The Illusion of Thinking in Metacognitive Monitoring of University Students

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Abstract

The article is based on the theoretical analysis of the concepts «illusion of thinking» and «metacognitive monitoring». The purpose of the paper is to find out the features of the illusion of thinking and to substantiate their importance in the metacognitive monitoring in the process of learning of university students. The role of illusion of thinking in metacognitive monitoring in the process of university students learning is analyzed.

Keywords: *metacognitive monitoring, illusion of thinking, cognitive illusion, learning activity, cognitive distortion, bias.*

1. Introduction

Scientists have been thinking about the nature of human thinking for a long time. Many scholars have found it disturbing that humans might have been rational enough to invent probability theory but not rational enough to use it in their daily thought (Rüdiger, 2005). Psychological and psychophysical characteristics of a person in most cases do not correspond to the level of complexity of the problems solved by it. Hence, it is quite possible that the individual is not able to evaluate correctly the actions

Journal of Cognitive Science 20-1:79-110, 2019

that he or she applies, they believe that there are no mistakes; everything is done in the right and proper way. In some cases, knowledge can avoid «traps» in making decisions, in others, − people can't go beyond their limits (Kashapova & Ryzhkova, 2015).

There are numerous documented situations where questions about probability or logic are answered on the basis of a readily accessible piece of information that is misleading or technically irrelevant to the decision in question (Kahneman, 2003; Thompson et al., 2014). For example, a decision about logical validity may be made on the basis of the believability of the conclusion (Evans, Barston, & Pollard, 1983; Thompson et al., 2014), a probability judgment may be based on a stereotype (Kahneman & Tversky, 1973; Thompson et al., 2014), an estimate of proportion may be based on set size rather than ratio (Denes-Raj & Epstein, 1994; Thompson et al., 2014), a decision about whether to take a risk may be based on the desirability of the outcome, rather than its probability (Finucane, Alhakami, Slovic, & Johnson,2000; Thompson et al., 2014). These intuitions are often accompanied by an affective experience of confirmation or sense of confidence (Hogarth, 2010; Sinclair, 2010; Thompson et al., 2014), which may act as a disincentive to re-examine the initial answer (Thompson et al., 2011; Thompson et al., 2014).

People make more or less mistakes in processes of evaluation, thinking and remembering information, deviating from some objective and «correct» standard. This discrepancy makes systematic mistakes in thinking − cognitive illusion extremely attractive to experts (Rüdiger, 2005). Featuring contributions from leading researchers, scientists discuss their theoretical status: Is such illusion proof for a faulty human information-processing system, or do it only represent by-products of otherwise adaptive cognitive mechanisms? (Rüdiger, 2017)

The studies of the illusion of thinking have recently become very popular in scientific literature. The analysis of existing theoretical and

empirical sources does not give promising forecasts especially in relation to the student's learning activities. We consider the illusion of thinking by actualizing the problem of the real existence of ways to overcome this illusion in the learning activities of students. This phenomenon is not completely considered in the field of metacognitive monitoring of learning activities of students. The purpose of the manuscript is to determine the concept of the illusion of thinking with its features and to substantiate their importance in the metacognitive monitoring in the process of learning.

2. Method

The paper used a set of theoretical methods corresponding to the problem. In particular, the theoretical and methodological analysis of the problem, the systematization of scientific psychological sources and data generalization were used in this paper. The study of the process and structure of metacognitive monitoring in learning activities is reflected in the works of M. C. Anderson, M. Avhustiuk, J. Dunlosky, D. J. Hacker, A. C. Graesser, R. Kalamazh, A. Koriat, J. Metcalf, I. Pasichnyk, Timothy J. Perfect, Bennett L. Schwartz, M. J. Serra, N. Yeung, C. Summerfield, D. J. Therriault, K. W. Thiede.

The question of the emergence of the phenomenon of illusion of thinking and the study of their features and causes of engagement were engaged by scholars such as D. Kahneman and A. Tversky (first introduced the term «cognitive bias» and its features, identified two types of thinking − fast and slow); F.Pohl Rüdiger (analyzed the illusion of thinking as illusions that imply the application of a particular rule and classified cognitive illusions); Gilovich, J. Griffin (described the role of heuristics and biases in our reasoning); James H. Barnes (considered the cognitive biases and their impact on strategic planning); T. J. Baron (the theoretical model of cognitive distortions is analyzed); T. Kliegr, S. Bahník, J. Fürnkranz

(described possible effects of cognitive biases on interpretation of rule-based machine learning models); H.R. Pfister (the causes of cognitive illusions are considered); J. Paley (analyzed cognitive illusions from the side of its errors and objectivity); E. Belyaeva, G. Kunafina (descry-bed the role of cognitive distortions in sociocultural activities); E. Kashapova, M. Ryizhkova (considered the cognitive distortions and their influence on the behavior of a person); T. Kulakovsky (the reasons for the emergence of cognitive prejudices are described); A. Popov, A. Vihman (analyzed the role of cognitive distortions in the process of making decisions).

