some of the assumptions about human experience that most cognitive scientists (as well as philosophers) have been taking for granted, will have to be re-evaluated. One of them being the supposition that the smoothly coordinated dance of human communication means that the actors are sharing not only behaviour but also experiences.

Instead with the conclusion, let me finish with some interesting questions that arise from this observation.

From the afore-mentioned example, it seems quite likely that there are different types of thinkers. All the phenomenological research on the subject shows that individual experiences of the phenomenon called thinking might differ dramatically and profoundly.

Assuming that there are certain cognitive processes that are experienced differently (i.e. are not phenomenologicaly intersubjective) the question arises: do they therefore produce different patterns of neuronal activities? In other words: do they have different physiological correlates?

Let us assume that we would be able to identify a number of groups of subjects that experience the same cognitive phenomenon distinctly different. Would they – performing the same cognitive task – exhibit different patterns of neuronal activation? If that assumption is correct, then we would have to change our ways of research in cognitive neuroscience. This would mean, for example, that experiments would have to start with a phenomenological scan of the involved subjects, determining whether the person in question is i.e. a type A or a type B thinker ...

But the real epistemological problem would arise in the alternative case – if people with clearly different experiences would produce same patterns of neuronal activations. Such results would endanger our very basic assumption: that neural dynamics correlates to experience.

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MIŠLJENJE O ISKUSTVU, ISKUSTVO MIŠLJENJA

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SAŽETAK

Rad ukratko opisuje relativno mladu disciplinu kognitivne znanosti posvećene istraživanju iskustva živih ljudi – fenomenološki uvid (ili istraživanje prvog lica). Pobrojani su razlozi obnovljenog interesa za proučavanje iskustva i naznačene relacije te discipline s ostalom kognitivnom znanosti. Služeći se primjerom (fenomenologija mišljenja), članak nastoji ilustrirati značenje sustavnog proučavanja iskustva i postaviti neka pitanja koja izviru iz takvog poduhvata.

KLJUČNE RIJEČI

fenomenološki uvid, perspektiva prvog lica, iskustvo, misli

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USER EXPERIENCE RESEARCH: MODELLING AND DESCRIBING THE SUBJECTIVE

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ABSTRACT

User experience research in the field of human-computer interaction tries to understand how humans experience the interaction with technological artefacts. It is a young and still emerging field that exists in an area of tension. There is no consensus on how the concept of user experience should be defined or on how it should be researched. This paper focuses on two major strands of research in the field that are competing. It tries to give an overview over both and relate them to each other.

Both start from the same premise: usability (focusing on performance) is not enough. It is only part of the interaction with technological artefacts. And further: user experience is not very different from experience in general. Then they develop quite different accounts of the concept. While one focuses more on uncovering the objective in the subjective, on the precise and the formal, the other one stresses the ambiguous, the human and suggests to live with the subjectivity that is inherent in the concept of (user) experience. One focuses more on evaluation rather than design and the other more on design than evaluation. One is a model and the other one more a framework of thought.

Both can be criticised. The model can be questioned in terms of validity and the results of the other approach do not easily generalize across contexts – the reliability can be questioned. Sometimes the need for a unified view in user experience research is emphasized. While I doubt the possibility of a unified view I think it is possible to combine the two approaches. This combination has only rarely been attempted and not been critically reflected.

KEY WORDS

human computer interaction, user experience, method comparison, overview

CLASSIFICATION

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INTRODUCTION

User experience (UX) research in the field of Human-Computer Interaction (HCI) tries to understand how humans experience the interaction with technological artefacts (e.g. computers, mobile phones, cameras, etc.). UX research is quite young, at most twenty years old, and moving and evolving rapidly. Therefore, most concepts including UX are not clearly defined nor agreed upon. HCI is an interdisciplinary field and benefits heavily from different views towards the problem. On the downside all the different backgrounds and vocabularies do not make progress easier.

While the lack of a unique definition for UX has sometimes been seen as deficiency [1] it enables us here to take a closer look at different views towards UX and their differences and commonalities. Let us start with a look at the past and see where the concept of UX comes from.

USABILITY – WHERE IT BEGINS

For the roots of UX we have to look at *usability*. It is a connected concept and some see it as enclosing UX while others say it is being enclosed by UX [2]. What looks like an unimportant subtlety reveals quite large differences in theoretical grounding when watching closely. ISO 9241-210 defines usability as the

> extent to which a system, product or service can be used by specified users to *achieve specified goals* with *effectiveness*, *efficiency* and *satisfaction* in a specified context of use [3; p.7] (emphasis by M. Glanznig).

I call this *Engineer's definition*. It emphasizes goal achievement and contains quantitatively measurable behavioural variables, with one exception: satisfaction. While effectiveness and efficiency are measured with error rates and task completion times satisfaction is approached with thinking aloud techniques and questionnaires. In usability engineering satisfaction was, with some exceptions, traditionally seen as a mere add-on, a nice-to-have feature, possibly because it was more difficult to measure.

Largely neglecting satisfaction became more and more unsatisfactory over time, because use of technology changed. Computers moved out of the workplace and entered the homes. Leisure usage (e.g. multimedia, games) became more important. Recently, ubiquitous computing (e.g. smartphones) added to this progress. All this contributed to a shift of focus from efficiency to satisfaction, which in turn caused the emergence of user experience as distinct concept [4, 5, 6]. Some have seen the emergence of UX as "old wine in new bottles", which in my opinion overemphasizes the utility of the satisfaction part of usability and underestimates the shift of focus that has occurred.

If we look at the definition of user experience in ISO 9241-210 we find the following:

> A person's perceptions and responses that result from the use or anticipated use of a product, system or service. [3; p.7]

While this gives us a general idea it is very vague, which continues throughout the document. The contribution of UX towards (perceived) product quality is recognized, but details are missing. For me the Engineer's definition is the old way, but this should not render usability irrelevant. It is an important, established and quite easily testable concept, which just does not tell us much about satisfaction or even experience of technology interaction. For that reason it is important that UX and usability are not being confused, which sometimes happens. Some people talk about UX but essentially mean usability, which contributed to the buzzword character of UX.

DIFFERENT VIEWS ON USER EXPERIENCE

Even when we are clear about the name of the concept there are different views on it. In UX research there is currently a vivid discussion in progress how the phenomenon should be researched. At least two movements are competing and are viewed by their proponents to be more or less opposing [2]. Sometimes the need for a unified view is expressed [2, 7, 8]. At first sight this might be beneficial, because the field would seem less confusing and efforts could be bundled. On the other hand the field would loose some of its diversity. For me the question remains open if such unified view would be possible or even desirable. To illustrate the two competing approaches let us now move to two other definitions of UX. They are by authors that assume a key position in the discussion about the direction of UX research.

> An experience is an episode, a chunk of time that one went through-with sights and sounds, feelings and thoughts, motives and actions; they are closely knitted together, **stored** in memory, **labelled**, **relived** and **communicated** to others. An experience is a **story**, emerging from the **dialogue** of a person with her or his world through **action**. *User Experience* is not much different from experience *per se* [9; p.8] (emphasis in bold by M. Glanznig).

In what I call *Psychologist's Definition* Marc Hassenzahl [9] emphasizes that an experience is a complex construct, which emerges through interacting with the world. User experience is very similar to experience in general.

> For [John] Dewey, experience is constituted by the **relationship between self and object**, where the self is always already engaged and comes to every situation with personal interests and ideologies. ... **action is situated** and creative. ... For [Mikhail] Bakhtin, the unity of felt experience and the meaning made of it are never available *a priori* but must always be accomplished **dialogically**. [10; pp.17-18] (emphasis in bold by M. Glanznig).

In what I call *Humanist's Definition* John McCarthy and Peter Wright [10] place the focus on the holistic nature of an experience and how meaning is made of it. Both definitions use overlapping vocabulary (e.g. dialogue), but they attach different meaning to it. While Hassenzahl stays heavily grounded in psychological research and its methods McCarthy & Wright take a more interpretive and qualitative approach towards user experience. We will come back to the two accounts and their differences and similarities later.

UX RESEARCH & ENGINEERING – THEORY VS. PRACTICE?

When we look at the two latter definitions of user experience and the definitions of usability and UX in ISO 9241-210 we notice that there are quite some differences between the engineer's point of view and that of UX researchers. These differences result in difficulties when engineers and UX researchers talk to each other and also when results of UX research try to influence software or systems engineering. UX researchers criticize engineering for still not looking beyond functionalism: "When the focus of a community is so tightly trained on the functionality of systems and how they can be made more accessible and usable, experience is an outsider concept" [11; p.3], "a product should not longer be seen as simply delivering a bundle of functional features and benefits" [12]. The response then may sound polemic like: "Don't have to know what it is like to be a bat to build a radar reflector" [13]. Both positions seem reasonable. Researchers worked hard to justify the claim "functionality and usability is just not enough" [12] and create what is known as user-centred design [9-11, 14]. In contrast engineering often calls for a pragmatic concept [13] that can be embraced in a cost-effective and easy way.

So far the focus has been more on the problematic relationship between user experience and usability and the debate between UX research and engineering. This enabled us to see the area of tension in which UX research as (still) emerging field finds itself. For an excellent critical analysis of empirical studies in UX that addresses these issues see [5]. For an overview of the history of HCI that also mentions these issues see [6]. Let us now move on to explore the two different strands of UX research we looked at earlier.

MODELLING USER EXPERIENCE

The psychologist Marc Hassenzahl [9] uses James Russell’s account on emotional experience, hierarchical goals and related action theories to develop his own model of user experience. As stated above in his definition he views UX as not being very different from experience as such, the difference being the focus on a specific mediator of experiences (e.g. interactive products). He stays heavily grounded in psychological research and its methods. While he explicitly distinguishes himself from authors such as John McCarthy and Peter Wright [10, 11], who are proponents of a holistic and dialogical, as the author calls it – “phenomenological” [9; p.73], approach, he also hints at a possible extension with such approaches [9; p.74].

A main point of critique towards Hassenzahl’s research is its reductionist nature [14] that sees the user as action/reaction system [11; p.6] while UX being a complex and possibly irreducible construct. In this vein the validity of the model is questioned. The author’s argument against this kind of critique is that his research is not so much a reduction than a necessary categorization and use of well-researched (psychological) models and theories. Additionally, he suspects experiences with technology to be far less unique and variable as the critics might imply [16]. Following psychologist James Russell [15] Hassenzahl views emotional experience as consequence of self-perception and categorization and as construction of a coherent and emergent, albeit complex, narrative in dialogue with the world. The great amount of single aspects that are integrated into an experience let it appear so unique and irreducible. Emotions and experiences may not be fully explainable and predictable from single underlying elements but they are not detached from them [9; p.4].

ESSENTIAL PROPERTIES OF EXPERIENCE

Hassenzahl gives experience the following attributes: subjective, holistic, situated, dynamic and positive (in the sense of worthwhile) [9; pp.9-31]. *Subjective* [9; pp.9-11] means that experience is created and remains in the experientor’s head. Objective values (e.g. task completion time) may be experienced differently (subjectively). However, this gap or mismatch can be described by rules. Therefore it is possible to shape experiences by knowing and using these rules.

Given a hierarchy of goals such as motor-goals, do-goals and be-goals (listed bottom to top), which may be “dialling in numbers”, “making a telephone call” and “feeling related to others”, interaction design traditionally focused only on do-goals and below (see above). The author refers to the necessary extension of HCI with the meaning providing be-goals as *holistic* [9; pp.11-16].

He also acknowledges the *situatedness* [9; pp.16-19] of single experiences – two of them are never alike. Descriptive approaches are therefore at a lost position [9; p.17]. Instead, categorization of experiences enables us to compare reality to prototypes of experiences, which is possible because accounts of particular experiences might differ, but the essence of the experience itself does not. Hassenzahl develops a form of categorization based on needs which he calls experience patterns [9; p.17, p.76]. It has been shown that needs are relatively independent from each other and (positive) experiences are often marked by a particular need [9; p.47]. Experience patterns can be seen as a blueprint of various experiences, a condensed, idealized and optimized version.

Experiences change over time. They are *dynamic* [9; pp.19-27]. Hassenzahl sees an experience as story. It is packaged, interpreted and labelled and is an construction, but not an objective account of the experience. However, he views the actual construction as only happening once and then being remembered unaltered.

In contrast to usability engineering, which focuses on problems and their removal (the difference between a bad and acceptable experience), an experiential approach strives to make an experience *positive* (pleasurable, good) [9; pp.27-31]. “Positive experiences we went through hold more power to increase well-being than any material possession.” [9; p.40]. In this remark Hassenzahl touches upon the shift towards a post-materialistic society, which also partly may explain why experience is emphasized nowadays. He also notes that need satisfaction (as motivation for an experience) is rarely an explicit goal. It is an emergent property.

THE MODEL

Hassenzahl calls his model the hedonic/pragmatic model of user experience [12, 17]. It has two different quality dimensions: *pragmatic* and *hedonic quality*. We already learned about the hierarchy of goals he builds upon: motor-goals, do-goals and be-goals (bottom to top). Pragmatic quality now refers to the product's perceived ability to support the achievement of do-goals (e.g. making a telephone call). Hedonic quality means the product's perceived ability to support the achievement of be-goals (e.g. being related to others). [9; p.49] These dimensions open up a two dimensional space in which a product can be placed with high values on both dimensions being desirable [18]. Pragmatic quality is more focussed on the product, while hedonic quality focuses on the Self [17]. The main assumption of the model is that these dimensions are viewed as unrelated by people. Hassenzahl: “In fact, all studies published so far support this notion.” [9; p.50].

How does usability relate to user experience in this model? Hassenzahl argues that the fulfilment of be-goals is the driver of experience [16]. Usability is more associated to the product and to do-goals. User experience is associated to the Self and be-goals. Lack of usability can be a barrier to the fulfilment of be-goals, but it is in itself not desired [16]. In other words, (good) usability is only a precondition of (good) UX.

Now we have to face the question how the product’s perceived ability to support the achievement of do- and be-goals can be assessed. Here Hassenzahl believes that it is possible to describe and characterize people’s experiences with the help of a questionnaire, which he sees as promising strategy for HCI [9; p.56]. For this purpose the AttrakDiff [18] questionnaire has been developed and validated. It comes in the form of a so-called semantic differential with twenty-one seven-point Likert scaled bipolar items with verbal anchors (e.g. confusing – clear, good – bad, ugly – beautiful etc.) [18]. The questionnaire has three subscales: perceived pragmatic quality (PQ), perceived hedonic quality-stimulation (HQ-S) and perceived hedonic quality-identification (HQ-I).

THE MODEL IN USE

We now leave the theoretical realm of Hassenzahl’s model but kind of stay in the lab to look at some work that has been done with the AttrakDiff questionnaire. We start with two studies by Marc Hassenzahl [19] where the interplay between perceived pragmatic attributes (PQ), hedonic attributes (HQ) and beauty of MP3-player skins has been investigated. Related work on beauty and usability has been done by Tractinsky *et. al.* on ATM layouts [20]. While pragmatic and hedonic attributes are perceived qualities beauty is an evaluative construct. Hassenzahl emphasizes the fact that “perceptions of hedonic or pragmatic attributes can *potentially* lead to a positive evaluation but they must not necessarily do so.” [19; pp.322-323] (emphasis in original).

The results of the first study did not support the clear relation between usability (PQ) and beauty that has been reported by Tractinsky *et. al.* [20]. Comparing ugly and beautiful skins (rated by participants) revealed greatest differences for HQ-I (hedonic quality-identification), followed by HQ-S (hedonic quality-stimulation) and PQ (pragmatic quality). As a major limitation participants in the first study only saw the interfaces, but never interacted with them [19; p.333]. Therefore, in the second study participants also interacted with the product after rating the interface and were allowed to revise their rating after interaction. [19; p.335] Interestingly, pragmatic attributes where affected by experience, but hedonic attributes remained stable in both ratings [19; p.340]. A related study further investigated the constructs beauty and goodness using websites [21].

Another study investigated the influence of usage mode (explorative vs. task-oriented) on perceived quality [22]. The research question was motivated out of the impression that “it is likely that success rates in traditional usability tests are higher than in natural settings.” [22] The participants interacted with an “ultra mobile personal computer” and had either to perform a task-oriented block and then an explorative block or vice versa. Additionally, they could choose between the input modalities touch input or voice control. The results showed that task-oriented settings reduce the experienced identification with the system and the overall attractiveness [22]. Pragmatic quality was strongly correlated to overall attractiveness in both usage modes, which is contradictory to what has been found by Hassenzahl [19; p.323].

DESCRIBING USER EXPERIENCE

The computer scientist Peter Wright and the psychologist John McCarthy [10, 11] use John Dewey's pragmatist philosophy of experience and aesthetics [23] and Mikhail Bakhtin's account of dialogue as grounding to develop their approach towards experience centred design. They see the term “user” in user experience as problematic as it suggests a limited view on a person, like that of a tool user. In their view one has to think of persons holistically: what they do, how they feel about it and how they give meaning to it. People have a past, a present and a future. Their history is part of what defines them as a person, embedded in complex and changing social networks [11; p.63].

The authors therefore suggest taking a more interpretive and qualitative approach towards user experience. They see experience centred design as designing for the richness of human experience [11; p.2]. For them experience centred design is not simply about technology, it is about people's lived and felt experience (their felt life), which is sometimes mediated by technology [11; p.3]. The authors despise any attempts to exploit their concept for business use only: “Experience-centred design must not become exclusively a business strategy” [11; p.9]. McCarthy & Wright also reject the usage of methods as recipes [11; p.90], because they think that research on experience is particularly difficult to express in a procedure. It is “not suited to fixed research designs and procedures” [11; p.83].

In the authors' view an individual is embodied in her lifeworld [11; p.14] and has to make sense of it. This sense making is a highly subjective and introspective process, which is also irreducibly social and is connected to voice and narrative [11; p.19]. In this sense sharing an experience involves a common history, a common ground, something, of which stories can be made. Stories can be seen as edited versions of our lived experience [11; p.20]. Meaning is not inherent in them (and in experience) and cannot be a logical inference of it [11; p.21]. Therefore, separations and reductions (e.g. as in usability engineering and affective computing) oversimplify the lived experience and miss the crucial point [11; p.14]. Also, the user is traditionally seen as subject and the designer as objective gatherer of data, which is problematic. Understanding experience requires involvement and not just observation [11; p.23]. It requires dialogue and not just surveying [11; p.70].

Doing research in experience centred design can be viewed as the construction and reconstruction of stories of people's experiences with technology [11; p.37]. However, stories of experiences come not ready-formed. Instead, they are brought into being in dialogue and emerge between speaker and listener(s) [11; p.39]. Dialogue or dialogism puts the emphasis on the process between communicating people instead of what happens within each of them [11; p.51]. There is also a similar notion in art theory that is named dialogical or relational aesthetics (also compare Dewey's [23] notion of interaction between subject and object in art). The authors believe that new meaning arises through engagement with the other person [11; p.54]. The dialogical approach treats relationships and communication as privileged to understanding experience [11; p.86]. But simply sitting down with people saying, "tell us your story" will not work. That is because people are used to construct scripted and stereotypical accounts of themselves (cf. Jerome Bruner's research on life narratives [24]). The result may be accounts that are carefully tailored to what the person thinks is needed by the researcher. In addition the whole picture also entails much that is not even obvious to the person herself. [11; p.64] Other researchers use similar notions. For example Russell Hurlburt *et. al.* use something they call "expositional interview" for their descriptive experience sampling [25] technique: "We call it the expositional interview to indicate that our intent is to expose (to make known, bring to light) what is hidden from us but present to the subject (though not necessarily, at first, clearly known to the subject either)." [25; p.86].

McCarthy & Wright's work [10] has received some criticism questioning the reliability of their approach. They used [11] to clarify their position, but did not explicitly respond to their critics. Hassenzahl [9, 16] tried to distinguish his own research from McCarthy & Wright's position. He doubts that the immense richness and diversity in experience as suggested by McCarthy & Wright exists in that way. In addition accounts of experiences might differ ("a poet may find beautiful words" [16]), but experience or at least the essence of it does not. At the same time Hassenzahl also acknowledges that a "phenomenological-oriented" approach is better suited to provide a detailed understanding of the people and the context [16].

THREADS OF EXPERIENCE

The authors provide us with some guiding threads to describe experiencing of technology (see e.g. [10; pp.79-104]). These threads should not be understood as fundamental elements or categories. The four threads are: the sensual, the emotional, the compositional and the spatio-temporal [10; p.80].

Trough our sense organs we participate directly in the world around us. The *sensual thread* of experience is about our sensory engagement with our environment, which orients us to the visceral character of experience. Part of this sensory engagement and therefore the interaction is also the body and the physicality of the technology. [10; pp.80-83].

The *emotional thread* refers to value judgements that, according to our needs and desires, make other people and things important to us. Perceiving, thinking, deciding are not the computational processes we might think, instead they are influenced by values, needs, desires and goals. Thus, we do not perceive an objective representation of the world but a unique version that is coloured by our values [10; pp.83-85].

The *compositional thread* refers to relationships between the parts and the whole of an experience (like the relation between elements of a painting and between painting, viewer and setting) [10; pp.87-91].

A *spatio-temporal* component is inherent in all experiences. For example our sense of time might change when we are bored or within an intense experience. Frustrating experiences can transform a space into something confining [10; pp.91-94]. We might first enjoy the vastness of the landscape on a mountaintop and later be frightened by the steepness of a cliff edge on the same mountain.

MAKING SENSE OF EXPERIENCE

McCarthy & Wright emphasize the sense making process of experience that occurs dialogically: “understanding or making sense of an experience occurs in the tension between self and other.” [10; p.73]. In this dialogue the experience is relived and also altered. The produced narratives of experience are selective interpretations that are tailored to a specific audience [10; pp.118-119]. The authors present six processes of sense making with no implication of linear and causal relations between these processes. They are: anticipating, connecting, interpreting, reflecting, appropriating and recounting [10; pp.124-127].

We do not arrive at an experience without expectations. We *anticipate* something. This not only happens prior the experience but also continues later on [10; p.124].

The term *connecting* refers to the immediate, pre-conceptual and pre-linguistic sense of an encountered situation. This may be an apprehension of speed or movement or stillness. It may also mean an immediate sense of tension or a thrill of novelty, a sense of relief or anticipation of something happening [10; p.125].

When *interpreting* an occurring experience we have to discern the narrative structure, the involved agents and action possibilities. We look at what has happened and think about what is likely to happen. This can result in anxiety of not knowing. We may feel disappointment at unmet expectations [10; p.125].

At the same time we interpret an experience we may also *reflect* on it and make judgements about it. We may want to see how we feel about things and if we have reached our goals (if there were any). This is like an inner dialogue that is going on and that helps us to meaningfully recount the experience to others later on [10; p.126].

Appropriating means making the experience our own by relating it to our Self, our personal history and our anticipated future. By putting the experience in the context of a past and a future we create a meaning that is more personal to us [10; p.126].

Recounting involves telling the experience to others or ourselves. It gives us the opportunity to savour it again, place it in the context of other experiences and find new meanings in it [10; p.127].

A TOOLBOX FOR PRACTICE

As already noted McCarthy & Wright think that research on experience is “particularly difficult to express in a procedure” [11; p.83]. And indeed, they don’t offer one. What they are offering is more a framework of thought where certain methods fit into. Namely, methods that “open up dialogue between designers, researchers and participants” [11; p.83]. These methods mostly originate in art practice, in the humanities and in the social sciences. They note that researching experience “requires an individual to develop the sensibilities of a good ethnographic researcher” [11; p.83]. Apart from some “homegrown” methods the authors list some methods from the social sciences: ethnography, interviewing, diary studies, focus groups, repertory grids and card sorting.

There are a variety of other methods for design or evaluation (see [26] for a more detailed overview) that can be used. Quite well known are Gaver *et. al.*'s *cultural probes* [27], where participants are given probe packages to provoke inspirational responses from them. Another popular method is Buchenau & Suri's *experience prototyping* [28] that builds upon the "experience it yourself" stance. McCarthy & Wright do not mention it, but it certainly fits here: the already mentioned *descriptive experience sampling* (DES) [25] by Hurlburt *et. al.*, where participant's experiences are randomly sampled and later on it is tried to uncover the essence of the sampled experiences through interviews. Not that different to DES is Kahneman *et. al.*'s *day reconstruction method* [29]. Here participants systematically reconstruct their activities and experiences of the preceding day while trying to minimize recall biases. The *fictional inquiry technique* [30] by Dindler & Iversen tries to create partially fictional settings and artefacts through a shared narrative. This should provide a space for collaborative design activities and help participants imagine desirable futures. Blythe & Wright use fiction as a resource in their *pastiche scenarios* [31] method to write character-based scenarios. They re-use existing (well-known) characters from fiction to recruit "a pre-existing rich understanding of the character-users and the use context" [31]. Bertelsen & Pold draw upon aesthetics and literary or art criticism to advance their *interface criticism* [32] technique. Swallow *et. al.* [33] developed techniques such as *persona matching*, where participants are recruited according to predefined personas and *"Do something"-challenges*. Here participants were able to select some emotional adjectives from a list and then carry out activities with the artefact they found to be representative with these descriptions (e.g. Do something funny / sexy / surprising … with your mobile phone.).

Let us now look at how to analyse the data. The above-mentioned methods mostly produce qualitative data so the researcher ends up with field notes or some transcript. This data could then be analysed with e.g. Grounded Theory, Content Analysis, Narrative Analysis etc. Whatever method is used, it should be able to capture the holistic and dialogical qualities of experience [11; p.85]. McCarthy & Wright stress the point that, when analysing the data, one has to bear in mind that design implications cannot be inferred without any creative or imaginative intervention of the person doing it. It is not possible to do it in a logical deductive manner. It is more like seeing a situation from different perspectives. Theories can serve as a guiding filter and a resource for dialogue but one should avoid the finalizing tendencies of approaches that assume that there is one correct theory or one possible best solution [11; p.67].

UNIFIED VIEW OR COMBINED APPROACH?

Both accounts that have been described so far start from the same premise: usability (focusing on performance) is not enough. It is only part of the interaction with technological artefacts. And further: user experience is not very different from experience in general. Admittedly, this is not so difficult to agree on if we ignore the debate between engineering and user experience research for a moment. Then they develop quite different approaches. While Marc Hassenzahl [9, 12, 16, 17]. focuses more on uncovering the objective in the subjective, on the precise and the formal, John McCarthy & Peter Wright [10, 11] stress the ambiguous, the human and suggest to live with the subjectivity that is inherent in the concept of (user) experience. Hassenzahl's model is more product-centred [12] and focuses more on evaluation rather than design. On the other hand McCarthy & Wright's approach is more a framework of thought that focuses on the human and more on design rather than evaluation.

In the beginning we have learned that some emphasize the need for a unified view [2, 7, 8] in user experience research. I doubt that it is possible to unify both approaches, because they build upon different epistemological foundations. These foundations are subject to intense debate. For example, Cockton expresses his displeasure on determinism in computer science: “Objectivity is preferred over subjectivity, precision over looseness, automation over human agency, and formality over ambiguity.” [6]. While I agree with his concerns others might as well citicise this subjectivity, looseness and ambiguity as unscientificial. It is all a matter of worldview and worldviews change very slowly (in whatever direction). If we now leave ideology aside, what is left? We have two approaches that try to investigate the same concept and focus on slightly different aspects. Both can be criticised. Hassenzahl’s work can be criticised in terms of how valid his model is. On the other hand, McCarthy & Wright’s approach can be criticised in terms of reliability because the results do not easily generalize across different contexts. While I doubt the possibility of a unified view I think it is possible to combine the two approaches. This is also acknowledged by Hassenzahl [9; p.74, 16]. However, in his view this combination takes the form of an extension of his own method.

Bargas-Avila & Hornbæk criticise in an analysis of empirical studies of UX that “some studies overemphasize their methodological stance to the extent of damaging research quality” and that only few studies try to combine what they call “uniqueness studies” (like McCarthy & Wright) and “dimension studies” (like Hassenzahl) [5]. One of these few is Karapanos *et. al.*’s study [34] that investigates the temporality of user experience (i.e. its development over time) with iPhone users. They used the day reconstruction method to capture “rich qualitative accounts” of experience. Participants were asked to pick the three most impactful experiences of one day and write a small story about it, which the authors call experience narration. For each narration participants rated the product using a shortened version of the AttrakDiff questionnaire. The collected experience narratives were analysed using a conventional qualitative content analysis and different phases of product adoption were identifyed. These phases were then related to the overall perceived quality of the product using the results of the questionnaire.

CONCLUSION

User experience research is a young and still emerging field that exists in an area of tension. There is no consensus on how the concept of user experience should be defined or on how it should be researched. The two major strands of research that are competing are quite different. One focuses more on uncovering the objective in the subjective, on the precise and the formal, while the other one stresses the ambiguous, the human and suggests to live with the subjectivity that is inherent in the concept of (user) experience. One focuses more on evaluation rather than design and the other more on design than evaluation. One is a model and the other one more a framework of thought not to say a philosophy. Both can be criticised. The model can be questioned in terms of validity and the results of the other approach do not easily generalize across contexts – the reliability can be questioned. While sometimes a unified view in user experience research is emphasized as desirable I think that it is not possible to unify both approaches, because they build upon different epistemological foundations. However, a combination of both approaches should be possible and this has actually already been done (e.g. [34]).

What is lacking so far is reflecting on how well this combination of approaches works in practice and what kind of data are more helpful for which questions and for which stakeholders. Methodological comparisons are rare. As Bargas-Avila & Hornbæk note: “New methods are merely used without comparison to other methods, or the comparisons are weak. We see much opportunity here to improve our understanding of the relative merits of methods aimed at assessing or evaluating UX." [5]. I plan to address this methodological comparison in further research with a study that evaluates the user experience of a product with both approaches and compares results.

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ISTRAŽIVANJA ISKUSTVA KORISNIKA: MODELIRANJE I OPIS SUBJEKTIVNOGA

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SAŽETAK

Istraživanja iskustva korisnika, u području međudjelovanja ljudi i računala, nastoji razumjeti kako ljudi doživljavaju međudjelovanje s tehnološkim artefaktima. To je novo, još izviruće područje koje prate unutarnje napetosti. Nema konsenzusa oko toga kako definirati i istraživati koncept iskustva korisnika. Ovaj članak fokusira se na dva glavna pristupa istraživanju. Nastoji dati pregled oba pristupa i međusobno ih povezati.

Polazište oba pristupa je isto: korisnost (uz fokusiranje na karakteristike) nije dostatna. To je samo dio međudjelovanja s tehnološkim artefaktima. Nadalje, iskustvo korisnika nije bitno različito od iskustva općenito. Nakon toga, u pristupima se razvijaju bitno različiti koncepti. Dok se jedan fokusira na razotkrivanju objektivnoga u subjektivnome, na preciznosti i formalnosti, drugi naglašava višeznačnost, ljudski pristup i predlaže uključivanje subjektivnosti koja je inherentna konceptu isksutva (korisnika). Jedan se pristup fokusira više na evaluaciju nego dizajn, a drugi više ne dizajn nego na evaluaciju. Jedan pristup je model a drugi više okvir razmišljanja.

Oba pristupa može se kritizirati. Model se može preispitati sa stajališta valjanosti dok rezultate drugog pristupa nije jednostavno generalizirati po konceptima – pa mu je pouzdanost upitna. Ponekad je naglašena potreba za unificiranjem gledišta u istraživanju iskustva korisnika. Iako sumnjam u mogućnost unificiranja tih pristupa smatram kako ih je moguće povezati. Njihovo je kombiniranje rijetko pokušavano te nije bilo kritički razmotreno.

KLJUČNE RIJEČI

međudjelovanje čovjeka i računala, iskustvo korisnika, metoda usporedbe, pregled

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SEMANTICS OF DISTINGUISHING CRITERIA: FROM SUBJECTIVE TO INTERSUBJECTIVE

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ABSTRACT

In this article we are aiming to build cognitive semantics over a first person perspective. Our goal is to specify meanings connected to cognitive agents, rooted in their experience and separable from language, covering a wide spectrum of cognitions ranging from living organisms (animals, pre-verbal children and adult humans) to artificial agents and that the cognitive semantics covers a broad, continuous, spectrum of meanings.

As regards the used method, the first person perspective enables a kind of grounding of meanings in cognitions. An ability of cognitive agents to distinguish is a starting point of our approach, distinguishing criteria and schemata are the basic semantic constructs.

The resulting construction is based on a projection of the environment into a cluster of current percepts and a similarity function on percepts. Situation schemata, more sophisticated similarity functions, event schemata and distinguishing criteria are built over that basis. Inference rules and action rules are components of our semantics.

An interesting property of the proposed semantics is that it makes possible coexistence of subjective and intersubjective meanings. Subjective (first person perspective) meanings are primary, and we have shown the way from them to collectively accepted (third person perspective) meanings via observable behaviour and feedback about success/failure of actions. An abductive reasoning is an important tool on that way. A construct of an instrument, which represents a measure for using intersubjective meanings, is introduced. The instrument serves as a tool for an inclusion of sophisticated meanings, e.g. of scientific constructs, into our framework.

KEY WORDS

meaning, cognitive semantics, situated agent, schema, distinguishing criterion

CLASSIFICATION

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INTRODUCTION

BACKGROUND

This article focuses on meanings. Traditional semantic theories almost exclusively dealt with meanings of linguistic expressions. Elements of language were either mapped to sets of objects and relations in the world (in extensional semantics, e.g. [1]) or to mappings from possible worlds to sets of objects and relations (in intensional semantics, e.g. [2, 3]). In any case, meanings were seen as something objectively existing regardless of any interpreting subjects. This so called *objectivist* approach has been criticized by Lakoff [1] [4] who proposed an alternative called *experientialist* approach. Within this approach, meanings are rooted in experience of physically embodied[2] beings, and this experience is richly structured even before language and independently of it. Lakoff's book has started an entirely new research program called cognitive semantics that no longer places meanings in the outside world. Meanings are mental entities and are conceptualized by *image schemas* and *idealized cognitive models* [4], geometrical or topological structures in so called *conceptual space* [5], or *force dynamics patterns* [6]. Relation of meanings to language, especially grammar, has been further elaborated e.g. in [7-10].

Cognitive semantics in its various forms has been around for about 25 years; still it has not given a satisfactory account of many issues. It has been criticized for absence of a satisfactory account of semantics of verbs and sentences/propositions and no theoretical account of how the proposed conceptual structures can be constructed; the proposed structures were intuitively plausible only for a small subset of basic cases and solutions for more complex cases were often described vaguely and in an ad-hoc manner [11, Ch.2]. In the next two sections we will specify problems that we try to address in this article and a quick view on their proposed solution. After that, more thorough motivation is given.

PROBLEM

Although cognitive semantics theoretically claims that meanings are "in the heads" of cognitive agents, they are almost exclusively studied and defined as if viewed from outside by an independent observer (from the third person perspective). Definitions used presuppose a common understanding of terms, which is often taken for granted. Also, it is quite modern to literally "look into the head" and search for neural correlates of meanings, e.g. [12, 13]. While we believe that such approach is certainly useful, in this article we want to forget about the brain and take more phenomenological stance. An open problem is to ground meanings by the first person perspective and subsequently to build an integrated theory of meaning over that basis.

This basic problem generates a series of other problems. We find as interesting to describe how it is possible to integrate purely subjective meanings with intersubjective meanings, meanings accepted by a society, meanings assigned to abstractions created in terms of a language and/or corresponding in a way to an external environment (and how those meanings may coexist).

PROPOSED SOLUTION

We propose a solution based on an ability of cognitive agents (and more generally, an ability of living organisms and their parts) to distinguish. This ability is demonstrated also as a selection/construction of a schematic view on a complex chunk of percepts (or more abstract entities). Our basic semantic constructs are schemata and distinguishing criteria, abstractions of the ability to distinguish. A background idea behind is an assumption that some meanings may be independent of (or even prior to) a language.

Similarly, we view and construct the world of meanings as a continuous one, containing a broad spectrum of meanings, from those which can be ascribed to animals or preverbal infants on one side to meanings, assigned to a language with a rich syntactic structure on the other hand.

This approach to cognitive semantics was first proposed in [14]. Distinguishing criteria conceived as functions were defined as abstraction of the ability to distinguish. Basic types of criteria of objects, classes, properties, relations, situations, changes, and plans were proposed, together with the way from pre-verbal biological roots through semantics of two-word language to language with full syntax and reasoning. The theory was further enhanced with more elaborated situation criteria [15] and short term (focus, situation, problem, event) and long-term (situation/event types, situation/action rules) distinguishing criteria [16]. The article [16] also analysed a case study of animal behaviour [17] in terms of the semantics of distinguishing criteria. In [18] we described a computational implementation of the framework focusing on autonomous construction of distinguishing criteria in interactions with the environment. In [19] we further elaborated the semantics of events and implemented it in a computational model.