2.1. Metacognitive monitoring in the learning activity of students

Metacognitive monitoring is those processes that allow the individual to observe, reflect on, or experience his or her own cognitive processes. Thus, one may know that one has mastered his or her arithmetic tables, or one may feel that they have understood a text they have just read. In the laboratory, metacognitive monitoring is revealed by asking participants to make feeling-of-knowing judgments, judgments of learning, ease-of-learning judgments, warmth judgments, judgments of comprehension, etc. Monitoring informs the person of the state of their cognition relative to their current goal (Perfect & Schwartz, 2002).

Error monitoring is the metacognitive process by which we are able to detect and signal our errors as soon as a response has been made. This process plays a crucial role in adaptive human behavior, allowing our actions to be shaped by their outcomes both in the short-term, for example, by responding more cautiously to avoid further errors, and in the longer term, through gradual learning of appropriate stimulus-response contingencies (Yeung & Summerfield, 2012).

Thiede, Anderson, and Therriault (2003) demonstrated the important role that accurate monitoring plays in learning from a text by manipulating monitoring accuracy and examining the effect on regulation of study and

learning outcomes. In this experiment, an initial important finding was that participants who were given a delayed-keyword-generation instruction (i.e., asked to generate a list of five keywords that captured the essence of a text prior to judging comprehension) more accurately monitored their comprehension on the first set of tests than did participants in a no-keyword-generation or immediate-keyword-generation group (Hacker, Dunlosky & Graesser, 2009).

Metacognitive monitoring can also occur at the end of a study session. When a student metacognitively examines studying, metacognitive control can be exercised to toggle study tactics on and off, or editing may be done to adapt the conditions, operations, or standards in the cognitive structure that describe studying. Dunlosky et al. investigated how practicing can help improve metacognitive monitoring. They argued that encouraging people to take practice tests can improve their ability to predict how they will do on the actual tests (Perfect & Schwartz, 2002).

Accurate metacognitive monitoring is critical to the effecti-ve regulation of study. If someone does not accurately differ-rentiate well-learned material from the less-learned material, they could waste time studying material that has already well learned or fail to re-study material that has not yet been adequately learned (Hacker, Dunlosky & Graesser,2009; Thiede, 1999; Win-ne & Perry, 2000).

So, we consider metacognitive monitoring as control the student's own cognitive activity and its results directly in the process of solving a certain cognitive task: during the preparation for the answer or the exam, doing of tests, reading educational texts, etc.; as an assessment by subjects of their own knowledge, knowledge of cognitive strategies and knowledge of the conditions necessary for the application of strategies influencing the learning process (Koriat & Bjork, 2006); as explicit judgments designed to promote the development of cognitive processes (Serra & Metcalfe, 2009). Metacognitive monitoring in the process of learning activity shows us

how well students are able to imagine the possibilities and limits of their own cognition in the process of solving various types of cognitive (motor, sensory-perceptual, mnemonic, thinking) and educational and professional problems, how effective are operations, which they use to regulate educational and cognitive activity (Avhustiuk, 2016 a; Avhustiuk, 2016 b; Pasichnyk, Kalamazh & Avhustiuk, 2014).

2.2. The concept of the «illusion of thinking» and its features

According to the Encyclopedia of Human Behavior (Wilke & Mata, 2012; Kliegr, Bahník & Fürnkranz, 2018), the term «cognitive bias» was introduced in the 1970s by Amos Tversky and Daniel Kahneman (1974) and is defined as systematic error in judgment and decision-making common to all human beings which can be due to cognitive limitations, motivational factors, and/or adaptations to natural environments. It describes people's systematic but purportedly flawed patterns of responses to judgment and decision problems (Wilke & Mata, 2012).

According to D. Kahneman (2011; 2017), we have two systems in our mind (System 1 and System 2). System 1 operates automatically and quickly, with little or no effort and no sense of voluntary control. System 2 allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration. As System 1 operates automatically and cannot be turned off at will, errors of intuitive thought are often difficult to prevent. Biases cannot always be avoided, because System 2 may have no clue to the error. Even when cues to likely errors are available, errors can be prevented only by the enhanced monitoring and effortful activity of System 2. In our daily life, however, continuous vigilance is not necessarily good, and it is certainly impractical. Constantly questioning our own thinking would be impossibly tedious, and System 2 is too slow and inefficient to serve as a substitute

for System 1 in making routine decisions. This leads to direct failure of livelihoods (Kahneman, 2017). Kahneman (2011) identified two types of thinking − fast and slow − where fast thinking is prone to cognitive bias and slow analytical thinking is required for understanding. People rely on cognitive shortcuts and rules of thumb to make decisions under conditions of uncertainty and when little time is available. These heuristics can interfere with information processing and hinder decision making, like cognitive biases. We can also find such concepts with the same meaning as «cognitive distortion», «heuristics», «illusion of thinking», «cognitive error», «cognitive prejudice» in the scientific literature review (Kahneman, 2017; Pasichnyk, 2015).