The semantic framework of distinguishing criteria has been developing for ten years. So far we and our students have produced 28 articles, eight master theses and one dissertation thesis elaborating various aspects of the theory and simulating its partial computational models. However, much of our work was only published in Slovak, hence inaccessible to the wider audience. This article intends to be comprehensive, but the theory presented here is substantially refined and different from our previous work. We will return to their comparison in Conclusions.

MOTIVATION

Let us motivate the first person perspective on meanings in more detail. A paradigmatic stance of science towards objects of research is to remove all marks of subjective points of view, to be looking on those objects as independent of the opinion of a researcher. Objects of a scientific research can be viewed metaphorically as the third persons. Also meanings, according to that attitude, are usually objects of research, independent of a researcher – they should be viewed as “It”.

Our approach to cognitive semantics is based on another stance: we start from subjective meanings (meanings adopted by an animal, by a preverbal infant, by me etc.). Hence, we start from the first person perspective and on that basis we try to reconstruct intersubjective meanings – meanings common to more agents and also meanings which may be understood as objective entities, metaphorically located in the realm of ideas.

We believe that such construction could be fruitful for cognitive semantics: the first person perspective enables a kind of grounding (embodiment) of meanings in cognitions of agents and the reconstruction of intersubjective meanings on the basis of subjective meanings completes the picture. Actually, there are many roles of meanings, from understanding of a local environment of an agent to mutual communication of ideas in a society or to an exactly verified view on the world.

Now a more detailed motivation for our basic semantic constructs follows. Our goal is to propose a semantic framework joining (integrating) all meanings, from purely subjective ones to intersubjective meanings, supported by a somehow codified status.

The central building blocks of the framework – semantic constructs called distinguishing criteria and schemata, cover a broad spectrum of meanings – from meanings which can help us to explain behaviour of animals to semantics of languages with rich syntactic structure. The framework enables coexistence of subjective and intersubjective meanings, understanding of different, but mutually close, subjective meanings and a characterization of a development of intersubjective meanings on the basis of subjective meanings.

This ambition is based on a belief that there are no strict boundaries between living organisms and capabilities of living organisms evolved continuously in the nature. There is also a continuum of cognitive capabilities in the nature; those capabilities are implemented through cognitive processes, their results can be considered as meanings and, finally and consequently, the world of meanings is continuous, without strict boundaries. This world is inhabited by subjective meanings of cognitive agents on initial stages of their mental development (imagine a little child which denotes also pigeons by the word "dog"), by meanings evolved from those initial ones, by meanings of expressions of languages with different levels of complexity, by meanings acquired in times of the elementary school etc. New strata of meanings are placed permanently over the previous ones. This continuous world of meanings reaches up to meanings of scientific theories.

Meanings assigned to animal cognition deserve an additional explanation. The analysis of animal behaviour leads to conclusions that animals are able to reason and that they have knowledge about the external world [16]. They observe results of their own actions or of actions of other agents. They distinguish success or failure of actions and learn on the basis of such observations. It can be said that they understand relevant features of the environment. This understanding can be described in terms of meanings.

Even a stronger and more general claim is justifiable. We do not assume that meanings are assigned only to language expressions. To the contrary, meanings are prior, in a sense, to language expressions. An acquisition (and also a development) of a language is possible only if some meanings are sooner acquired by the future users of the language. A little child is able to use a word correctly, to acquire a meaning of a word only after it is able to recognize, to distinguish the corresponding referent or situation in the environment[3]. Similarly, animals are able to recognize, to distinguish some important objects, their properties, situations in the environment without a use of a (human-like natural) language [17]. As a consequence, we believe that an understanding of a stratum of some language expressions is possible only on the basis of some experience with meanings of some more elementary strata of the language. This also holds for understanding of abstract expressions. In that case an experience with abstract objects is required, e.g. we can understand the notion of the (mathematical) derivative only after some (computational and conceptual) experience with the notion of the limit of a function.

BASIC FEATURES OF OUR SEMANTICS

We emphasize cognitive nature of meanings. Objects of the real world, their properties, classes of objects etc. are traditionally considered as meanings. Meanings in our semantics are embodied in a sense – they are connected to cognitions (cognitive agents[4]), and they are our abstractions of capabilities of cognitive agents. Two important points should be explained in the context of the previous sentence. Meanings are constructed by cognitive agents (i.e., our position is constructivist [20]): if an agent distinguishes something and a meaning is identified with the ability to distinguish, then the meaning is a product of the agent. On the other hand – meanings are not reducible to mental or neural processes. Cognitions are connected to the external environment. Contents of cognitions are dependent on the state of the external world (this can be denoted as an externalist position). However, when we speak about this relation between cognitive agents and the external world, we locate meanings on the side of the agents. We are not interested in meanings which could exist without agents. This is the reason why our semantics could be considered as cognitive semantics.

In this article, we are not going to enter debates about true ontological status of meanings;

rather we conceptualize them by constructs which enable to explain some observable features of the behaviour of cognitive agents.

We sum up and motivate some important properties of our semantics. A satisfaction of those properties is important, if we want to build a realistic account of meanings used by cognitive agents.

1) First, we emphasize an *evolutive* nature of meanings. The experience of cognitive agents leads to some updates or revisions of their beliefs and notions. Notice that beliefs are in our approach meanings - we do not identify beliefs of agents with a knowledge base in a form of sentences of a language, but we view them as a cluster of meanings. Also extensions of knowledge bases and of the conceptual apparatus of an agent should be considered as an evolution of meanings because of mutual dependencies of pieces of beliefs and of concepts.
2) Further, an *approximate* nature of meanings should be taken into account. Meanings (most importantly, beliefs and also meanings of sentences) are constructions of the agents. Our opinion is that those constructions could be, and often are, improved, précised. The evolutive and approximate natures of meanings are two sides of the same coin. The second one stresses impreciseness of meanings, the first one their development in time, which may sometimes lead to more precise meanings.
3) *Fluent* nature of meanings is something different from both features mentioned above. The world of meanings contains many examples of similar meanings with small continuous differences.
4) Usually, meanings are treated as independent of knowledge. It is argued that knowledge is composed of words and their meaning is given. We believe that *meanings are tightly connected to knowledge*. Recall our opinion that knowledge bases of cognitive agents are constructed of meanings, not of words. When a knowledge base is built, a set of meanings is built. What is important, meanings of words are acquired, modified, made more precise in the context of the knowledge base. If we want to express something more subtle, words are selected in a stepwise way, their meaning is fluently changed and accommodated in order to reach a satisfiable final or preliminary expression of our evolving idea.
5) Similarly, meanings are tightly connected to reasoning. Cognitive agents need to reason, in order to understand and create meanings.
6) Some meanings are dependent on context, viewpoint and temporary focus of a cognitive agent.

To sum up, we are aiming to build the semantics with evolving, approximate and fluent meanings, which are connected to knowledge and reasoning and dependent on a context.

OVERVIEW

The rest of our paper is structured as follows. First, an analysis of intuitions and different connotations of the word *distinguish* and its semantic relatives *discriminate, identify, recognize* is presented. After that, basic ideas and constructs of our semantics are described, explained and defined. We start with a conception of a situated agent ("Me") in an environment. A projection of the environment into a cluster of current percepts and a similarity function on percepts are introduced. Subsequently, situation schemata, representations of percepts, are described together with further important notions – more sophisticated similarity functions, knowledge base, event schemata and distinguishing criterion of change. A current state of "Me" is defined as a six-tuple comprising of its knowledge base, percepts, beliefs, desires, intentions and behaviour in a given time point. The last one is observable from outside; the others can be seen from the first person perspective only. After that, we introduce transformers – distinguishing criteria that express transformations of schemata. Special types of transformers, called constructors, construct detectors – a type of distinguishing criteria which represent common characteristics of categories recognized on schemata by "Me". Another type of transformers – updaters keep track of evolving schemas and distinguishing criteria. Note that with the developing semantic apparatus, further kinds of similarity functions are introduced. We introduce several types of detectors (of individuals, properties etc.). Inference rules and action rules are built over this equipment.

The subsequent part of the paper describes a way from subjective meanings (of "Me") to intersubjective meanings. That part starts with a look on an evaluation of subjective meanings with respect to observations of success or failure of actions. After that, the third person perspective (of an agent "It") is described. Only actions – the behaviour of "It", are observable. Meanings accepted and used by "It", its knowledge base with beliefs, desires and intentions can be hypothetically derived by abduction. A construct of an instrument, which represents a measure for using intersubjective meanings, is introduced. The measure is accepted by a group of agents, it is generally accessible and interpreted in a unique way. A summary of semantic constructs is presented in the Appendix. Conclusions contain a description of main contributions of this paper and a list of open problems and topics for the future research.

DISTINGUISHING

We consider distinguishing a basic cognitive ability of living systems, ranging from primitive forms such as moving toward/from light or following a gradient of concentration of particular chemicals, to distinguishing members of a category from non-members or judging appropriateness of certain behaviour or a linguistic expression in particular social context. Because of this basic ability, some authors postulate elementary cognition on very low evolutionary levels, such as molecules or simple bacteria [21, 22]. Before making distinguishing a core element of our cognitive semantics, we would like to analyse different connotations of the word *distinguish* and its semantic relatives *discriminate, identify, recognize*.

According to the Oxford Dictionaries[5], *distinguish* is a verb meaning to:

1) recognize or treat (someone or something) as different (**distinguishing** *reality* **from** *fantasy*); recognize or point out a difference (**distinguish between** *two kinds of holiday);* be an identifying characteristic or mark of (*what* **distinguishes** *sport* **from** *games?),*
2) manage to discern something barely perceptible (*it was too dark to distinguish anything more than their vague shapes*),
3) **(distinguish oneself)** make oneself worthy of respect by one's behaviour or achievements *(many distinguished themselves in the fight against Hitler*).

While the third sense is unrelated to our analysis, the first two senses refer to recognizing/discerning differences, as well as identifying common characteristics. In the same Oxford Dictionaries, the relevant sense of the word *discriminate* is to "recognize a distinction, differentiate (**discriminate between** *different facial expressions);* perceive or constitute the difference in or between (*features that* **discriminate** *this species* **from** *other gastropods)*".

Definition of relevant senses of *recognize* includes "identify (someone or something) from having encountered them before; know again (*I recognized her when her wig fell off);* identify from knowledge of appearance or character (*Pat is very good at recognizing wild flowers);* (of a computer or other machine) automatically identify and respond correctly to (a sound, printed character, etc.)".

Definition of *identify* includes the sense "establish or indicate who or what (someone or something) is (*the men* **identified** *themselves* **as** *federal police);* recognize or distinguish, especially something considered worthy of attention (*a system that ensures that the pupil's real needs are identified).*

The dictionary definitions are somewhat circular, as the meanings of the words *identify*, *discriminate*, *distinguish* and *recognize* are intertwined; however in the following text we will use the word *recognize* when emphasizing knowing again, the word *discriminate* when emphasizing telling a difference, the word *identify* to establish an identity or a category membership or a state of affairs, a fact, a rule, and the word *distinguish* in a more general sense encompassing all the previous ones. A similar distinction is made in Harnad's seminal paper [23] in a more technical description of processes in a cognitive system: "To be able to discriminate is to be able to judge whether two inputs are the same or different, and, if different, how different they are. Discrimination is a relative judgment, based on our capacity to tell things apart and discern their degree of similarity. To be able to identify is to be able to assign a unique (usually arbitrary) response – a "name" – to a class of inputs, treating them all as equivalent or invariant in some respect. Identification is an absolute judgment, based on our capacity to tell whether or not a given input is a member of a particular category."

According to Harnad, discrimination needs so called *iconic representations* (internal analogue projections on distal objects on our sensory surfaces), while identification needs *categorical representations* (selected invariant features of icons that reliably distinguish a member of a category from non-members). One of us analysed the difference between discrimination and identification in the context of our semantic theory in [18].

In a sense, the ability to identify (e.g. a particular horse as a horse) presupposes the ability to discriminate (tell apart (at least some) horses from non-horses) and also includes recognition (I could hardly identify a horse if I hadn't seen any horses before).

As our ambition is to build a semantic theory, we cannot avoid the term *understand* too. In line with our proclaimed goal, we would be willing to extend its meaning beyond the most usual "understand a word or a linguistic expression" toward understanding situations, events, and the world around us. Moreover our notion of *understanding* or *meanings* should also include animals, preverbal infants, and even artificial agents. In a basic sense, understanding a situation means reacting to it appropriately with respect to one's goals [20]. However, this somewhat behaviouristic definition does not include a case when someone understands something without displaying any overt behaviour. Our ultimate definition of (high-level) understanding is[6] "knowing the truth about something and being able to explain why". Elaborating the concept of truth and intersubjective instruments of knowing within the framework of the proposed semantic theory is one of the novel contributions of this paper.

THE FIRST-PERSON SEMANTICS OF "ME"

The goal of this section is to gradually build semantic constructs as they are seen by the cognitive agent itself. However, on the (meta-) level of presentation, we cannot completely avoid the third-person-type descriptions, as we are hoping to transfer our ideas to the reader in interpersonal communication by words with commonly established meaning. The way from subjective to interpersonally accepted meanings is proposed later in the article.

SITUATED AGENT AND ITS ENVIRONMENT

We already mentioned that our semantic framework is cognitive, i.e. we place the meanings inside the cognitive agents. It also significantly overlaps with pragmatics, in the sense that meanings are related to knowledge, understanding and reasoning of a particular agent. Usefulness/correctness of meanings can be tested by pragmatic criteria in the real world/environment (external to the agent).

Imagine a cognitive agent situated in an environment *Env*. The agent is coupled with its environment via sensing and acting. The environment is dynamic in the sense it can change from moment to moment based on the agent's actions and other factors (external to the agent) including actions of other agents. We will denote a current state of the environment Env_t (where t stands for a time point).

Currently being performed actions of the agent constitute[7] its observable behaviour Beh_t. We assume that the agent has an internal view on itself – its internal state, memories, knowledge, which are not directly observable from outside[8]. This view (called "Me") is described in more detail in the following section. The agent is dynamic too, as its internal state and knowledge are changing in time (shaped by its experience).

PERCEPTS

In any moment, the agent's perception of the environment is mediated via its senses. So, the agent views the environmental state as a collection/cluster of current percepts $P(Env_t)$. In this sense, P is a projection function (projecting the environment into the agent's internal perspective) but also a *selection* function: what exactly is projected is determined by the agent's embodiment and physical limits[9], its past experiences, its current mental state and focus of attention, etc.

However, we do not ascribe to P much of a sense-making; this is applied to $P(Env_t)$ afterwards. $P(Env_t)$ contains rather crude (low-level) percepts forming *iconic representations* in Harnad's sense [23] (see section Distinguishing). Iconic representations allow for *discrimination*, i.e. being able to tell if the things are different/similar, and possibly how different/similar they are. We formalize this subjective discrimination ability by a similarity function sim_d. In the first approximation, sim_d operates on percepts and is able to detect perceptual similarities/differences; later we extend the agent with more sophisticated similarity functions.

SITUATION SCHEMATA

The similarity function enables the agent to recognize common patterns among recurring percepts and gradually extract schematic views of their relations. In people (and probably other embodied agents too), basic schemata[10] arise directly from recurring sensorimotor experience early in development[11] [24] and more complex ones are gradually built on top of these. Cohen et al. [25] describe how different levels of schemata (perceptual redescriptions) can be learned based on detecting statistical contingences among perceptual streams (e.g. inferring a concept of an *object* as time-locked correlations of percepts in different sensory streams – a sort of a multimodal integration; see also [26]). Schemata allow the agent to make sense of its current perceptions by establishing their relation to previous experiences (by recognizing similarity and evoking memories) and, more generally, integrate the new experience within the web of existing knowledge (expressed by schemata). This corresponds to Piagetian process of *assimilation* [24].

In this sense, a sense making act σ (*signification* in [27]) of the agent is a process of constructing or evoking appropriate schemata, given the current percepts $P(Env_t)$. We will denote the result of signification $\sigma(P(Env_t))$ and call it *situation schema*. Unlike percepts that are pure transductions of the external environment, a situation schema is a *representation* with the added value of interpretation of percepts [28]. A situation schema can be formally represented by a labelled graph with percepts in vertices linked by edges expressing their mutual relations. More precisely, only some vertices correspond to percepts; other express inferred constructs. For example, if the agent recognizes percepts in multiple modalities as constituting a single object, the graph will contain a separate vertex for this object, with all its percepts linked to it by edges of an appropriate type. The type/semantics of an edge is represented by its label. The object vertex can further be linked to other schemata in memory, recognized/evoked as similar or related in some aspect to this object (e.g. recognizing this object as my dog). Sometimes a relation is so complex it is best expressed by a schema of its own; in that case, an *n*-ary relation is represented by an $(n + 1)$-ary hyperedge[12] with one vertex serving as a handle/access point to another schema. So we can see that the schema can contain vertices of various types. The type of a vertex is expressed by its label. We allow multiple labels for vertices and edges; these can be interpreted as different views on the same situation. Formally we can organize labels in layers (thus creating a layered graph) or we can see the layers as separate schemata linked together (by establishing similarity/identity relations among the corresponding vertices and edges). Later we will define means for transformations among schemata.

In order to establish a relation to previous experiences, the agent needs to maintain some sort of memory. We will call the agent's long term memory its *knowledge base* KB_t. The knowledge base is a set that includes the agent's remembered situation schemata – a subset[13] of $\{\sigma(P(Env_i)) \mid i < t\}$ (we will gradually extend the definition of KB_t with other constructs). The knowledge base also contains a set of similarity functions (without going to details, we assume that the agent gradually learns to use functions for detecting similarities/differences among schemata, derived from the most elementary sim_d that operates on percepts).

EVENT SCHEMATA

The world around the agent is dynamic; situations change to other situations. A change of one situation to another constitutes an *event*. Being endowed with similarity functions, the agent is able to perceive temporal changes in situations. We describe this ability by a construct of a *distinguishing criterion of change.* We formalize a distinguishing criterion of change as a function defined on pairs of the form $(\sigma(P(Env_{t-1})), \sigma(P(Env_t)))$; if the second one is a result of a change of the first, the assigned value is 1.

The agent represents distinguished events by *event schemata*. An event schema consist of two or more situation schemata linked by (hyper)edges labelled by distinguishing criteria of change. Event schemata can be constructed or evoked from memory (in case of recognition of a similarity to a past event). We will denote the act of event selection ε and its resulting event schema $\varepsilon(\sigma(P(Env_t)), KB_t)$. We will also extend the definition of the knowledge base to include event schemata

$$KB_t := KB_t \cup \{\varepsilon(\sigma(P(Env_i)), KB_i) \mid i < t\}. \qquad (1)$$

CURRENT STATE OF "ME"

So far, the agent's current knowledge base is described as a bag of interlinked schemata of situations and events. However, schemata do not have a uniform status at each moment: some of them describe the interpretation of the current/recent situation/event; others are related or associated to it, yet others are "inactive" at the moment. Some are attended to or focused on, others are not. Moreover, the agent can be in the middle of executing a plan or pursuing a goal. A *goal* of an agent can be expressed as a situation schema of a desired situation. A *problem* or a question can be expressed as a situation schema (perhaps with special vertex/edge labels) too. The agent needs to distinguish what a particular schema represents in a moment – its particular *autoreflexive attitude* toward the schema. In the first approximation, we imagine the autoreflexive attitudes are represented by special labels on (elements of) schemata. Current autoreflexive attitudes temporarily give some of the schemata in the knowledge base a special status. These schemata can be further factorized to a current set of the agent's *beliefs* B_t (schemata of currently perceived situation/event), a set of *desires* D_t (schemata of the agent's needs and long-term goals), a set of *intentions* I_t (schemata of the agent's current goal, a plan to achieve this goal together with a state of its execution, and other agenda-related structures) [14]. A current state of "Me" can be defined as

$$Me_t = (KB_t, P(Env_t), B_t, D_t, I_t, Beh_t), \tag{2}$$

where only the agent's overt behaviour Beh_t is observable from outside; all other structures can only be seen from the first person perspective.

TRANSFORMERS

We have said that situations and events are related in various ways. Initially (while the agent's similarity function does not go much beyond crude holistic "same/different" perceptual similarity judgements), the agent's knowledge base will mostly contain holistic "snapshots" of its experiences (schemata with a few basic labels). Later, when the agent has accumulated sufficient number of exemplars, it can extract their common/invariant features, etc.[15], which results in more complex similarity functions and a richer repertoire of labels. Simpler schemata can be *refined* – transformed to more informed ones by adding new layers of labels, simplified (*zoomed out*) by removing labels, linked to other schemata by *associations,* pruned by attention shift or focusing on a particular detail (*zoomed in*), merged (*abstraction*), etc. [16].

We will formally describe the agent's ability to distinguish (and perform) these (and other) transformations on schemata with a construct of *transformer*. A transformer is a type of distinguishing criterion that expresses transformations of schemata: it has both a declarative aspect (as a description of relations among schemata) and a procedural aspect (as a device that transforms a schema into another schema).

A special type of transformer is called *updater*. The concept of updater expresses the idea of evolutive nature of meanings: If some of the agent's meanings change in time, the agent can keep track of this change by using an updater that will take the schema of the old (original) meaning and connect it to the schema of the new (updated) meaning by a specially labelled edge. The same holds for updates of distinguishing criteria. A schema with a single node labelled by an original distinguishing criterion is linked by a specially labelled edge to another schema with a single node labelled by the new (updated) distinguishing criterion. This mechanism helps to preserve the identity of (evolving) meanings.

DETECTORS

By noticing recurring patterns and similarities, the agent can start grouping together situation and event schemata recognized as similar in some respect (i.e. by some similarity function). These groups of similar exemplars constitute elementary *types of situations/events*. Extracting common features of the exemplars can in turn lead to construction of more sophisticated similarity functions which can be used to factor schemata into categories[16]. Special transformers called *constructors* operate on sets of schemata (exemplars) and construct a new distinguishing criterion representing their common characteristics, called *detector*[17]. Internally, a detector consists of a schema specifying a template with features important for category membership (in some cases more or less abstract representation of a prototypical, salient or most frequent category member) and a similarity function specifying how important the particular features are and how they contribute to the overall similarity. Functionally, a detector can be formalized as a partial[18] function that operates on (fragments of) schemata and returns their degree of membership in the implicitly represented category (either as 0 equals to "no", 1 equals to "yes", or by a fuzzy value from the closed interval [0, 1]).

A detector operates on schemata (or their elements – vertices and edges) and is able to distinguish not only its constituting exemplars, but also generalize to other similar schemata.

Some detectors distinguish *situation types* (e.g. a traffic jam) and *event types* (e.g. a car crash), others distinguish their elements – *objects/individuals* (such as Barack Obama), *classes* of objects (dog, stone, food), *properties* of objects (red, big, hairy), *relations* between/among objects (bigger than, ancestor), *changes* (grow, faint).

INFERENCE AND ACTION RULES

Having defined schemata, transformers and detectors, we can revisit the signification and view it as an iterative process; for example the situation schema of a woman with a dog can initially consist of two unidentified objects (linked with their percepts), perhaps linked together by an unlabelled edge. Fragments of this situation schema will then be recognized by detectors vaguely distinguishing dogs and women. Hence, the object vertices will be appropriately labelled by or linked to the detectors. Another detector can recognize their spatial configuration, so the edge connecting the objects will be given a new label, too.

This can in turn trigger further transformations on the situation schema, depending on the current context (the current state of "me"). The agent can keep track of sequences of transformations typically occurring in certain situations and extract this knowledge in the form of *rules* – schemata connecting *premises* (prerequisites – the rule's applicability conditions represented by distinguishing criteria of situation and event types) to *consequences* (represented either directly by situation and event schemata or indirectly by transformers that can be applied to the current situation/event and construct the resulting one), optionally with *justifications* (situation and event types guarding the evidence that would prevent the application of the rule in case of *default rules*; see [16] for more details). Some rules specify dynamics of internal transformations (so called *inference rules*), others specify the effects of overt actions on the environment (so called *action rules*, see the next section). Rules can be chained together in the form of *plans*, presumably leading to satisfaction of a goal. The agent can keep track of success/failure of a plan in the past. Remembered successful plans are called *routines*.

TOWARDS INTERSUBJECTIVE MEANINGS

MEANING AND BEHAVIOUR

A first important step on the way from purely subjective meanings to intersubjective meanings is described in the following paragraphs.

Assume that a cognitive agent ("Me") equipped with subjective meanings only observes results of its own actions or of actions of other agents. "Me" distinguishes success or failure of actions and learns on the basis of such observations. "Me" evaluates its own behaviour and gets a kind of distinguishing of something what can be regarded as truth.

We will describe how such observations lead to objective meanings, more precisely, how some subjective meanings induce behaviour and how "Me" can assign truth to some schemata.

It was stated in the previous section that some transformers trigger overt behaviour. Actions are represented by complex schemata – action rules. Their consequences are transformers which assign a schema representing a resulting situation to the current situation schema. Those transformers may have for some agents a rather complex structure. They may realize a short-term mental operation – an imagination of the action, a specification or a recall of the required effects of the action and, finally, firing the action. The change specified by the transformer is an expected result of the action and it is expected that the result complies with the specified effects of the action.

Let us describe in more detail how an action rule is selected, fired and how its result is evaluated. "Me" non-deterministically selects some desires (represented in its knowledge base by a distinguishing criterion or a schema), transforms them using some transformers onto intentions and subsequently other transformers are used in order to map intentions onto actions (members of *Beh*).

However, triggering (an attempt to do) an action is essentially a complex trial and error procedure, which comprises learning of prerequisites and effects of the action (operations on situation schemata) and evaluating success/failure of the action. We will describe it in terms of our semantics.

Assume an agent that connects an action rule with a distinguishing criterion of a required change (a goal, a required effect of the action). If the corresponding action was executed, then the premise and consequence of the corresponding action rule may be modified according to the current situation schema and the current change of the situation schema by the action.

If an action should have been executable in a situation (according to the premise of the corresponding action rule), but the attempt to execute it failed, then the agent modifies the premise of the corresponding action rule. There is a variety of possibilities how to modify it [29], but we will not discuss them here.

What is important here, an evaluation of an action rule is based on a comparison of situations (the premise of the rule vs. the situation in which the action was executed; the consequence of the rule and the required effect vs. the real effect of the executed action).

The comparison is described in our semantics in terms of a similarity function. An application of this function, even if it is a subjective distinguishing criterion, enables to evaluate (subjective) meanings with respect to the results of a behaviour in the external environment and to reach a kind of understanding and of an (approximate) truth (or falsity) of prerequisites, effects and action rules, which is dependent on the external environment via the success or failure of observations.

Reasoning capabilities (some transformers, some rules) can be tuned in a similar manner.

A final remark – besides rules of the structure described above, other complex schemata, such as modalities, deontic constructions, more complex generalizations, etc., are also construable on the basis of situation or event schemata. However, we will not discuss them. As regards the truth or falsity point of view, some actions can serve as tests of their (approximate) truth.

We believe that an evaluation of a success or a failure of actions in an environment makes possible a stepwise more precise comparison of subjective meanings and a more precise approximation of truth.

Now, when we are equipped with a notion of an approximate truth, we can proceed to a kind of the third person perspective.

THE THIRD-PERSON PERSPECTIVE

The third-person agent, observable from the viewpoint of "Me" may be represented on the basis of pure observations as $Ag_t = (Beh_t)$. We can – and will – use "It" instead of "Ag".

"Me" considers actions of other agents as events. Suppose that "Me" observes an action of an "It". The current situation and the effect of the action are observable by "Me". On that basis an abduction of action rules of "It" is possible. Similarly for an inference of its *P*(*Env*), *B, D, I*, i.e., *KB*, by "Me". Notice that the results of this inference are not in general identical to subjective meanings of the agent "It" (to emphasize this difference, we mark the inferred structures with the apostrophe (’). We will call them an *external view on subjective meanings*.

Thus, we can specify a derivable third-person agent:

$$It'_t = (KB'_t, P'(Env_t), B'_t, D'_t, I'_t, Beh_t), \tag{3}$$

also indexed by the agent if needed.

In general, an external view on distinguishing criteria and schemata of other agents may be specified in terms of distinguishing criteria and schemata of “Me”. We can say that “Me” creates a “theory of mind” of other agents.

Some similarity functions enable to identify similarity of subjective meanings of one agent in two different time-points, of distinguishing criteria corresponding to different sensual inputs etc. Most importantly, they enable to compare Me’s external views on subjective meanings of two different (third-person) agents. “Me” can also compare its own subjective meanings and its external view on subjective meanings of other agents.

Thus, a relation of a close neighbourhood (or of an approximate identity) of two distinguishing criteria or schemata is created for high values of a similarity function. The approximate identity specifies a chunk of distinguishing criteria or schemata and enables a step from subjective to intersubjective meanings.

OTHER STEPS TOWARDS INTERSUBJECTIVE MEANINGS

In this section a brief survey of some possible conditions leading to intersubjective meanings is given.

Similarity functions and their impact on creating close neighbourhood relations represent our attempt to include autoreflexive reasoning into our semantic constructions. Autoreflexive attitudes were discussed in Section Current state of “Me”. It was noticed that the simpler way how to specify autoreflexive attitudes were labels. Autoreflexive reasoning implemented in terms of similarity functions and close neighbourhood chunks is a more advanced form of autoreflexive attitudes.

In the preceding section we described how this kind of autoreflexive reasoning can enable a transfer from subjective to less or more intersubjective meanings. In general, we consider autoreflexive reasoning an important step towards intersubjective meanings. It is well known that autoreflexive reasoning enables to create hypotheses about the mental states of other agents (a theory of mind) [30].

Consider communication and cooperation of agents (without a language capability). Again, observations of success or failure of some actions fired in a process of communication/cooperation lead to mutual tuning of meanings (rules, situation and event types, distinguishing criteria) [31].

Next, we note that there are physical conditions for acquiring similar meanings, i.e., agents with similar “bodies” (similar anatomic, physiologic and genetic dispositions are determined to have similar subjective meanings, if they live and act in an environment of a common type.

Finally, we mention an exceptionally effective role of a language on the way to intersubjective meanings. A detailed investigation of this topic is one of our future goals, but it should be noted that most of our past works were devoted to the distinguishing criteria semantics in a relation to a language in general (to languages with different levels of complexity) or to a language acquisition (see e.g. [14, 15, 18, 20]).

Our attention is focused on a semantic treatment of verbs and sentences in order to overcome simplifications of logical or linguistic semantics. A way based on schemata of situations and events is proposed. As a consequence, we can characterize a situation based meanings of some sentences without a clear reference to some external objects.

Finally, it should be noticed that a plenty of meanings (distinguishing criteria and schemata) are introduced in terms of a language. We can speak about intersubjectivity modulo vagueness of a natural language.

INSTRUMENTS

In this section a tool is introduced which models an intersubjectivity of meanings beyond the limits of natural language with an inherent vagueness. However, it should be noticed that a natural language has a potential of bootstrapping such levels of intersubjectivity which overcome a common use of the natural language.

We model intersubjective meanings (distinguishing criteria and schemata) in terms of a measure, which is generally accessible, interpretable in a unique way and accepted by a group of agents. We will call it *instrument.*

Some comments are needed. First we focus on the *acceptance by a group* of agents. Dogmata recorded in some texts with an officially codified status and interpretation may be accepted by a group of agents, but not by another group. This is not only the case of dogmata; measurements were instruments verifying truth of geometrical claims for old Egyptian experts in geometry. A proof of geometrical claims was an acceptability instrument for ancient Greeks.

A selection of an instrument may be considered a cognitive *paradigm*. Let us consider Elements by Euclid [32]. We may assume that Euclid believed that his own axiomatization of geometry is an embodiment of a pattern of human thinking, and he chose this pattern as a paradigm for a presentation of the knowledge of geometry.

Second, a general *accessibility* of an instrument is a natural condition – if an instrument should play a role of a tool of intersubjectivity for a group of agents, then an access to the instrument for each member of the group must be guaranteed.

Third, an *interpretation* of an instrument in an *unambiguous* way is an important condition, which requires a deeper analysis.

At least two levels of this condition may be distinguished. An interpretation of the instrument may be based on a *mechanical procedure*, on an *algorithm* as an extreme case, which evaluates the value of the instrument for given inputs. A simple example of such instrument is a multiplication algorithm or a cooking recipe (we will discuss examples in more detail below). However, there is also a less strict possibility. A group of agents is equipped with advanced knowledge and (reasoning) methods, which enable answer questions reliably. Distinguishing of a malign tumour by a histologist is an example of this. In an ideal case, all (good) histologists should diagnose a case of a malign tumour equivocally[19].

Let us proceed to a more formal account of instruments. A function, which represents a distinguishing criterion equipped by an instrument, has an additional argument, which denotes the instrument. The value of the function is computed (determined) according to the instrument. The weight of an object may serve as an example. An example of a distinguishing criterion with a non-algorithmic instrument is an atlas of mushrooms.

Instead of a subjective similarity function and an induced close neighbourhood relation of distinguishing criteria, thanks to instruments we can obtain exact transformations between distinguishing criteria, e.g. from kilograms to pounds.

It is obvious that distinguishing criteria are made more precise by instruments.

Schemata with instruments require a more elaborated description. We start with an example. Imagine a situation type, which represents the multiplication operation on natural numbers. The schema may contain a ternary hyperedge assigning a result to two operands. The role of vertices (operand or result) is specified by a label[20]. In general, labels may specify different roles of vertices connected by a hyperedge in an arbitrary schema. A finite set of correct (true) instances of this schema may be generated by an instrument – a transformer associated with the well-known table.

The infinite set of all true instances may be generated, e.g. by a recursive definition of the multiplication. The table and the recursive definition play the role of instruments in our semantics. Both the table and the recursive definition are parts of the knowledge base. The first one can be represented as a set of hyperedges connecting three vertices labelled by two operands and one result. The second one is discussed as follows. Our goal is to represent the following two equations by a transformer and an associated situation schema:

$$x.0 = 0, \tag{4}$$

$$x.\mathrm{s}(y) = (x.y) + x. \tag{5}$$

The schema may contain two hyperedges: one with two occurrences of vertices labelled by 0 and one occurrence of an unlabelled vertex. This hyperedge corresponds to expression (4) and represents the base case of the recursion. The second hyperedge corresponds to expression (5) and represents the recursive case. It connects an unlabelled vertex (corresponding to x), then a vertex (corresponding to $s(y)$) connected by an edge to the access point of another schema, which assigns a predecessor to a given number, and, finally, the third vertex (result) connected by an edge back to the (access point of the) multiplication schema and by another edge to the access point of an addition schema. The transformer realizes a recursive algorithm for an arbitrary pair of natural numbers and generates a situation schema – a true instance of the schema of the situation type, e.g. an instance that contains a hyperedge with vertices labelled by 2, 3 and 6. For example, the transformer first performs pattern matching that reduces the problem to series of more elementary problems (2.2, 2.1 and 2.0) and finally it halts on the case 2.0 = 0. On the way back, it computes the series of additions (0 + 2 + 2 + 2 = 6).

A decision about a malign tumour by a histologist was mentioned as an example of a non-algorithmic instrument. We can imagine the instrument used by a histologist as a situation schema with a vertex labelled as tumour and a set of edges with target vertices labelled by the relevant histological properties of malign tumours. Some other labels may be assigned to those vertices – they contain a description of the corresponding property in a language. Moreover, some other means of expression may be used: e.g. some properties are optional, some obligatory (this corresponds to a possibility to introduce partial properties which were discussed before). This expressivity may be added by operators labelling the corresponding edges. Sometimes also some (generalized) quantifiers applied to a set of edges might be used: for example, at least m of n properties should be present (general and existential quantifiers are special cases).

To sum-up: A *distinguishing criterion with an instrument* is a function with a parameter that specifies how to compute its value for its arguments. The parameter is called *instrument* and it is a transformer. The transformer is either an algorithm or a conventional, more or less mechanical, procedure based on an expert knowledge. In the latter case, the expert knowledge is expressed by a set of schemata associated with the transformer (as its additional arguments). A schema generated by transformer and a set of associated schemata will be called *schema with an instrument*.

Some final remarks: A precise notion of an identity of meanings can be based on transformers defined on instruments. Sometimes rather subtle tools are needed.

An optional specification of a group of agents can be added as an argument to a distinguishing criterion with an instrument.

A specification of a group of agents in a schema may serve as an example of meta-level features of schemata, e.g. a schema may be connected by an edge labelled e.g. as “owner” to a vertex labelled by an identification of a group of agents.

CONCLUSIONS

MAIN CONTRIBUTIONS

Building on our previous works, we have proposed a semantic framework with meanings connected to cognitive agents, rooted in their experience and separable from language, covering a wide spectrum of cognitions ranging from living organisms (animals, pre-verbal children and adult humans) to artificial agents (softbots, robots, multi-agent systems etc.) In this article, we substantially revised our previous conception of distinguishing criteria (added transformers and constructors), enriched the framework with schemata, knowledge base, belief – desire – intention structures and other constructs (for their full list, see the Appendix).