The narrow initial definition of cognitive bias as a shortcoming of human judgment was criticized by German psychologist Gerd Gigerenzer, who started in the late 1990s the «Fast and frugal heuristic» program to emphasize ecological rationality (validity) of judgmental heuristics, use of which results in some notable cognitive biases (Kliegr, Bahník & Fürnkranz, 2018).

«Cognitive distortion» is a systematic mistake in thinking or pattern rejection arising from dysfunctional beliefs embedded in cognitive schemes − conceptual structures used by people to understand the world and people around them. Cognitive distortions are easily detected in the analysis of automatic thoughts. People are inclined to create their own «subjective social reality» that depends on their perception and this subjective reality can determine their behavior in society. Thus, in the process of socialization, a person creates his own reality, through which perceives, memorizes and evaluates social information. On the basis of this subjective reality, the individual thinks, makes a decision, conclusions and forms the algorithms of own behavior. Cognitive distortions appear to be systematic mistakes of this reality, the natural limitations of the human mind inherent in every member of society (Belyaeva & Kunafina, 2016).

Cognitive distortions are mostly mistakes in our thinking that happen while we try to process information. To make a decision a person needs to sort out a lot of information, sometimes quickly. Our cognitive distortion is the shortest path to which the brain manages to help make the decision faster. These paths are extremely useful in situations where a person is in danger. Our distortions are less useful when someone tries to deceive us (Henson, 2017).

Cognitive bias seen as a representative for various cognitive phenomena that materialize themselves in the form of occasionally irrational reasoning patterns that allow humans to make fast judgments and decisions. Their cumulative effect on human reasoning should not be underestimated as already early work in this area showed that «cognitive biases seem reliable, systematic, and difficult to eliminate». The effect of some cognitive biases is more pronounced when people do not have well-articulated preferences, which is often the case in explorative machine learning (Kliegr, Bahník & Fürnkranz, 2018).

Rüdiger (2005) defined illusion of thinking as that involves the application of a certain rule (like Bayes' theorem, hypothesis testing, or syllogistic reasoning). These rules are derived from normative models (like probability theory, falsification principle, or logic) and their results usually serve as standards against which human performance is evaluated. The crucial point is that naïve persons usually don't know these rules and therefore behave rather intuitively. Typical tasks are to estimate a probability, to verify a logical conclusion, or to discover a hidden rule.

Kahneman and Tversky warned that cognitive bias can lead to violations of the Bayes theorem when people make fact-based predictions under uncertainty. These results directly relate to inductively learned rules, since these are associated with measures such as confidence and support expressing the (un)certainty of the prediction they make (Kliegr, Bahník & Fürnkranz, 2018). The term «cognitive illusion» has evolved in analogy

to the better-known domain of «optical illusion». The cognitive illusion is more complex than the optical illusions (such as Müller-Lyer illusion), but the epistemological position is exactly the same. There is a clear distinction between «how it is» and «how it seems», and an intersubjective agreed and reliable procedure for determining the truth of the matter (Paley, 2005; Rüdiger, 2005; Rüdiger, 2017).

The first and main feature of a phenomenon to count as an illusion thus is that it leads to a perception, judgment, or memory that reliably deviates from «reality». In cases of optical and memory illusions, it may be immediately evident what constitutes reality (because subjective perception and recall can be compared to external or original stimuli, respectively), but in thinking and judgment, the matter is less clear. The problem concerns how to define an objectively «correct» judgment or decision. Researchers are still disputing in some cases which models might be used as norms and which not (Rüdiger, 2005).

Importantly, cognitive biases of many types have been described in the general population: they are not reduced to pathological or handicapped reasoning. Rather, they are usually considered adaptive, as they can lead to sensible-enough and fast decisions (Kliegr, Bahník & Fürnkranz, 2018).

One important thing is that cognitive bias can be used to reject conflicting information or to magnify data that support the current beliefs. For example, the literature on motivated reasoning shows that people actually reason in ways that favor their prior political attitudes, which is akin to showing a confirmation bias. In a classical experiment, researchers presented participants with two scientific studies on the effectiveness of the death penalty to reduce the crime rate. According to one of the studies, death penalty lowered the crime rate, whereas the other study supported the opposite conclusion. Additionally, the researchers gave participants information about the potential shortcomings and methodological flaws of both studies. That is, the studies contributed ambiguous information:

although they claimed to support one hypothesis, their arguments were imperfect. Lord et al. reported that participants, in fact, gave higher ratings to the study that supported their own pre-existing view on the death penalty, and pointed the problems in the study that contradicted such view, even when both studies were methodologically identical. Thus, the confirmation bias can affect the way people treat scientific evidence (e.g., neglecting it when it collides with such existing attitudes). A similar process could take place when learning causal relationships from evidence (Blanco, Gómez & Matute, 2018).