An interesting property of the proposed semantics is that it enables coexistence of subjective and intersubjective meanings. Subjective (the first person perspective) meanings are primary, and we have shown the way from them to collectively accepted (the third person perspective) meanings via observable behaviour and feedback about success/failure of actions and instruments. We have defined the notion of truth in a similar way. This is a novel and previously unpublished contribution.

OPEN PROBLEMS AND FUTURE RESEARCH

First of all, the proposed semantic framework is in many respects still a blueprint, especially in terms of a proper mathematical formalization. A more detailed, deeper and more precise analysis of the features of our semantics is needed; together with an argumentation that the features are really satisfied and an attempt to argue that those features should be satisfied by each cognitive semantics that aspires to be biologically relevant.

Regarding particulars, construction of more complex schemata as rules, a more detailed re-construction of reaching an approximate truth with subjective meanings and an elaboration of the idea of instrument are necessary.

It is also needed to elaborate details of the relation of the proposed semantic constructs to natural language and particular linguistic constructions, e.g. define semantics of verbs and propositions, and analyse the role of natural language on the way to intersubjective meanings.

We also plan to tell a developmental story in more detail – how can an agent construct/learn schemata and distinguishing criteria from experience. The theory calls for empirical evaluation in terms of analyses of animal behaviour, child development studies and psychological experiments. It should also be supported by computational models and their simulations. Regarding instruments, it would be interesting to come up with particular case studies of methodologies and paradigm shifts in the history of science.

Our future plans further include enhancing schemata and distinguishing criteria with affective values (possibly based on previous success/failure or reinforcement), elaboration of the agent's motivational system, detailed formalization of (non-monotonic) reasoning within this framework, including fast reasoning (jumping to conclusions).

Despite these open issues, we have identified an important research direction and have taken first steps toward more biologically relevant semantic theory. We believe that this theory has a potential to address several current issues in linguistics, logic, cognitive science and philosophy of science, with possible interesting applications in artificial intelligence, adaptive knowledge representation, machine learning and cognitive modeling.

APPENDIX

SUMMARY OF SEMANTIC CONSTRUCTS

Semantic construct	Formalization
Current percepts	$P(Env_t)$ – a function projecting the current state of the environment into a cluster of percepts (low-level iconic representations such as retina image etc., essentially numerical vectors/matrices).
Perceptual similarity function	sim_d – a function operating on percepts; returns their degree of similarity (0 $\Leftrightarrow$ none,1 $\Leftrightarrow$ total, or fuzzy values from [0, 1]).
Schema	A basic meaning-carrying building block of our semantics. A layered labelled hypergraph; both vertices and edges can have multiple layers of labels. Some vertices are percepts, others are inferred constructs; the edges express relations. The labels are distinguishing criteria or autoreflexive attitudes (carrying type information).
Distinguishing criterion	DC – another basic meaning-carrying building block of our semantics, formalized as a function. Types: DC of change, transformers and detectors.
Signification	Sense-making function σ; it maps current percepts onto a situation schema.
Situation schema	$\sigma(P(Env_t))$ – result of signification; it represents the current situation.
Distinguishing criterion of change	A function defined on pairs $(\sigma(P(Env_{t-1})), \sigma(P(Env_t)))$; it returns 1, if the latter is the result of a change of the former.
Event schema	$\varepsilon(\sigma(P(Env_t)), KB_t)$ – two or more situation schemata linked by (hyper)edges labelled by DC of change.
Similarity functions	More sophisticated functions operating on schemata; they return their degree of similarity. We will denote the set of all the agent's current similarity functions as Sim_t.
Knowledge base	KB_t – a set of the agent's past and current situation and event schemata and similarity functions. $KB_t = \{ \sigma(P(Env_i)) \mid i \leq t \} \cup \{ \varepsilon(\sigma(P(Env_i)), KB_i) \mid i \leq t \} \cup Sim_t$
Autoreflexive attitude	A type of vertex/edge label carrying information about their semantic type (e.g. object vertex, schema handle, current goal, active, inactive, "related to" edge, etc.).
Beliefs	B_t – a set of schemata of the agent's currently perceived situation and event(s).
Desires	D_t – a set of schemata of agent's current needs and long-term goals.
Intentions	I_t – a set of schemata of the agent's current goal, a plan to achieve this goal and the state of its execution.

Semantic construct	**Formalization**
Behaviour	Beh_t – the set of the agent's currently performed actions. The behaviour is observable by other agents.
Current state of "Me"	Me_t – the agent's current knowledge base, percepts, beliefs, desires, intentions and behaviour, $Me_t = (KB_t, P(Env_t), B_t, D_t, I_t, Beh_t)$
Transformer	A type of DC; a function that transforms schemata to other schemata, e.g. refine, zoom in/out, abstract, merge, etc.
Constructor	A type of transformer that creates/modifies detectors (usually by inducing common properties of exemplars).
Updater	A special type of transformer that keeps track of changing schemas and DC.
Detector	A type of DC; a function operating on (fragments of) schemata and returning their degree of membership in an implicitly represented category. Internally, it consists of a template schema and a similarity function. Types: individuals, classes, properties, relations, changes, situation types, event types.
Rule	A schema connecting premises (prerequisites expressed as DC of situation/event types) and justifications (situation/event types preventing the rule application) to consequences (transformers of situation/event schemata).
Inference rule	A rule with transformers realizing internal/mental operations such as change of the focus of attention, zooming in/out, etc.
Action rule	A type of a rule associated with an action (overt behaviour); the rule specifies the prerequisites and consequences of the action execution.
Goal	A desired situation - a situation schema labelled with the autoreflexive attitude "goal".
Plan	A chain of rules supposedly leading to the fulfilment of a goal.
Routine	A plan successful in the past.
The other agent – observable "It" in a time point *t*	$It_t = (Beh_t)$ – observed behaviour in a time point t.
Abducible agent "It" (possibly in a time point *t*)	$(KB'_t, P'(Env_t), B'_t, D'_t, I'_t)$ – all components marked with ' are constructed by abduction based on the Me's own knowledge (theory of mind).
Complete view of another agent	$It'_t = (KB'_t, P'(Env_t), B'_t, D'_t, I'_t, Beh_t)$.
Close neighbourhood relation	A relation between distinguishing criteria or schemata determined by high values of a corresponding similarity function.
Distinguishing criterion with an instrument	A function with an instrument parameter; the parameter specifies a transformer able to compute the value of the function.
Schema with an instrument	A schema generated by a transformer (an algorithm or a conventional, rather mechanical procedure, based on an expert knowledge) and a set of associated schemata.

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REMARKS

[1]See also [5] for an analysis of shortcomings of traditional semantic theories.

[2]Meanwhile, so called embodied approach (see e.g. [33-36]) is becoming a dominant paradigm in modern cognitive science.

[3]However, we do not deny the influence of language on further shaping of concepts.

[4]By agent we mean any autonomous entity that achieves some goals in its environment by sensing and acting [37]; this includes virtual/simulated actions in virtual environments, too.

[5]http://oxforddictionaries.com, accessed 8th Aug 2012.

[6]The insight or ability to explain/justify is a measure indicating different levels of understanding on a continuum. If two people come to the same conclusion about something, but only one of them is able to explain why, it is this one whose understanding is better/deeper.

[7]Actions usually do not last an instant but a time interval. In this article we abstract away from temporal issues and simply assume that the same action will (re)appear in the Beh_t set for all t in its time span.

[8]For the moment we put aside the question whether the agent can *consciously* access *all* its knowledge, memories, drives etc. Unconscious aspects of the agent's experiences, embodiment, etc. (if any) co-determining its decisions and behavior can be viewed from the agent's perspective as non-deterministic aspects of its cognitive processes.

[9]See Jacob von Uexkull's convincing description of different *Umwelts* (subjective worlds) of different animals [38].

[10]These so called *image schemata* include basic spatial and topological relations, goal-directed movement etc. [4, 39].

[11]Some basic schemata may be innate.

[12]A hyperedge is an edge connecting more than two vertices. A graph that contains hyperedges is called *hypergraph*.

[13]Some situation schemata may have been forgotten.

[14]See also the BDI architecture of Rao and Georgeff [40].

[15]The research in machine learning and artificial neural networks has yielded many good ideas how to extract knowledge from examples by mostly uninformed statistical calculations [41, 42].

[16]In the past, we have successfully formalized and implemented distinguishing criteria as similarity functions each with their own Mahalanobis metric with parameters induced from statistical characteristics of the exemplars [18].

[17]Constructors can also modify an existing detector when new exemplars arrive.

[18]The function only returns a value for some inputs. It is undefined for others, which can be interpreted as a "don't know" value.

[19]However, in fact this condition is rarely satisfied. With non-algorithmic instruments, there is always a possibility of alternative (mis)interpretations. In our example with a case of malign tumour, all interpretations that misdiagnose a malign tumour as benign are considered incorrect.

[20]Depending on the labels specifying which vertices have numerical values assigned, the same schema can be used for multiplication, division, or checking the truth of the corresponding statement.

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SEMANTIKA IZDVAJAJUĆIH KRITERIJA: OD SUBJEKTIVNOGA DO INTERSUBJEKTIVNOGA

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SAŽETAK

U ovom članku gradimo kognitivnu semantiku iz perspektive prvog lica. Cilj nam je precizirati značenja povezana s kognitivnim agentima, povezana s njihovim iskustvom i razdvojena od jezika, a koja pokrivaju široki spektar kognicija od živih bića (životinja, djece u dobi prije nego počnu govoriti te odraslih ljudi) do umjetnih agenata, te ostvariti kognitivnu semantiku širokog, kontinuiranog spektra.

Perspektiva prvog lica omogućuje utemeljenje značenja u kogniciji. Sposobnost kognitivnih agenata za izdvajanjem polazna je točka našeg pristupa, dok su kriteriji izdvajanja i shema osnovne semantičke konstrukcije.

Zaključna konstrukcija temelji se na projekciji okoline na grozd tekućih percepata i projekciji funkcije sličnosti na percepte. Na taj temelj postavljeni su shema konteksta, sofisticiranije funkcije sličnosti, sheme događaja i kriteriji izdvajanja. Pravila zaključivanja i djelovanja dijelovi su naše semantike.

Zanimljivo svojstvo predložene semantike je to što omogućuje koegzistiranje subjektivnog i intersubjektivnog značenja. Subjektivno (perspektiva prvog lica) značenje je primarno. Pokazali smo put od njega do kolektivno prihvaćenog (perspektiva trećeg lica) značenja pomoću opaženog ponašanja i povratne veze o uspjehu ili neuspjehu djelovanja.

Preuzeto zaključivanje značajno je sredstvo na tom putu. Uvedena je konstrukcija instrumenta koji predstavlja mjeru korištenja intersubjektivnog značenja. Instrument služi kao sredstvo uključivanja sofisticiranih značenja, npr. znanstvenih pristupa, u naš okvir.

KLJUČNE RIJEČI

značenje, kognitivna semantika, agent u kontekstu, shema, izdvajajući kriterij

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USING OF STRUCTURAL EQUATION MODELING TECHNIQUES IN COGNITIVE LEVELS VALIDATION

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ABSTRACT

When constructing knowledge tests, cognitive level is usually one of the dimensions comprising the test specifications with each item assigned to measure a particular level. Recently used taxonomies of the cognitive levels most often represent some modification of the original Bloom's taxonomy. There are many concerns in current literature about existence of predefined cognitive levels. The aim of this article is to investigate can structural equation modeling techniques confirm existence of different cognitive levels. For the purpose of the research, a Croatian final high-school Mathematics exam was used (N = 9626). Confirmatory factor analysis and structural regression modeling were used to test three different models. Structural equation modeling techniques did not support existence of different cognitive levels in this case. There is more than one possible explanation for that finding. Some other techniques that take into account nonlinear behaviour of the items as well as qualitative techniques might be more useful for the purpose of the cognitive levels validation. Furthermore, it seems that cognitive levels were not efficient descriptors of the items and so improvements are needed in describing the cognitive skills measured by items.

KEY WORDS

cognitive levels, structural equation modeling, validity

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INTRODUCTION

One of the most influential taxonomies of educational outcomes based on the levels of cognitive processes is for sure the one proposed by Bloom in 1956. The Bloom's taxonomy (BT) represents a classification of six cognitive processes: knowledge, comprehension, application, analysis, synthesis and evaluation [1]. All categories, except the knowledge, form together the "abilities and skills". The basic assumption is that the categories lie on the continuum which represents a cumulative hierarchical structure [2]. The existence of this framework has several important consequences for the whole system in which the educational process takes place, from the experts who make decisions on the curriculum, to the teachers and students.

The authors of the BT believed that they had created a common framework for the classification of the educational outcomes that can contribute in positive change and development of item writing for the large scale assessments. Hence, they believed that the taxonomy can affect the testing procedures and create new ideas and paradigms within the field of testing. One of the primary goals of the BT was to emphasize that the simple information recognition and recalling are not the only aims of the education. The BT underlined the importance of many different cognitive processes testing rather than asking only for factual knowledge.

Very soon after its origination the BT became very popular and has been highly accepted both among educational scientists and practitioners. Thus, numerous research works aimed to determine all the procedures in which taxonomy can be applied and how to incorporate the taxonomy in the specific educational fields. Researchers also became very interested in investigating whether the BT's proposed hierarchical structure is truly presented in the real tests and is it possible to construct a test that would measure six different levels of cognitive processing. Therefore, the problem of the BT's validity became a serious research issue.

One of the first and most important research among the researches on the BT's validity was definitely the one conducted by Kropp and Stoker in 1966. Many other authors replicated lately their study or used their data in their own studies in which many of them intended to develop new approaches in the BT's validation. Kropp and Stoker [3] constructed four knowledge tests consisted of the six subtests. Each of the subtests was constructed in order to measure one cognitive level proposed by the BT. The tests were administered to the 15 to 17 year old students. In addition to the knowledge tests, a battery of the intelligence tests was delivered. Kropp and Stoker confirmed the cumulative hierarchical structure only for the first four levels. They also found that the correlation between each subtest and the general intelligence factor increases when the cognitive level measured by the subtest is becoming higher.

Madaus, Woods and Nuttal [4] taken over the data gathered by the Kropp and Stoker [3] and used causal modeling methodology in examining the relationship between the results of knowledge tests and the general intelligence factor. They found a letter Y-shaped model where the base is consisted from the first three levels (knowledge, understanding and application). Then, one branch goes from the application to the analysis and the other one from the application to the synthesis and evaluation. They concluded that the obtained Y-shaped model can be identified as the Cattell's model of the fluid and crystallized intelligence where the first branch goes from knowledge to the analysis approximates the crystallized intelligence. The second branch consisted of the synthesis and evaluation could be identified with the fluid intelligence. These results were confirmed in the study conducted by Miller, Snowman and O'Hara in 1979 [5].

Similarly to the results of the previous research, Smith [6] showed in his study that the BT can be divided into two parts. The first four cognitive levels (knowledge, comprehension, application, analysis) go to the first part and the last two categories (synthesis and evaluation) go to the second part. His interpretation was different from those given by Madaus, Woods and Nuttal [4]. Smith linked the two obtained parts of the BT to the intelligence and creativity. He found that the first part correlates only with the intelligence and the second part both with the intelligence and creativity. It is similar to the modern construct of the divergent and convergent production.

The functioning of the cognitive taxonomy within the test specification of an allied health certification examination was studied in the Webb, Kalohn and Cizek's [7] research. The taxonomy used was a simplified BT in which items were classified as comprehension, application and analysis. A factor analysis of responses did not support expected cumulative hierarchical model of the cognitive complexity. The results of the factor analysis suggested unidimensional solution.

Gierl [8] in 1997 conducted an examination to determine whether the BT can provide an accurate model to guide item writers for anticipating the cognitive processes used by students on a large-scale achievement test in Mathematics. Thirty seventh graders were asked to think aloud as they solved items on the Mathematics test. Their responses were classified with a coding system based on the BT. The overall match between the cognitive processes expected by the item writers and those observed from the students was about 54 %. The author concluded that the BT does not provide an accurate model for guiding item writers to anticipate the cognitive processes used by students.

Lipscomb [9] in 2001 compared in his study a six level semantic differential scale using the bipolar terms "simple" and "complex" to the BT for classifying eighteen test questions. The participants were junior college faculty who had participated in one of the two instructional sessions: a BT session or a semantic differential session. The proportion of responses of each group was compared on each of the eighteen questions using the chi square statistic. The result showed that there was no difference between classifying the items according to the BT and to the six level complexity scale. Hence, the study showed that the BT does not represent an improvement over the scale "simple-complex".

Most of the conducted studies pointed out that the construct validity of the Bloom's taxonomy is questionable and that the dimensions could be replaced by simpler concepts such as the complexity of the items [9] or with some model of intelligence such as Cattell's [4]. Despite the lack of evidences that would confirm existence of different cognitive levels in knowledge tests, original or some form of the revised versions of Bloom's taxonomy are used in modern educational systems round the world [10]. Accordingly, abbreviated version of the Bloom's taxonomy consisted of the first three levels became the central model used in development of the state-level tests in Croatian educational system.

Although many theorists suggested discarding the BT as well as the other classification schemes arised from it [11], contemporary researchers [12-13] believe that the taxonomy itself is not so problematic but its use. They strongly recommend using the taxonomies when constructing the items rather than using them as a part of post-hoc item specification procedures which has become customary. Furthermore, they claim that the more complex methodological procedures, can classify the items into cognitive categories more accurately than the traditional single-method approaches.

STRUCTURAL EQUATION MODELING

Since the researches on the validity of the BT were mainly conducted to the mid 90's, methodology of the structural equation modeling (hereinafter: SEM) generally was not used.

Although this methodology dates back to the seventies, the existence of fast and powerful computers was necessary to make it more popular among scientists. As it was described in the introductory part, researchers as Madaus, Woods and Nuttal [4] as well as Miller, Snowman and O'Hara [5] used approaches similar to SEM to test BT validity. Validity researches conducted in the last twenty years have proven usefulness and necessity of SEM for that type of research [14]. Hence, this methodology will be used in this study.

SEM represents a group of methods that are regularly used for representing dependency (arguably "causal") relations in multivariate data in the behavioral and social sciences [15]. Generally, a structural equation model is a complex composite statistical hypothesis. It consists of two main parts: the measurement model represents a set of *p* observable variables as multiple indicators of a smaller set of *m* latent variables, which are usually common factors. The path model describes relations of dependency—usually accepted to be in some sense causal—between the latent variables. The term *structural* model is reserved here for the composite SEM, the combined measurement and path models. SEM provides: testing multivariate hypotheses; testing causal relationships even in the correlation studies (only with a proper research design); testing alternative hypotheses. It allows reducing of number of variables to a simpler model and determination of the mutual effects size between latent and observed variables [14]. Thus, it can be said that SEM represents an analytical framework that unifies several multivariate methods which purpose is to provide meaningful and parsimonious explanations of relationships between a set of variables.

SEM consists of the following six steps: model specification, model identification, construct operationalization, parameter estimation, hypotheses evaluation, and, model respecification [14]. The first step is model specification, which means the representation of the research hypotheses in the form of structural models. This involves drawing a model diagram using a set of more or less standard graphical symbols or writing of series of equations. These equations define the model's parameters, which correspond to presumed relations among observed and/or latent variables that will be estimated with sample data. Regardless of the representation form (graphical model or set of equations), the model must contain clearly defined parameters that indicate the relationships between observed and latent variables. This model serves as a framework for testing the sample data. Model specification is probably the most important step. This is because results from later steps assume that the model is basically correct.

The next step is to identify the model and parameters. The model is identified if there is a theoretical possibility to derive a unique estimate for each parameter of the model. The term parameter refers to a numerical value that describes some aspect of the model in the population [16]. One of the main goals of the SEM is to assess as precise as possible the values of model parameters.

The third step is a selection of measures which will be represented by variables in the model. This step also includes data collection and their screening. This is followed by the next step: analysing the model. The fourth step involves assessing the parameters values and their fit to the collected data. There are many methods used to estimate parameters, but the most usual one is maximum likelihood method (ML). ML estimates all parameters simultaneously. The name "maximum likelihood" describes the statistical principle that takes place during the process of parameters derivation: the estimates are the ones that maximize the likelihood (the continuous generalization) that the data (the observed covariances) were drawn from this population [17]. This method has iterative nature which means that the computer program derives the initial solution and then tries to improve the estimation. The improvement means that the covariance model in each of the next iteration is more similar to the observed covariance.

The penultimate step is the evaluation of the proposed model with the observed data. If it turns out that the fitting is satisfactory, the following actions are interpretation of the parameters and consideration of equivalent of near-equivalent models. Equivalent model explains the data just as well as the proposed model but does so with a different configuration of hypothesized relations among the same variables.

If the proposed model does not fit well to the observed data, respecification and evaluation of the revised model should be done on the same data. As an initial specification, this new research should be guided by hypotheses.

There is a large number of goodness-of-fit indices that can be used when evaluating the model fit. Those indices can be divided into several groups: comparative, absolute, parsimonic, residual indices, and the proportion of variance explained by the model [18]. Therefore, selection of the specific index is not easy. However, high-quality models have desirable measures of fitting regardless of the choice of indicators. If different indicators give conflicting and inconsistent information, it is recommended to reconsider the model. Whatever combination of indices is selected, it should be taken into account several things. First, the values of these indices show an average fitting between models and data. Thus, it may happen that some parts of the model fit poorly with the data even though the overall indicators of fitting have the optimum values. In addition, the goodness-of-fit indices do not say anything about the theoretical meaning and significance of the results [19]. Therefore, even if the indices are satisfactory, theory driven interpretation of the parameters is critical for the model evaluation. And finally, values of goodness-of-fit indices do not say anything about the model predictive power. In conclusion, the model evaluation and testing of its fitting with the collected data is not a binary decision whether the model fits or not, but it is rather a process in which is more appropriate to describe model with the terms such as: reasonable, adequate, satisfactory, etc. with referring to a number of criteria.

OBJECTIVE

When constructing knowledge tests, cognitive level is usually used in the test blueprint to help describe what each item is designed to measure. Recently used taxonomies of the cognitive levels most often represent some modification of the original Bloom's taxonomy. There are many concerns in current literature about existence of predefined cognitive levels. Accordingly, the aim of this article is to investigate do structural equation modeling techniques confirm the existence of different cognitive levels?

It is expected to get three predefined cognitive levels: knowledge, comprehension, and application. That would confirm functionality and purpose of using cognitive levels in the test construction. Otherwise, if it is not possible to find different cognitive levels even if they were used while constructing the items, last few decades of practice using cognitive taxonomies for test construction could be reconsidered.

METHODOLOGY

For the purpose of this research, a Croatian final high-school Mathematics test was used as a central instrument. It was administrated in June 2010 to N = 9626 senior high-school students. The test consisted of 45 items: 15 multiple-choice and 30 open-ended. Some of the items were polytomously scored so the highest possible score on the test was 60 points. Subject-matter specialists who constructed the test classified the items into three categories based on the cognitive level that they supposed to measure: knowledge, comprehension, and application. These categories represent the abbreviated version of the Bloom's six-level hierarchical taxonomy. Hence, the assumption is that the items that measure higher levels require mastering the items that measure lower cognitive levels.

To examine the existence of three-level hierarchical structure, Mathematics test data were analysed by using confirmatory factor analysis (CFA) and structural regression model (SR). Both of these methods can be considered as the SEM techniques. The technique of CFA analyses measurement models in which both the number of factors and their correspondence with the indicators are explicitly specified. Standard CFA models have the following characteristics: (i) each indicator is a continuous variable represented as having two causes - a single factor that the indicator is supposed to measure and all other unique sources of influence (omitted causes) represented by the error term; (ii) the measurement errors are independent of each other and of the factors; (iii) all associations between the factors are unanalysed (the factors are assumed to covary). The assumption under which CFA was conducted was the next: if the cognitive complexity differentiates the test items, then cognitive complexity levels should appear as different factors. Under a similar assumption as [7] conducted an exploratory factor analysis (EFA) in their study with the similar hypothesis. In this study, CFA was used rather than exploratory EFA for several reasons. As it was previously mentioned, analyses the measurement model in which the number of factors and their relationships with indicators are explicitly defined. Therefore, it can be implemented only if the theory that is being tested is well established. Since in this case there is a clear hypothesis of the existence of three latent variables that is theory driven, CFA is a logical choice.

The CFA tests only hypothesis about existence of different cognitive levels. To test hypothesis about relationships among latent variables (cognitive levels) and their directions, it is necessary to conduct SR model. It is probably the most general kind of core structural equation model. An SR model comprises both structural and measurement model which makes possible to test at the same time both structural and measurement relations. The aim of the SR model in this case was to determine the relationships among latent variables marked as cognitive levels.

Beforehand, items were parcelled in order to reduce number of indicators per first two latent variables (cognitive levels). Since there were only five items supposed to measure the third level, they were note parcelled. There are few reasons why the parcelling was done. Bandalos and Finney [20] offered two categories of argument in favour of parcels. The first category is oriented on the differing psychometric characteristics of items and parcels. When comparing the separate items with aggregate-level data or parcels, item-level data contain at least one of the following disadvantages: lower reliability, lower communality, a smaller ratio of common-to-unique factor variance, and a greater likelihood of distributional violations. Item-level data also have fewer, larger, and less equal intervals between scale points than do aggregate-level data [21-22]. The stated arguments are related to the basic psychometric theory. The second category of argument is focused on the factor-solution and model fit. The various indexes of model fit are expected to be more acceptable when parcels, rather than items, are used because of the psychometric and estimation advantages of parcels. Compared with the item-level data, models based on parcelled data have fewer estimated parameters in defining a construct as well as in representing the whole model. Hence, these models are more parsimonious. Furthermore, their residuals have smaller chances to be correlated, and they reduce various sources of sampling error [22].

There was one more important reason for parcelling. The test used in this study is mostly consisted from dichotomous items. Since the structural equation techniques are primarily developed to deal with the continuous variables [14], the grouping items into parcels was necessary in order to create suitable indicators for SEM analysis. An important assumption that has to be satisfied when creating parcels is the unidimensionality of the items to be parceled. To determine the dimensionality of each sets of items to be parcelled (those supposed to measure first two cognitive levels), principal component analysis were conducted. The first component for both item sets have explained about 30 % of the variance and the ratio of the first two eigen-values were bigger than five. According to Hattie [23], obtained results indicate the unidimensionality. The first item set contained twelve items and the second set had twenty-eight items. Since the optimal number of indicators per latent variable is three to four [14], items from the first item set were aggregated into three parcels consisted of four items. The second item set was grouped into four parcels made of seven items. Parcelling was done using the "item-to-construct balance" method proposed by Little, Cunningham, Shahar, and Widaman [24]. The aim of that method is to create parcels that are equally balanced in terms of their difficulty and discrimination.

When the parcelling was done, three alternative models were proposed and tested. The analyses were done with LISREL 8.80 software. Covariance matrix used in the analyses is presented in the Appendix.

CFA was firstly conducted. Its aim was to check the existence of three latent variables which represent cognitive levels. As it can be observed from the graphical representation (Model A in Figure 1), the model allows covariations among latent variables which are expected based on the Bloom's taxonomy assumptions. Prior to the parameters estimation, model identification was checked. There are some straightforward rules for CFA models that concern minimum numbers of indicators per factor. For standard CFA it means that every indicator loads on just one factor and there are no measurement error correlations. More precisely, according to the two-indicator rule, a standard CFA model is identified if every factor has two or more indicators, each row of the Λ matrix (matrix of factor loadings λ) has only one nonzero element; error covariance matrix (δ) is diagonal, and has zero elements outside the diagonal; and variance/covariance matrix of latent variables (Φ) has at least one nonzero element [14]. These requirements are all met in the CFA model presented in this article.

Parameter estimation was made using maximum likelihood estimation on covariance matrices. Covariance matrix for the observed data is given in the Table 1. When the parameters were estimated, four different goodness-of-fit indicators were considered: Chi-Square (χ^2), comparative fit index (CFI), root mean square error of approximation (RMSEA), and Akaike information criterion (AIC).

Since the standard CFA is limited on testing whether latent variables exist or not rather than explaining their relationships, two alternative models were built and tested in order to provide a clearer insight into the nature of relationships among latent variables, as well as among observed and latent variables. Both of them are grounded in the BT assumptions and the findings of the previous studies reported in the introductory part of the article. The first proposed SEM model, model B (Figure 1), represents the expected hierarchical cumulative structure of the BT. The expected structure is operationalized through the latent-growth model in which each previous level "cause" the next one. Usually, that type of models can be found in the longitudinal studies where are they employed in order to control high covariations between

Table 1. Goodness-of-fit statistics for tested models.

Model	**Goodness-of-fit Statistics**			
	χ^2	**RMSEA**	**AIC**	**CFI**
A	1874,5 (N = 9626, df = 51, p < 0,001)	0,061	1938,0	0,988
B	1875,8 (N = 9626, df = 52, p < 0,001)	0,061	1944,1	0,988
C	1874,5 (N = 9626, df = 52, p < 0,001)	0,061	1938,0	0,988

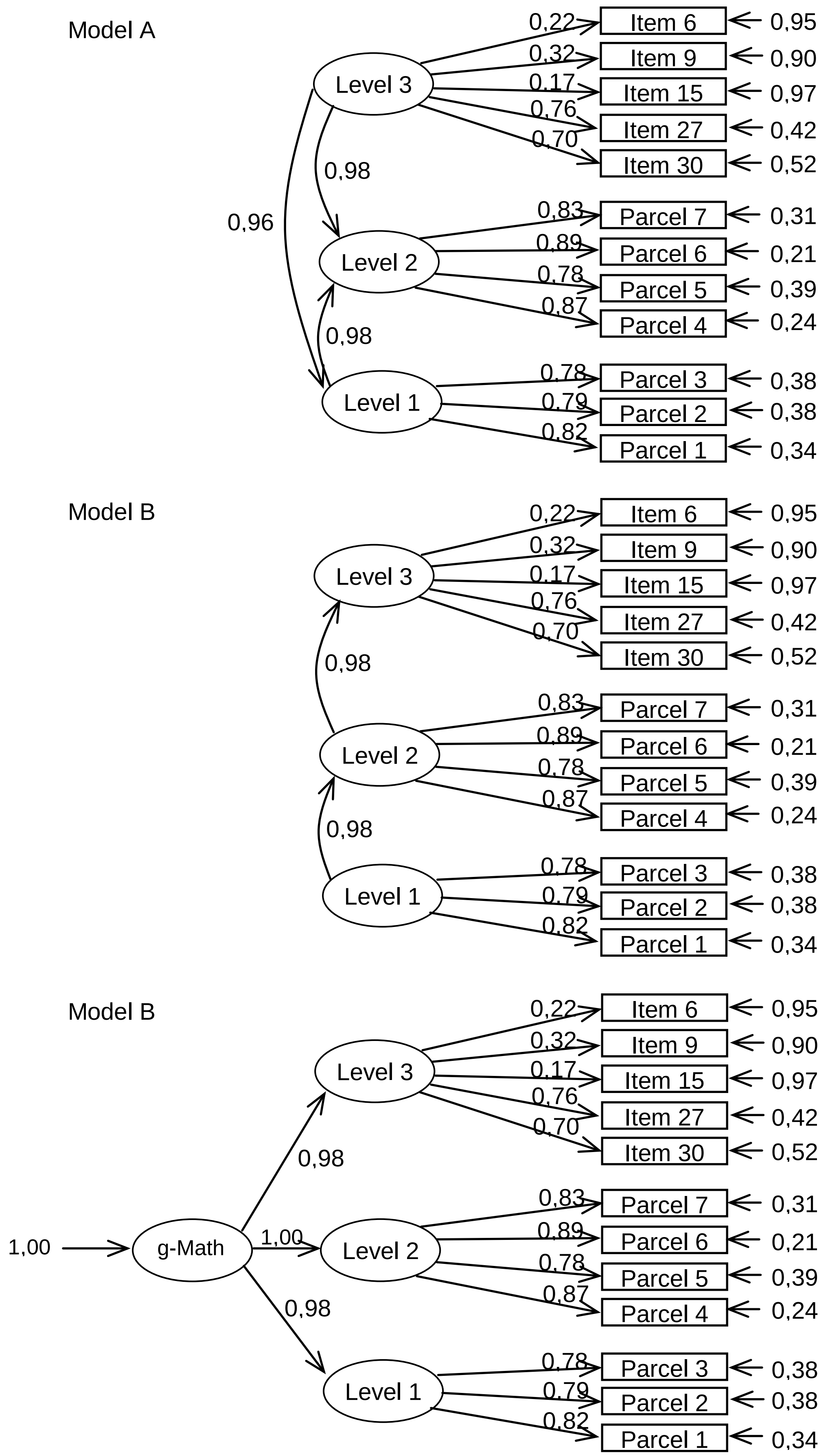

Figure 1. Tested models A, B and C of cognitive levels. The path coefficients are standardized.

measurements of the same construct in different points in time. It should be noted that the model is recursive which automatically means that it is identified [14].

In the second model, model C (Figure 1), higher order factor was introduced. In its nature it is an extension of the standard CFA model. The second-order factor was named "general knowledge of Mathematics". The model is mostly based on the results of earlier studies which dominantly did not confirm expected hierarchical cumulative structure. Furthermore, studies that included testing of the general intelligence factor showed its strong relationship with the cognitive levels. Even though the intelligence was not measured as a part of this study, it is expected that the general knowledge can also successfully explain the most of variance of the test achievement [25]. Therefore, it seems plausible to predict that the general knowledge of Mathematics would be a factor responsible for the covariations between the first-order latent variables.

For both models parameters were estimated by the maximum likelihood method and the goodness-of-fit statistics were checked in the same manner as for the first CFA model.

RESULTS AND DISCUSSION

The set of three latent models was tested. Their purpose was to examine the existence of three latent variables responsible for covariations among the items that measure specific cognitive level. The tested models with obtained standardized parameters are shown in Figure 1. Goodness-of-fit indices related to each model are presented in Table 1.

The model A was the simplest and it should have tested only the existence of three predefined factors or cognitive levels. Comparative and parsimonic indices of goodness-of-fit (RMSE, CFI, and ACI) for this model indicate excellent agreement between estimated and observed parameters. However, the estimated standardized parameters between latent variables were almost equal to one which indicates strong unidimensionality rather than existence of three separate factors. Therefore, two additional models were introduced. Their purpose was a reduction of the variance among latent variables and provision of a clearer picture of the relationships between latent variables and their relations to observed variables.

The first of these two models, model B, was a hierarchical factor model. Hierarchical confirmatory factor analysis models depict at least one construct as a second-order factor that is not directly measured by any indicator. This second-order factor is also presumed to have direct effects on the first-order factors, which have indicators. These first-order factors do not have unanalysed associations with each other. Instead, their common direct cause, the second-order factor, is presumed to explain the covariances among the first-order factors [14]. In this case the model was introduced with the expectation that it would "pick up" the variance among the lower order factors (cognitive levels). Such a solution agrees with the theory because the second-order factor can be explained as a general factor of mathematical abilities, skills and knowledge. Some earlier attempts of BT validation also used the general factor in explaining covariations between cognitive levels [3]. However, introduction of general factor did not change an impression that the data are strongly unidimensional. Relationships between each first-order factor and second-order factor are almost equal and extremely high.

Model C was built under the assumption of the cumulative-hierarchical structure of the BT. It represents an example of the latent-growth models that take into account high covariations among latent variables. However, this model revealed similar results as the previous two models. In other words, covariations among latent variables remained extremly high which indicate the existence of unidimensional construct. These findings are consistent with some previous research findings that used SR models. Thus, Hill [26] and Hancock [27] generally failed to confirm the cumulative-hierarchical structure of the BT. Furthermore, similar results to these, but obtained by using exploratory factor analysis were reported by Webb, Kalohn and Cizek [7]. They also confirmed existence of only one factor instead of three.

There are several possible explanations for the findings of this study. The most likely one is related to the construction of the test. The aim of the construction is to select the best possible items on which results could be made valid conclusions about student achievement and knowledge. One of the most important indicators of the quality of items is their discriminative power. Hence, the items for the Mathematics test were mostly selected based on their discrimination parameters. Although the tests within the Croatian state level testing program are not pretested, content method specialists who build the tests use the results of previously delivered tests. They are advised to retain item types or to clone the items that proved to be very discriminative in the previous applications. Item cloning is a practice that is well established in the modern testing centres in order to reduce expenses related to the construction of new items [28]. Glas, and van der Linden [29] showed in an extensive study that cloned items remain very similar psychometric characteristics as “items-parents”. According to fact that the Mathematics test included only those items which “parents” showed high discrimination in the past five years, it was expected to have items with very similar psychometric characteristics. In other words, it was expected to have items with high discrimination parameters (above 0,3 in the classical test theory terms). The average value of the discrimination parameters in this test was 0,45 which indicates that the tasks were carefully chosen; such high values could not be achieved by random selection, or only based on the item content. Thus, a common feature of all items was their high discrimination. It is likely that the very high discriminations were the common factor or the variable that created high covariations among the latent variables. This situation is not uncommon in the test preparation and there are numerous examples where the psychometric characteristics of items, such as difficulty or discrimination, strongly affect the dimensionality of a test [30-31].