As a third criterion, the observed phenomenon needs to deviate from the normative standard in a systematic fashion (i.e., in a predictable direction) rather than just randomly. Therefore, most designs include a control group, assuming that any deviations in the control group's data result from random error alone, while the experimental group shows, in addition, a systematic effect. Special care has to be taken if demonstrations of an illusion depend on repeated measures because it involves the danger of being prone to regression effects, which could possibly lead to false interpretations of the data. As a related feature, the mechanisms eventually leading to cognitive illusion typically include a number of probabilistic processes so that an illusion will not necessarily be observed on each and every single trial, but may only become evident as a systematic bias if the data are summed across a larger number of trials or participants (Rüdiger,2005; Rüdiger, 2017).

An entertaining example of the illusion of thinking is the Monty Hall problem. In this problem, a game-show contestant is invited to choose one of three doors, behind one (but only one) of which is an attractive prize. Once a door has been chosen, the host (Monty Hall) opens one of the two remaining doors and shows that there is no prize behind it. He then tells the contestant she can either stick with her original choice or switch to the third door. Most people are convinced that this is a 50/50 decision; but, in fact, the chance of winning if you switch doors is 2/3 and only 1/3 if you

stick. In this example, then, a familiar type of choice is clearly related to a probability assessment. Not only do the vast majority of people get this assessment wrong, but the incorrect answer often strikes them as «obvious» (Paley, 2005).

Incidentally, it is the fact that a significantly high proportion of people get the judgement wrong, and in an identical way, that distinguishes «succumbing to an illusion» from simply «making a mistake». If I make an error in an arithmetical calculation, for example, that is a one-off mistake, because there is no reason to suppose that anyone else would get it wrong in the same way. It is only when a lot of people make the identical error (as with the Müller-Lyer) that we have grounds for thinking there is something about the problem itself which is creating an illusion (Paley, 2005).

A fourth aspect of the illusion of thinking is that it appears involuntarily, that is, without specific instructions or deliberate will. They just happen. This is analogous to what has been found in research on suggestions: The suggested reaction manifests itself in the given situation without any conscious decision to do so. This does not mean that motivational factors or conscious meta-cognitions may not be influential, too, but they are not the ultimate cause of the illusion itself. They only moderate its size. Another aspect is that persons who have fallen prey to a cognitive illusion usually don't realize what has happened: «Illusions mock our belief that what we perceive, remember, and know is in perfect accord with the state of the external world. That is, illusioned persons are still convinced to have judged, decided, or recalled something to the best of their knowledge» (Rüdiger, 2005; Rüdiger, 2017).

It should be emphasized that cognitive illusions are perva-sive. The subtitle to Piattelli-Palmarini's book («How mistakes of reason rule our minds») may be slightly over-egging it, but there is no doubt about the extent of our vulnerability to cognitive error. This is something «found almost anywhere, in almost anyone, and just about at any moment»

(Piattelli-Palmarini, 1994; Paley, 2005).

Like the optical illusion, the illusion of thinking is perni-cious, compelling and it persists even when we know they are prone to error. Through many empirical demonstrations Kahne-man and colleagues have shown that even when rational analyses indicate that our subconscious decisions may be flawed, we remain susceptible to them and often act on them regardless (McGregor, Tapp & Hughes,2017).

The illusion illusion of thinking is hard if not impossible to avoid. While this is probably true for all optical illusions, the criterion is much weaker for cognitive ones. For some illusions, a proper instruction, careful selection of the material, or other procedural variations may reduce or even eliminate the illusion, while for other illusions, most (if not all) attempts to overcome the effect have failed (Rüdiger,2005; Rüdiger, 2017).

And finally, the last point to consider and to distinguish cognitive illusions from other forms of typical errors, misunder-standings, illusion often appears as rather distinct from the normal course of information processing. An illusion somehow «sticks out» as something special that «piques our curiosity» and thus attracts researchers to explain this unexpected but robust finding. In other words, ordinary forms of forgetting (leading to omission errors), drawing schema-based inferences (leading to commission errors), or deviations resulting from simple mis-understandings would not be considered «illusions». Roediger and McDermott (2000) accordingly described such phenomena as «distortions». This is not to say that a cognitive illusion cannot be explained with ordinary and general mechanisms of information processing. In fact, one of the theoretical goals of research on cognitive illusions is to avoid the assumption of any special mechanism that is responsible only for this one phenomenon, but instead to explain the observed effects with what one already knows about cognitive processes in general (Rüdiger, 2005; Rüdiger, 2017).