The next finding to which attention should be paid is goodness-of-fit of the tested models. The parsimonic and comparative indices showed excellent agreement between model and the data while the absolute index (χ^2) and standardized residuals indicated complete disagreement between the models and data. Chi-square in this case is not so problematic because of the large number of participants. The chi-square statistic is a sample size sensitive. When using the SEM techniques, it is recommended to work with the large samples because of the more accurate estimates. At the same time, with the large samples null hypothesis that the model fits the data is with chi-square almost always rejected. That is why chi-square in this case is not suspicious. However, high values of standardized residuals are not expected. It is surprising that the differences between observed and estimated covariance matrices are so big. Another unexpected findings are extremely high regression coefficients obtained between the latent variables. Such high regression coefficients together with the high standardised residuals indicate the existence of certain problems with the data. Since there are no clear guidelines for the interpretation of the residuals [14, 32], it is necessary to consider all the characteristics of the results obtained by the different analyses. One of the possible explanations for such high values of standardised residuals is a fact that the various analyses of the observed variables showed up a number of overlaps between the subtests that are supposed to represent the factors, which indicate nonlinear relationships. On the other hand, SEM techniques are often referred as linear structural modeling which emphasizes that those techniques assume linear relationships between variables. It is possible that the nonlinearity makes impossible to find a structural model that would fit the data and also confirm the predicted structure.

Based on the stated arguments, it could be concluded that the structural evidences of the BT validity are not unambiguous. The analyses of latent variables indicate strong unidimensionality which can be reasonably explained by the principles used in construction of the test, or extremely high discrimination indices.

CONCLUSION

Cognitive levels are commonly used in item writing and test construction. An extensive SEM methods study was conducted to investigate whether the cognitive levels used in item and test construction really exist. Results obtained by confirmatory factor analysis and structural regression model indicated the existence of strong unidimensionality. Even though the goodness-of-fit statistics for the three proposed models suggest good fit of each of the models, the relationships between cognitive levels are so high that it is not realistic to keep them as separate latent variables. Such strong relationships between levels are possibly the consequence of the item selection procedure. The psychometric criterion was their discrimination parameters. Since they all have psychometrically similar characteristics, it is not surprising that they revealed unidimensionality. The results of this research suggest retaining the cognitive levels as an important part of the test construction procedures but also their reconsideration directed towards making them more operationalizable.

Studies results of the SEM methodological approaches used in this study should be compared in the future to some of the cognitive-psychometric models which allow for modeling the relationship between the item responses and student proficiency in various cognitive processes [12, 13, 33]. Also, new studies emphasize the role of qualitative research methodology in examination of the cognitive levels used to solve the items [34].

APPENDIX

Table 2. Covariances among observed variables (N = 9626).

Variable	1	2	3	4	5	6	7	8	9	10	11	12
Parcel 1	1,858											
Parcel 2	1,219	1,910										
Parcel 3	1,296	1,304	2,288									
Parcel 4	1,214	1,147	1,272	1,561								
Parcel 5	1,913	1,893	2,139	1,965	5,475							
Parcel 6	1,424	1,365	1,513	1,394	2,327	2,101						
Parcel 7	1,342	1,354	1,460	1,387	2,371	1,621	2,301					
Item 6	0,279	0,194	0,294	0,233	0,463	0,289	0,221	1,000				
Item 9	0,340	0,348	0,388	0,328	0,602	0,385	0,451	0,207	1,000			
Item 15	0,092	0,070	0,057	0,159	0,425	0,191	0,205	0,016	0,053	1,000		
Item 27	1,334	1,421	1,574	1,352	2,390	1,603	1,614	0,140	0,371	0,416	2,816	
Item 30	1,742	1,574	1,800	1,648	2,926	2,042	1,890	0,386	0,568	0,389	1,980	5,154

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UPORABA STRUKTURALNOG MODELIRANJA U ISPITIVANJU VALJANOSTI KOGNITIVNIH RAZINA

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SAŽETAK

Pri konstrukciji tekstova znanja kognitivne razine uobičajeno se koriste kao dio specifikacije testa gdje se navodi koji zadatak mjeri koju kognitivnu razinu. Najčešće korištene taksonomije kognitivnih razina predstavljaju neku od modifikacija originalne Bloomove taksonomije. U literaturi se navode brojne poteškoće vezane uz korištenje te taksonomije. Stoga je cilj ovoga rada istražiti može li se tehnikama strukturalnog modeliranja potvrditi postojanje različitih kognitivnih razina.

U svrhu istraživanja, korišten je ispit iz matematike primijenjen na hrvatskoj državnoj maturi u ljeto 2010. (N = 9626). Tri različita modela testirana su pomoću konfirmatorne faktorske analize te strukturalno-regresijskih modela. Rezultati dobiveni primjenom ovih tehnika ne podržavaju postojanje različitih kognitivnih razina te se takvi nalazi mogu interpretirati na više načina. Neke druge statističke metode koje uzimaju u obzir nelinearno „ponašanje“ zadataka mogle bi možda biti učinkovitije u postupku validacije kognitivnih razina. Nadalje, čini se da kognitivne razine definirane modificiranom Bloomovom taksonomijom nisu osobito učinkovit deskriptor zadataka te su očito potrebne promjene i poboljšanja u korištenju taksonomija kognitivnih razina pri opisivanju zadataka.

KLJUČNE RIJEČI

kognitivne razine, strukturalno modeliranje, ispitivanje valjanosti

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METACOGNITION AND DECISION MAKING: BETWEEN FIRST AND THIRD PERSON PERSPECTIVE

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ABSTRACT

The aim of the article is firstly, to show how metacognitive monitoring, control (regulation) and meta-knowledge are important in guiding decision making and secondly, to argue that researching experience is necessary for a more complete understanding of the role of metacognition in decision making. In the context of dual process theories of cognition it is sometimes proposed that people usually do not deliberate or reflect on their judgments and decisions, but rather follow their intuitions. Some metacognition researchers propose that metacognitive experiences (such as feeling of rightness or difficulty) play an important role in determining whether we change our intuitive responses for more deliberate, reflective reasoning and decision making. Although metacognition researchers' contribution to understanding the role of metacognitive experiences in decision making is valuable, their studies face some serious problems. Furthermore, it is not only our experiences, but also our evaluations of those experiences (metacognitive judgments) and our metacognitive knowledge that influence our judgments and choices. I argue that if we want to understand how and why people decide, we should be studying the entanglement of all these influencing factors from first and third person perspective. We should also conduct more thorough first person research. I conclude the article by arguing that first and third person perspective on metacognition and decision making should mutually constrain and inform each other about insights and contradictions that arise between them.

KEY WORDS

metacognition, decision making, intuition, deliberation, self-observation

CLASSIFICATION

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INTRODUCTION

Are we self-reflective in our judgments and decisions or is our behavior simply guided by intuitive processes? Is the role of emotions and feelings only to lead us astray from normatively "correct" judgments and optimal decisions, biasing and producing errors or does it help us in navigating complex environment we live in? What is the role of various metacognitive processes (metacognitive feelings, judgments and knowledge) that enable monitoring and control of decision making processes? As we shall see, metacognitive feelings (e.g. feeling of rightness, difficulty, fluency, etc.) are many times determining whether we accept our intuitive responses or change them for more deliberate, reflective strategies of reasoning and deciding. Our metacognitive capabilities are on one hand limited, but on the other very important for guiding our judgments and decisions. Various experiments on risky choices, metacognitive feelings of fluency and decision difficulty point to a complex nature of answers to questions such as what actually is decision making, why we choose as we do, when and why we avoid decisions, how we experience decision making, etc. Research on the influence of metacognitive experiences, beliefs and knowledge on decision making and cognition in general indicates that our metacognitive experiences are interwoven with our goals, our beliefs, theories about the source of our experiences, knowledge about our own cognition and cognition in general.

Although studies and theoretical considerations of metacognitive researchers are very valuable for a better understanding of decision making (they are not only testing how well people perform on tasks, but are trying to study experiences as well), they are faced with some serious problems. It is for example questionable whether methods they use really offer insight in the rich experiential world, participants in their experiments are not trained self-observers, etc. Third person approaches, being informative about how people decide in some regards, are not telling the whole story. We need to research experience of decision making and metacognition more thoroughly leaving room for a more open, subject oriented approach.

WHAT IS METACOGNITION?

A classical definition of metacognition is "... knowledge and cognition about cognitive phenomena …" [1; p.906], generally and broadly understood as cognition about cognition or thinking about thinking. Nelson and Narens [2] were the first to depict the relationship between cognition and metacognition in a schematic way. The basic structure they propose is that there are two interrelated levels of cognitive processes, the object-level and the meta-level. The meta-level "contains a dynamic model (e.g., a mental simulation) of the object level" [2; p.126]. This assumption is necessary if the meta-level is to control the object-level. There are two dominance relations between the two levels: control and monitoring. Meta-level controls the object-level by initiating an action, continuing an action or terminating an action and. The information on which control is based flows from the object-level to meta-level (monitoring). In this way "A system that monitors itself (even imperfectly) may use its own introspections as input to alter the system's behaviour." [2; p.128].

Koriat explains this relation in the following way: "The object level includes the basic operations traditionally subsumed under the rubric of information processing – encoding, rehearsing, retrieving, and so on. The meta-level is assumed to oversee object-level operations (monitoring) and return signals to regulate them actively in a top-down fashion (control). The object level, in contrast, has no control over the meta level and no access to it." [3; p.290].

This characterization of the meta-object-level relation might be understood to imply that metacognition is always metarepresentational – object-level carrying first-order representations, meta-level carrying second-order representations of the object-level. This could seem obvious, especially if we understand metacognition as being principally thinking about thinking as some do [4]. This stricter definition of metacognition is defended by Carruthers and Fletcher [4-5] who claim that if a process is to count as metacognitive it is necessary for it to be metarepresentational. By this definition metacognitive feelings (also called epistemic feelings, noetic feelings and metacognitive experiences[1]) arguably do not count as metacognitive. On the other hand others [3, 6-8] propose a weaker definition of metacognition which sometimes involves metarepresentations and sometimes not[2]. They claim that metarepresentational character of cognitive processes is not relevant in defining metacognition. Metacognitive processes can be metarepresentational or can be just "first-order representations happening to be about internal rather than external states. In a nut-shell, they are first-order but self-directed, as opposed to world-directed" [8; p.311]. Metacognitive experiences can be said to be metacognitive "insofar as their intentional contents yield information (or misinformation) concerning one's own epistemic states, processes, and abilities" [8; p.310]. On the other hand, metacognitive judgments, beliefs and knowledge (if about our own cognition) usually are metarepresentational, but they count as metacognitive principally because they inform us of our own cognitive processes, guiding our decisions, judgments and behaviour. Koriat for example gives the following (weaker) definition of metacognition: "Metacognition research concerns the processes by which people self-reflect on their own cognitive and memory processes (monitoring) and how they put their metaknowledge to use in regulating their information processing and behaviour (control)" [3; p.289]. Metacognition in this weaker sense encompasses many phenomena, including metacognitive monitoring, metacognitive control and metacognitive knowledge.

METACOGNITIVE MONITORING AND CONTROL

Dunolsky and Metcalfe define metacognitive monitoring as "assessing or evaluating the on-going progress or current state of a particular cognitive activity" [7; p.3] and metacognitive control as "regulating an on-going cognitive activity, such as stopping the activity, deciding to continue it, or changing it in the midstream" [7; p.3]. Metacognitive control would not be possible without monitoring (usually understood to be conscious[3]) of what is going on in our own minds. Information available to our conscious "experience" about our own cognitive processes and activities comes both from our metacognitive feelings and our general knowledge about our own mind. This information is then used for forming judgments, guiding behaviour and decision making processes. It has to be pointed out that the information available to conscious monitoring can be "mis-informative" because it is sometimes "contaminated" by impressions formed by our unconscious processes. This means that the available information which is for example biased by anchors or primed might lead to incorrect judgments or "non-optimal" decisions.

Imagine a student (example adapted and expanded from [7]) who after some time judges (judgment of learning) that she has a hard time remembering the lobes of the brain (metacognitive conscious feeling of difficulty as information for monitoring, about unconscious processes of learning and remembering). She therefore decides to dedicate more time (control) to this particular material or decides to change her learning strategy by inventing a song about the four lobes. On the other hand, our student could experience fluency in learning the four lobes (ease of learning) and proceed to studying other things. This can be helpful in guiding her decision to put more effort in things she does not yet know well, but can also lead to bad performance on the test. This can happen if she for example misjudged how well she remembered the four lobes. In this case the feeling of ease of learning would be erroneously cueing her decision that stopping is a good idea. But the picture is more complex, since her decisions are also based on her knowledge about her own cognition and cognition in general.

EXPERIENCE-BASED AND THEORY-BASED METACOGNITIVE JUDGMENTS

Koriat [3] distinguishes two kinds of information we base control of our cognitive processes on:

1) Experience-based metacognitive judgments (judgments and decisions based on our metacognitive feelings).

2) Theory based metacognitive judgments (judgments and decisions based on our metacognitive knowledge).

Experience-based metacognitive judgments are based on subjective metacognitive feelings. It is important to note that the sources and mechanisms that produce metacognitive feelings are not observable (cannot be introspected). They are considered as an "end product" of the unconscious, intuitive processes [3, 9] and inform us – in an indirect an "interpretative" way – about those inaccessible unconscious processes (mechanisms). Price and Norman stress that as intuitive feelings are used to "guide behaviour in a controlled and contextually sensitive manner that would not be permitted by purely non-conscious influences on behaviour" [10; p.28].

On the other hand it is not only metacognitive experiences that guide our judgments and decisions but also theories (metacognitive knowledge) we have about cognition (and decision making). Dunolsky and Metcalfe [7] define metacognitive knowledge as declarative knowledge about cognition (they basically mean declarative knowledge but one that is about cognition). Flavell [1] further categorizes metacognitive knowledge into three categories:

1) the person category of metaknowledge includes our knowledge about what we believe about ourselves and other persons as "cognitive processors",

2) the task category includes knowledge about a specific cognitive task, how should it be managed, how successful we are at achieving it, etc. and

3) the strategy category which includes knowledge about the effectiveness of strategies employed in achieving a goal or a subgoal.

It should be stressed that what most metacognitive researchers consider as metaknowledge is not only knowledge about our own cognitive processes but also knowledge about cognition in general if we use this knowledge to regulate our own cognitive processes and behaviour[4].

To return to our student, her metacognitive knowledge about cognition in general and her own cognition is important as well: she knows that creating poems (metacognitive strategy) is helpful for remembering list of items. But if she has experience that she is terrible at remembering poems (her metaknowledge about her own cognition) she would probably ignore the strategy, try another strategy or give up on finding a strategy and stay with repeating the lobes.

Koriat's distinction of experience-based metacognitive judgments and theory-based metacognitive judgments (metacognitive knowledge) [3] is similar to what is proposed by many dual process/system theories of human cognition, namely the distinction between two types of processing, one being more intuitive, the other more deliberate, analytic.

METACOGNITION IN THE CONTEXT OF DUAL PROCESS THEORIES

In the last decades cognitive science has seen many theories describing a kind of basic duality of human mind (for reviews see [11-13]). They were proposed as a theoretical framework for explaining various cognitive processes (decision making, (social) judgments, memory, learning, thinking, reasoning, etc.) or as a generic theory of human cognition. Some of them advocate the stronger claim that human cognition is composed of two relatively separate and autonomous systems implying a dual system architecture of human mind and/or brain (dual system theories). Others advocate the weaker claim of human cognition being composed of two (or more) distinct types or modes (Evans [13]) of cognitive processing which does not presuppose two architecturally distinct systems of human mind and/or brain (dual process theories). But both types of dual theories generally agree that human beings process information in two distinctly different ways. They divide cognitive processes into two categories according to certain characteristics they possess – processes that are fast, automatic, parallel, unconscious, high capacity, intuitive, contextualized and undemanding of working memory, etc., fall under the category of type 1 or System 1, processes that are slow, sequential, conscious, low capacity, deliberate, abstract and demanding of working memory fall under the category of type 2 or System 2.

Being a useful two-category distinction for explaining various cognitive phenomena some authors claim this distinction is too simple. Stanovich [14] proposed that we should not talk about System 1 processes but instead talk about the autonomous set of systems (TASS) which emphasizes the heterogeneity of various type 1 processes which are autonomous, automatized, respond automatically to triggering stimuli and are not under the control of deliberate (analytic) processes. He also proposed a division of System 2 into two levels, the algorithmic and the reflective level of processing. His idea of reflective mind comes roughly from the observation that some critical thinking biases (e.g. myside thinking, belief bias) are relatively independent of intelligence – individual differences in such critical thinking tasks are better predicted by thinking dispositions or cognitive style tests (e.g. need for cognition, actively open/minded thinking, etc.) than IQ tests. The main role of the reflective mind is the initiation of cognitive decoupling by sending "out a call to begin cognitive simulation or hypothetical reasoning more generally" [14; p.62]. On the other hand, the function of the algorithmic mind is to sustain cognitive decoupling that is necessary for hypothetical reasoning. According to Stanovich, the capacity for cognitive decupling (initiation and sustenance) is necessary for taking intuitive "response tendencies" offline. This in turn enables one to substitute these intuitive responses for "better" / different responses.

Similarly, although emphasizing the influence of metacognitive experiences in the process of making decisions or judgments (online), metacognitive researcher Valerie A. Thompson proposes that "the regulation of S2 intervention requires a third type of processes that is not captured by the S1/S2 distinction", (S1 meaning System 1, S2 System 2) [15; p.180], namely metacognitive processes (in the weaker sense, as described at the beginning). According to Thompson [15] one of the functions of metacognition is to monitor outputs (metacognitive experiences or feelings) of intuitive, unconscious processes to guide decisions of whether to intervene when for example a conflict between our goal and an intuitive response is detected. These metacognitive experiences are further interpreted by second-order judgments (metacognitive judgments about metacognitive feelings) which determine whether to accept the intuitive response or start a more deliberate analysis of the problem, decision, judgment.

Kahneman [16; p.717] proposed four ways in which decisions or judgments can be made after an intuitive judgment, decision or intention is initiated. Intuitive judgments and decisions can be:

1) accepted by System 2 (type 2 deliberate, analytic processes) processes,

2) adjusted (many times insufficiently when for example primed or anchored),

3) corrected (or overcorrected) when (and if) we recognize that our judgment or decision is biased by irrelevant information to the task such as affect,

4) blocked: Kahneman states this is least possible. But some experiments concerning affective self-control show that in fact the effect of emotions on thoughts and behaviour can be blocked (at least in some situations) using various metacognitive strategies (e.g. delaying gratification [17], the ability to work through negative emotions without increasing their negative affect by taking a more reflective stance towards our emotional memories [18]).

When no intuitive response comes to mind (e.g. when having to calculate the square root of a large number) judgment or decision is carried out by System 2 processes.

Most of the time people accept their intuitive responses, adjust them incorrectly or insufficiently [16, 19], confabulate reasons for their choices and behaviour [4, 13], etc. The "imperfection" of metacognitive mechanisms of monitoring and control is due to what Kahneman [16] calls natural assessments, i.e. impressions we form unconsciously about objects and thoughts we perceive. What is accessible to our conscious awareness (for more deliberate processing) is already "contaminated" by primes, anchors, frames, emotions, salient properties of objects, etc. How for example a risky choice is made is determined by how options are formulated (framed) [20]. Frames influence what features are more accessible, which in turn biases our choices. In the Asian disease problem for example [21], positively framed choice options (framed as gains) lead to more loss aversive choices (choosing the sure-thing), negatively framed choice options (framed as losses) on the other hand, lead to more risk seeking choices (choosing the risky choice).

One of the important questions in studying judgments and decision making is why people usually accept their intuitive responses (already framed, primed, biased, etc.) and not change them by a more deliberate analysis of the problem, situation, choice options. Metacognitive researchers advocate the view that metacognitive experiences, conscious feelings that accompany intuitive processes, are an important determinant of that.

METACOGNITIVE EXPERIENCES AND COGNITIVE REFLECTION: BETWEEN INTUITION AND DELIBERATION

Flavell nicely illustrates the richness of metacognitive experiences: "Metacognitive experiences can be brief or lengthy in duration, simple or complex in content. To illustrate, you may experience a momentary sense of puzzlement that you subsequently ignore, or you may wonder for some time whether you really understand what another person is up to. These experiences can also occur at any time before, after, or during a cognitive enterprise. For instance, you may feel that you are liable to fail in some upcoming enterprise, or that you did very well indeed in some previous one. Many metacognitive experiences have to do with where you are in an enterprise and what sort of progress you are making or are likely to make: You believe/feel that you have almost memorized those instructions, are not adequately communicating how you feel to your friend, are suddenly stymied in your attempt to understand something you are reading, have just begun to solve what you sense will be an easy problem, and so forth" [1; p.908].

How metacognitive experiences[5] such as feeling of rightness influence our judgments and choices can be illustrated by Cognitive reflection test (CRT) developed by Frederick. CRT consists of three "simple" questions [19; p.27]:

1) A bat and a ball cost 1,10 US$ in total. The bat costs 1,00 US$ more than the ball. How many cents does the ball cost? _____ cents

2) If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes

3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? _____ days

In the first problem the answer 10 cents[6] comes rapidly to mind and as Frederick's result show, most people accept such quick responses without any further deliberation, following their "impulsive", intuitive responses (at least in such tasks). Even top end university students (MIT or Princeton) made many mistakes on CRT. MIT students scored highest with a mean score of 2,18 (48 % of them getting all 3 answers correct), followed by Princeton university students with a mean score of 1,63 (only 26 % of them getting all 3 answers correct). University of Toledo students (not considered a top end university) were the worst with a mean score of 0,57 (only 5 % getting all 3 answers correct).

An explanation offered by Thompson [15] is that CRT questions elicit a strong metacognitive feeling of rightness (FOR; feeling of correctness of the answer that comes intuitively to mind). It is this strong FOR which is responsible for people not overriding their intuitive response (the test is designed on purpose so as to elicit fluent and "persuasive" responses). According to Thompson metacognitive processes "provide a means to assess the output of one's cognitive processes and determine whether further action should be taken. … It is this intuition, of Feeling of Rightness (FOR), that is the reasoner's cue to look no further afield for the answer." [15; p.175]. Especially relevant for the feeling of rightness is the role of fluency of retrieval: "metacognitive feelings are mediated by the fluency with which the information is brought to mind. On this view, the key to understanding the basis of the FOR is to understand that it is produced by a retrieval experience. That is, heuristic outputs are retrieved from memory, and this retrieval is accompanied by metacognitive experience, based on properties of that retrieval experience, such as fluency of processing. Moreover, given that heuristic attributes are highly accessible [7], even processed ballistically [14], the experience should be very fluent and result in a strong FOR"[7] [15; p.176]. Thompson, Prowse Turner and Pennycook [22] for example showed that a low feeling of rightness correlated with longer rethinking times and increased probability of answer change (both associated with more deliberate, analytic thinking). Furthermore, it was shown [23] that when CRT questions were printed in a hard to read font (eliciting a feeling of disfluency or difficulty), participants scored higher compared to when it was printed in an easy to read font, presumably thinking about the questions in a more deliberate, analytic way.

Frederick [19] also showed that when choosing between risky options, participants that scored high on CRT were more willing to take risks in the domain of gains (especially when gambles had higher expected value), but less willing to take risks in the domain of losses (when gambles had lower expected value). Participants, who on the other hand scored low on CRT showed the opposite behaviour: they were much less willing to take risks in the domain of gains (even though gambles had higher expected value than non-risky options) and much more willing to gamble in the domain of losses (even though gambles had smaller expected values than non-risky options). In the domain of gambles, maximizing gains seems as a good decision making strategy and the minority of participants that were more "able" to reflect[8] on and change their impulsive, intuitive responses for a more deliberate analysis were also more "successful" on the task.

Although such findings [19, 22] are generally believed to show that we usually do not deliberate too much when deciding or judging and that our (metacognitive) experiences are partly responsible for that, we should be careful about our conclusions. Even though such research is indeed valuable in trying to take into account participants' experience it faces some problems: the use of questionnaires, self-rating scales and think-aloud protocols for gathering data about experiences is highly questionable (if not completely useless) from the perspective of phenomenology. In this regard answering the question of what participants "really" experienced, when choosing between risky options and monitoring their own choices (if at all) would require deeper and more subject (person) oriented look at the experiential world of participants.

Furthermore, some experiments [24] with risky choices show that the picture is much more complex that the one proposed by prospect theory and scores on CRT test. Wang [24] showed that negative and positive frames (in the Asian disease death-or-life scenarios) influence our decisions differently in different contexts. He showed that participants preferred risky choice options regardless of whether they were framed as losses (negative frame) or gains (positive frame) if the scenario included only a few individuals instead of 600 or if individuals it included were presented as family members. Participants explained that they were willing to risk (where people do not risk in classical choice problems) because they wanted to give everybody an equal chance of surviving (perceived fairness). Wang based his explanation of perceived fairness by at least considering participants' experiences in the form of post-experiment interviews. Unfortunately, he did not specify how interviews were conducted which is again of critical importance from the perspective of phenomenology, e.g. how to conduct phenomenological dialogues [25].

THE INFLUENCE OF METACOGNITIVE EXPERIENCES AND METACOGNITIVE KNOWLEDGE ON CHOICE

Novemsky, Dhar, Schwartz and Simonson [26] indirectly showed that choices of consumers are influenced by their feeling of difficulty when forming preferences for choice options. Before making their choices between two products one half of participants were asked how easy or difficult it would be to name two reasons for their choice, the other half how easy or difficult it would be to name ten reasons for their choice. Participants rated naming ten reasons as more difficult (measured by a scale). Participants that were asked how difficult it would be to name ten reasons for their choice later deferred the choice more (61 % of participants) compared to participants that were asked how difficult it would be to name two reasons for their choice (49 % of participants). Similar findings on decision avoidance are reviewed by Anderson [27]. Schwartz [28] also showed that "maximizers" who analyse, deliberate on and compare different options much more persistently than "satisficers", when faced with abundance of choices, experience more regret, are less satisfied with their life, more prone to social comparison, experience less satisfaction with their choices and show bigger increase in negative mood than satisficers, when working on a task along with a peer that performs better than them. Further on it was shown [26] that participants deferred choice more, when choice options (between cordless telephones) were printed in difficult to read font (42 %) compared to choices printed in normal font (17 %). On the other, hand when participants were told that the font may be difficult to read the same percentage of participants deferred choice (16 %) regardless of the font. They could form a belief that their metacognitive experiences were contaminated by irrelevant factors. This finding is similar to a classical study [29] in the context of judgment where participants were asked to rate self-assertiveness in two conditions: they had to either recall a few (six) or many (twelve) episodes where they were assertive. In the few episodes condition they judged themselves as more assertive than in the many episodes condition. But when they were led to believe that the music playing in the background was causing their experienced difficulty in recalling many assertive episodes they rated themselves as more assertive in the many episodes condition.

Such research of processing fluency and decision difficulty points to a more complicated picture of what we base our decisions on, what choices we prefer, etc. Our metacognitive experiences are interwoven with our goals, our beliefs, theories about the source of our experiences, our motivations, social context, etc. Oppenheimer states that “people do not use fluency blindly as a cue for judgment but attempt to attribute it to the appropriate source. This leads people to develop naive theories about the causes of their fluency experience and to apply fluency accordingly … when there is an obvious alternative cause for fluency people will spontaneously discount the fluency experience, and the effects of fluency on judgment will be diminished or reversed … Thus, the interpretation of a fluency experience relies on past experience and the current context, and depending on the interpretation, fluency can have very different influences on judgment.” [30; p.238]. Our choices are influenced by diverse factors: metacognitive experiences, judgments of metacognitive experiences, accessible declarative information and theories we use to interpret them [31]. If our choices were completely bound by our metacognitive experiences or similarly by strong emotions we would not be able to be flexible in our decisions adapting them to our goals, beliefs and values. If we never had the opportunity to monitor and self-reflect on our intuitive responses, we would be bound to “chains of the moment”. On the other hand our metacognitive experiences and also emotions [32] help us navigate the complex world we live in. It is this entanglement of experiences and beliefs (metacognitive and cognitive) we should take a close look at: from a third person perspective and maybe even more so from a first person perspective, especially if we are to understand how each individual experiences and makes decisions.

THE IMPORTANCE OF FIRST PERSON RESEARCH OF DECISION MAKING AND METACOGNITION

What are people really experiencing as they experience the feeling of rightness or difficulty when judging and deciding? What does it mean for people to experience such feelings and how do these experiences influence each individual’s decisions from their own perspective? Researching metacognitive experience, and not only testing how well people perform on certain tasks or tests, is a very valuable contribution of researchers working in the field of metacognition. On the other hand metacognition research faces some serious problems and more thorough first person research is needed.

First, it is questionable whether self-rating scales, questionnaire and think-aloud protocols – often used for gathering data about experiences in metacognition research community – are good methods for “measuring” experiences at all. Questionnaires and self-rating scales already predefine the contents of reports about experiences and put the experimenter (or questionnaire designer) as the “judge” of what these experiences mean. If we want to understand how each unique individual decides, perceives and experiences his/her own decisions, we have to admit that the person in question is the only expert of his/her own experiences [25].

Secondly, participants in experiments are not trained self-observers and are thus not good reporters of experiences, at least from the perspective of phenomenology and some meditation traditions (especially Buddhist). Self-awareness and self-observation are essentially skills that have to learned and cultivated [34] by sustained practice and attitude towards our own experience. In this sense some meditation practices propose cultivating a state of mindfulness where people can be curious (non-judgmental) towards their own experiences: “Mindfulness is further defined by an orientation to experience that is adopted and cultivated in mindfulness meditation practices. This orientation begins with making a commitment to maintain an attitude of curiosity about where the mind wanders whenever it inevitably drifts away from the breath, as well as curiosity about the different objects within one’s experience at any moment. All thoughts, feelings, and sensations that arise are initially seen as relevant and therefore subject to observation. The client thus is not trying to produce a particular state such as relaxation or to change what he or she is feeling in any way. Rather, the client is instructed to make an effort to just take notice of each thought, feeling, and sensation that arises in the stream of consciousness" [33; p.233].

Last but not least, studying cognitive phenomena only from the third person perspective can render us vulnerable to interpreting the data in a wrong way. To echo Thomas Nagel's question "how it is like to be bat" [35] we should be asking "how it is like to be a decision maker". We should try to use third person data and experiential reports to mutually constrain [34] first and third person perspectives on metacognition and decision making. In his seminal article *Neurophenomenology, A Methodological Remedy for the Hard Problem* Varela proposed such a strategy. Explaining the hypothesis of neurophenomenology to tackle the hard problem of consciousness more productively, he states: "only a balanced and disciplined account of both the external and experiential side of an issue can make us move one step closer to bridging the biological mind-experiential mind gap. … The key point here is that by emphasizing a co-determination of both accounts one can explore the bridges, challenges, insights and contradictions between them. This means that both domains of phenomena have equal status in demanding a full attention and respect for their specificity. It is quite easy to see how scientific accounts illuminate mental experience, but the reciprocal direction, from experience towards science, is what is typically ignored. What do phenomenological accounts provide? At least two main aspects of the larger picture. First, without them the firsthand quality of experience vanishes, or it becomes a mysterious riddle. Second, structural accounts provide constraints on empirical observations" [34; p.343].

CONCLUSIONS

In the article I tried to show that our monitoring and control metacognitive capabilities and our metacognitive knowledge influence our decision making. Our metacognition is on one hand limited, but on the other hand very important for guiding our judgments and decisions helping us to navigate the complex world we live in. Various experiments on risky choices, metacognitive feelings of fluency and decision difficulty show that it is not only metacognitive experiences that influence our choices but also our metacognitive judgments we form about our experiences. Such research combined with further theoretical considerations points to a more complex nature of the role of metacognition in decision making.

What theories and studies of the role of metacognition in decision making mostly do not take into account (their experimental tasks are not designed in such a way) is that decision making is hardly similar to simple choice scenarios presented to participants in experiments. In such simple choice scenarios all choice alternatives are normally pre-given and do not have to be generated by the decision maker him/herself. Also, choice environments are mostly stripped of all context, social situatedness, etc. Furthermore, I believe we should put more emphasis on studying decision making as a long-term process that is continuously unfolding (decisions being repeated and made over longer periods of time). We should also look at how metacognitive processes influence decision making when we are not making decisions, for example when we are evaluating past decisions.

In conclusion I would like to emphasize two things: firstly, we should consider the entanglement and co-determination of metacognitive experiences, beliefs, theories, post-decisional evaluations and the context in which we make decisions, if we want to understand how and why people decide. And secondly, we should study decision making processes and our capacity to self-reflect and self-observe our own minds from first person and third person perspective, exploring "bridges, challenges, insights and contradictions between them" [34; p.343]. If we do not try to strive towards these goals we will be leaving out a lot of what, in my opinion, essentially constitutes metacognition and decision making.

REMARKS

[1]I will use terms metacognitive experiences and metacognitive feelings interchangeably. To distinguish emotions from feelings, Scherer defines feelings as “the subjective emotional experience component of emotion, presumed to have an important monitoring and regulation function” [36; p.699]. Metacognition researchers see metacognitive feelings in such way with two additional comments: metacognitive feelings are usually thought of as being directed towards one self and besides their usually affective character they are seen as cognitive as well, sometimes lacking affect (similarly to Scherer’s cognitive appraisal).

[2]When using the term metacognition I will refer to the weaker sense without implying that a process is metarepresentational.

[3]Metacognitive processes are usually understood as conscious processes, but monitoring and control can also operate on an unconscious level – the degree to which they are conscious is disputable and an unresolved issue.

[4]It is arguable if knowledge about cognition in general could really count as metacognition, metacognitive knowledge.

[5]There are many different metacognitive feelings described in literature on metacognition: feelings of knowing/not knowing, tip-of-the-tongue experiences, feelings of certainty/uncertainty, feelings of confidence, feelings of ease of learning, feelings of competence, feelings of familiarity, feelings of *déjà vu*, feelings of rationality/irrationality, feelings of rightness, feeling of difficulty [12]. Some of them are more connected to decision making, others less (like tip-of-the-tongue-experiences). In this article I primarily focus on the feeling of rightness and the feeling of difficulty.

[6]The correct answers are for (1) 5 cents, for (2) 5 minutes and for (3) 47 days, whereas the intuitive, most common responses are for (1) 10 cents, for (2) 100 minutes and for (3) 24 days.

[7]The use of the term heuristic in this context is somehow problematic, since heuristics can also be fast deliberate shortcut strategies used to improve judgments and decisions, for example take-the-best heuristic [37].

[8]The question of whether participants really did reflect more on their intuitive answers or were just more analytical thinkers in general remains open.

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METAKOGNICIJA I ODLUČIVANJE: IZMEĐU PERSPEKTIVA PRVOG I TREĆEG LICA

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SAŽETAK

Ciljevi ovog članka su, kao prvo, pokazati kako su metakognitivno promatranje, kontrola (regulacija) i meta-znanje značajni u upravljanju odlučivanjem, a kao drugo diskutirati koliko je istraživačko iskustvo neophodno za cjelovitije razumijevanje uloge metakognicije u odlučivanju. U kontekstu kognitivnih teorija dualnog procesa katkad se smatra kako ljudi uobičajeno ne planiraju ili preispituju svoje prosudbe i odluke, nego češće slijede svoju intuiciju. Neki istraživači metakognicije smatraju kako metakognitivna iskustva (poput osjećaja pravde ili poteškoće) zauzimaju znatnu ulogu u određivanju da li mi mijenjamo intuitivne reakcije za više namjeravana, preispitana zaključivanja i odlučivanja. Iako su istraživanja metakognicije znatno doprinijela razumijevanju uloge iskustva u metakognicije, ta istraživanja prate neki ozbiljni problemi. Nadalje, ne samo naša iskustva nego i naše procjene tih iskustava (metakognitivne prosudbe) te naše metakognitivno znanje utječu na naše prosudbe i odabire. Tvrdim da ako želimo razumjeti kako i zašto ljudi odlučuju moramo proučavati povezano sve navedene utjecaje iz perspektive prvog i trećeg lica. Moramo također provedti više sustavnih istraživanja prvog lica. Članak zaključujem tvrdeći kako se perspektive prvog i trećeg lica u metakogniciji i odlučivanju moraju međusobno uvjetovati i nadopunjavati o uvidima i proturječnostima koje između njih nastaju.

KLJUČNE RIJEČI

metakognicija, odlučivanje, intuicija, namjera, autoopservacija

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