In the present view, we define cognitive biases and asso-ciated

phenomena broadly. We include cognitive biases related to thinking, judgment, and memory. But the illusion of thinking in-clude descriptions of thinking strategies and judgmental heu-ristics that may result in cognitive biases, even if they are not necessarily biases themselves (Kliegr, Bahník & Fürnkranz, 2018).

So, we see that the illusion of thinking can be understood as (a) dysfunctional errors of the system, (b) faulty by-products of otherwise functional processes, or (c) as adaptive and thus functional) responses (Rüdiger, 2005;Rüdiger, 2017).The illusion paradigm seeks out those environments or problem descriptions in which the judgment and choice processes people rely on lead to clear errors. The purpose was not to emphasize the predominance of the illusion of thinking over accuracy but to find the clearest testing grounds for diagnosing the underlying simple processes or judgmental heuristics that people habitually employ (Holyoak & Morrison, 2012). The main features of the illusion of thinking are presented in Fig.1

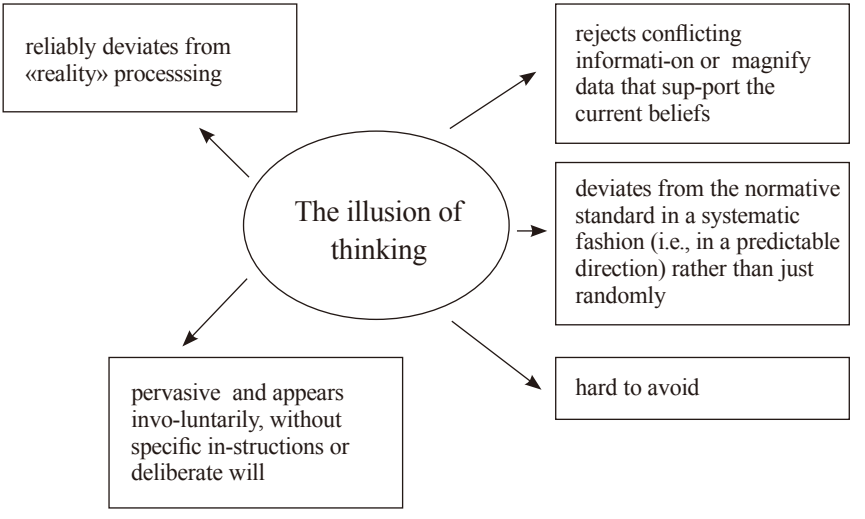

Figure 1. The features of the illusion of thinking

2.3. The reasons and factors of the illusion of thinking

The illusion of thinking can arise due to various reasons. So, H.R. Pfister connects their manifestations with: «crashes» in pro-cessing information (heuristics); «mental noise»; the limited possibilities of the brain concerning the processing of information; emotional and moral reasons; social influence (Belyaeva & Kunafina, 2016).

Cognitive distortions can influence the decision-making process in cases where great value is given to desirable solutions (for example, misleading irreversible costs: a person refuses to accept logical facts and arguments that are on the «surface», guided in the decision-making only by emotions and what is called «intuition»). Others, such as illusory correlations, affect the decision on the nature of causal relationships (in particular, the tendency individuals with the illusion of correlation to see the connection where it is really not). A special class of cognitive distortion is associated with memory properties, including such as a sense of constancy (wrong recall of certain past positions and behaviors, reminiscent of present positions and behavior) (Belyaeva & Kunafina, 2016).

Other cognitive distortions reflect human motivation, in particular, the person's desire to form a positive attitude towards oneself. This explains the nature of many patterns and stereotypes of mass consciousness (for example, the illusion of asymmetric insight, distortion at own expense, distortion of self-glorification). There are distortions related to behavior in groups: distortion in favor of their group, distortion in the assessment of the homogeneity of members of another group (Belyaeva, 2016).

There is a group of cognitive distortions associated with the features of the brain to perceive, recall and draw conclusions. For example, cryptomnesia − a wrong person's peculiarity to establish the «authorship» of a particular event, when it mistakenly receives the result of the imagination of the truth (someone's ideas and creativity are perceived as it is own). With the function of memorization, the effect of the level of processing

information is related: the depth of the analysis of a situation or state depends on what should remain in memory. Surface study leads to unstable flashbacks in memory, and a deep level of information processing leads to its conservation for a long period of time (Belyaeva & Kunafina, 2016).

However, the positive illusion of thinking can contribute to more effective individual actions in specific circumstances. In addition, they allow making quicker decisions in situations where the speed of decision-making is more important than its accuracy. Thus, in some cases, distortion of perception, inaccurate judgments, illogical interpretations may lead to ineffective decisions in the situation, but in many situations, these «simplified» procedures are adequate and useful, since they allow a person to select quickly the desirable way of action (Belyaeva & Kunafina, 2016).

Cognitive prejudice has a number of cognitive («cold») or motivational («hot») explanations. In this case, both effects can be present at the same time. Prejudice can be considered as consequences of the use of rules for processing information (for example, «recapture of paths»). These rules are used by the brain to make decisions or to create judgments. Prejudice in judging or making a decision may also arise due to the peculiarities of motivation, for example, «the adoption of the desired for the real». For example, a person, carrying out entrepreneurial activity, certainly faces the field of uncertainty − the insufficient amount of information and resources necessary to make a balanced rational decision. Under such conditions, an algorithmic process of solving problems becomes impossible, and the very use of the heuristics begins to play a decisive role in accelerating and simplifying the decision-making process. J. Baron argues that such conditions maximize the effect of cognitive prejudices. These include high-level levels of uncertainty, novelty, lack of time, informational reloading and emotional stress (Kulakovskyi, 2017).

Cognitive illusions can arise as the possibilities of the human mind are limited in solving complex problems in comparison with the size of

problems where decisions are necessary for objective and rational behavior in the modern world. Thus, people use heuristics (some of the cognitive distortions are called heuristics because the solutions to which they lead are not false: they are approximate and incomplete to facilitate decision making) (Popov & Vihman, 2014). First, although the heuristics are distinguished from normative reasoning processes by patterns of biased judgments, the heuristics themselves are sensible estimation procedures that are by no measure «irrational». Second, although heuristics yield «quick and dirty» solutions, they draw on underlying processes (e.g., feature matching, memory retrieval) that are highly sophisticated. Finally, note that these heuristic processes are not exceptional responses to problems of excessive complexity or an overload of information, but normal intuitive responses to even the simplest questions about likelihood, frequency, and prediction (Gilovich, Griffin, & Kahneman, 2002).

In the theoretical model of cognitive distortions, J. Baron identified three groups of cognitive distortions. The first section consists of three blocks of phenomena: 1) distortions, during which the attention of the person operates with bright and accessible information; 2) distortions associated with the wrong understanding of correlations and use to explain the events of unrelated information; 3) distortions in which the attention of a person focuses on one attribute, denying others. The second and third groups describe distortions related to the influence of motivation and psychophysics on beliefs (Baron, 2007; Popov & Vihman, 2014).

Whereas some scientists adopted a rather pessimistic view, seeing cognitive illusion as the indicator of built-in errors of the human information-processing system (Piatelli-Palmarini; Thaler), most others endorsed the second view, seeing it as mere by-products (or as the «backside of the coin»). For example, «many illusions, in perception and cognition, represent the backside of otherwise adaptive and prudent algorithms» as Fiedler puts it (Rüdiger, 2017).

Some researchers, however, went one step further and asserted that the illusion itself, not just their underlying mechanisms, could possess adaptive value. Generally, the question whether a decision, judgment, or memory is «correct» (in a normative way) usually is secondary to the question whether that decision, judgment, or memory is helpful in the current situation. Boyer accordingly asserted that «it makes evolutionary sense to keep in mind that organisms do not develop cognitive abilities (e.g., retrieval of past experience) for abstract epistemic benefits (knowing what used to be the case). It retrieves information inasmuch as it helps fitness-enhancing decision-making in the present». Also, Schacter et al. (2011) argued that under some conditions false memories can have beneficial effects. As an example, they discussed «that people frequently remember their pasts in an overly positive or negative manner in order to inflate their current self-evaluation» (Rüdiger, 2017).

Similarly, McKay and Dennett (2009) discussed the functions of some «misbeliefs» and claimed that many of them should be considered faulty but tolerable by-products, but that some may represent genuine adaptive functions. They especially focussed on «positive illusion», that in their view is highly adaptive. Sutton further noted that the positivity bias in autobiographical memory is related to enhanced emotion regu-lation, that forgetting is also an adaptive response, and that «misremembering things in particular positive ways might have direct personal, motivational, and social benefits» (Rüdiger, 2005; Rüdiger,2017).

Of course, such an illusion like the positivity bias could not have evolved unlimited, because otherwise, we would all have lost contact with reality (which would have been detrimental to survival). Rather, the amount of bias that is beneficial is also a matter of evolutionary selection, which may have yielded an «optimal margin» of such illusions (Rüdiger, 2017).

Bias may also result from our inability to understand the fundamental principle of sampling. Tversky and Kahneman (1971) found that

psychologists, trained in statistics, had seriously incorrect notions about the amount of error and unreliability inherent in small samples of data. This form of bias poses a particularly nagging problem in forecasting the likelihood of uncertain future events since one's forecast must be based on a limited sample of past data. The subjects studied in Tversky and Kahneman's experiments showed biased behaviour in several ways: first, they often gambled their research hypothesis on small samples without realizing that the odds against obtaining accurate results were unreasonably high; second, they often possessed undue confidence in early trends from the first few data points and in the stability of observed patterns of data; third, they were found to have unreasonably high expectations about the replicability of results; and finally, they rarely attributed a deviation from expectations to sampling variability, usually finding some other causal explanation for any discrepancy. In a related study, Kahneman and Tversky found that subjects failed to grasp the notion that sampling variance decreases as sample size increases (Barnes, 1984).

There are significant differences between the different sources about the types of bias or illusion, so it is often difficult to determine which mechanism is responsible for the observed illusion. In the scientific world, the generally accepted approach to classification and explanation of cognitive corrections has not yet been achieved (Nicholls, 1999).

Correspondingly, the catalogue of different forms of bias, affecting how we reason in a very wide range of circumstances, is extensive (Baron, 2007; Paley, 2005). It is sobering to reflect that we are particularly likely to succumb to illusions about ourselves and that it is routine to feel completely confident about our illusory judgments (Griffin & Tversky, 2002; Paley, 2005). Indeed, so consistent is the evidence for the ubiquity of cognitive illusion that it is not unreasonable to wonder how, on this view, human beings ever manage to accomplish anything (Gilovich & Griffin, 2002; Paley, 2005). While the evidence does not entail «that people are

perceptually or cognitively inept» (Paley, 2005; Tversky & Kahneman, 2002), it is still not at all obvious how to explain the fact that we go wrong so often.

We define the most common factors and reasons that cause the illusion of thinking: «crashes» in processing information (wrong recall of certain past positions and behaviors, reminiscent of present positions and behavior); the limited possibilities of the brain concerning the processing of information (associated with the features of the brain to perceive, recall and draw conclusions); emotional and moral reasons (emotional stress); social influence (where great value is given to desirable solutions; related to behavior in groups).

3. Discussions

The paper is devoted to the study of the illusion of thinking in metacognitive monitoring in learning activity of university students.

We review some illusions of thinking that are sometimes used to inform metacognitive judgments and that can produce errors in metacognitive monitoring. This section is not meant to describe all of the potential errors that might arise in metacognitive monitoring, but simply to provide some illustrative examples (Hacker, Dunlosky, &Graesser, 2009).

Learners' familiarity with the information being judged can have an influence on their metacognitive judgments. Because this experience of familiarity often results from prior exposures to and learning of the information, it can be diagnostic of a greater likelihood that the information is known (i.e., it often results in accurate judgments). Unfortunately, familiarity can also arise in situations where it is unrepresentative of knowledge. For instance, the study conducted by Reder and Ritter (1992) with solving difficult arithmetic problems. When all the problems were presented, participants had to quickly choose whether to calculate the

answer to each problem or recall it from memory (calculation, of course, was the only option the first time a problem was presented). Participants received 50 points for correctly recalling an answer and 5 points for correctly calculating an answer (but only if the selections and responses were made within the designated time limits).Participants were later paid 0.05 cents for each point earned. By manipulating the occurrence of specific numbers in the set of problems, Reder and Ritter manipulated the participants' familiarity with the numbers present in the problems independent of their memory for specific problems and their solutions. Participants were able to use their familiarity with the numbers—both independently and as whole problems—to quickly decide whether they knew the answers to the problems. This strategy proved helpful when the specific problem had actually been presented in accordance with the participants' familiarity for the numbers, but proved to be faulty when familiar numbers were combined into novel problems—problems for which the participants could not actually recall an answer. The results of the study results pointed to the importance of cue familiarity (Hacker, Dunlosky,& Graesser, 2009; Metcalfe, Schwartz,& Joaquim,1993; Schunn, Reder, Nhouyvanisvong, Richards, & Stroffoli-no,1997).

Although familiarity might sometimes be an appropriate basis for metacognitive judgments, in many situations inappropriate use of familiarity during study can produce monitoring errors. For example, many textbooks provide a list of key terms that students should be knowledgeable about and practice questions that they should be able to answer after reading a chapter. A student who bases a judgment of their memory or understanding for the chapter on their familiarity with these terms or the phrases in the questions rather than on an attempt to define the terms or answer the questions would be likely to overestimate their learning and might be expected to have poor relative accuracy. Such a situation was illustrated well by Metcalfe, Schwartz, and Joaquin (1993), who manipulated the familiarity of cues for

feeling of knowing judgments (aka FOKs, which are judgments that one will be able to recognize the correct target word of an incorrectly recalled cue-target pair at a later time) independent of the retrievability of the targets. This was achieved by manipulating the frequency of the cue words across pairs using a classic interference design (i.e., A-B A-B; A-B′ A-B; A-D A-B; and C-D A-B pairs). So, for the A-B A-B procedure, participants studied the same cue-target pairs on each of two lists, whereas for the A-D A-B procedure, participants studied the same cues on each of two lists, but they were matched with different targets on each list (hence a change from D to B).Participants gave higher FOKs to items that had familiar cues (e.g., A-B A-B; A-B′ A-B; and A-D A-B pairs) than to pairs that had less familiar cues (C-D A-B) even though interference was produced in some of the former conditions, which impaired recognition perfor-mance (Hacker, Dunlosky, & Graesser, 2009). Metcalfe (1993) also argued that the cues that evoke errors are probably more familiar than those that evoke nothing, because at least they were familiar enough to lead to some response. The cues for omission errors were so unfamiliar that they produced no response.

Familiarity can also cause monitoring problems when lear-ning must be monitored across a variety of topics, as is common in educational settings (e.g., studying for multiple final exami-nations during the same week). Students vary in their knowledge and understanding of the different topics they encounter in school and this information—their domain familiarity—is sometimes used to inform students' metacognitive judgments. Participants in a study by Glenberg, Sanocki, Epstein, and Morris (1987) read and judged their understanding for texts on a number of topics before being tested on their understanding of the texts. Glenberg et al. (1987) found that participants used their familiarity with the topic of each text as the basis for their metacomprehension judgments rather than basing their judgments on their understanding of each particular text. Basing judgments on domain familiarity rather than an understanding of the texts impaired the

accuracy of the participants' judgments. Students study topics in multiple domains at the same time in the classroom, and so they might fall prey to a similar error. For example, a student studying for both a mathematics and social studies test the following week might devote more time to studying mathematics because he or she feels less knowledgeable about this topic than social studies. This might often be a good strategy, but if in fact the student has poor understanding for the current social studies lesson and does not factor this into their plan of study, they might go into the social studies test under-prepared (Hacker, Dunlosky, & Graesser, 2009).

In the original study, Glenberg and Epstein found a negative relationship between the accuracy of metacomprehension jud-gments (readers' predictions of whether they would be able to answer comprehension questions about texts they had just read) and the number of courses they had taken in the content area. One of the main reasons for the popularity of Glenberg and Epstein's finding is likely that it stands in contrast to most findings related to domain knowledge and performance on domain-related tasks, i.e. that the possession of domain knowledge usually improves performance on domain-related text comprehension and problem-solving. This conclusion suggests that experts may be less likely to review information that they fail to comprehend accurately on their first pass through a novel text. Moreover, if high-knowledge individuals assume that they understand novel domain-related information on the basis of their general proficiency in the domain, they may inaccurately encode this information, or fail to encode it altogether. This may increase the probability that these individuals will commit undesirable and potentially costly errors (Jee, Wiley, & Griffin, 2006).

Sometimes, after the information has been obtained or understood, people think they knew or understood it all along. For example, Fischhoff (1975) provided participants with des-criptions of a historical event involving the war between the British and the Gurka. Some participants did not learn the

war's outcome, whereas others learned that «The British and the Gurka reached a military stalemate». Subsequently, participants consi-dered several possible outcomes, including the actual outcome. For each possible outcome, participants estimated how likely it would be for a naïve peer to predict that outcome. Compared to participants who did not learn the true outcome, participants who learned the outcome estimated that naïve peers would be more likely to predict the war's true outcome (Ghrear, Birch, & Bernstein, 2016).

Fischhoff (1975) demonstrated that these participants could not avoid using their knowledge of the outcome when making this judgment; they even judged that they would have correctly predicted highly unlikely events (some of which were false). The participants in his study demonstrated hindsight bias—a tendency to use new knowledge when thinking about the past—without even knowing that they were doing so (Hacker, Dunlosky, & Graesser, 2009). When we attempt to understand past events, we implicitly test the hypotheses or rules we use to both interpret and anticipate the world around us. If in hindsight, we systematically underestimate the surprises which the past held and holds for us, we are subjecting those hypotheses to inordinately weak tests and, presumably, finding little reason to change them. Thus, the very outcome knowledge which gives us the feeling that we understand what the past was all about may prevent us from learning anything from it (Fischhoff, 1975).

More so than students, teachers should be wary of a form of hindsight bias when judging if their students understand the lesson being taught. Teachers might overestimate their students' understanding of a lesson because—to the teacher—the lesson is easy to understand. Teachers should favor objective measures of their students' understanding (such as quizzes) instead of relying on their own or their students' subjective assessments of the students' learning (Hacker, Dunlosky, & Graesser, 2009).

Yang taught participants of the experiment to think explicitly about

what is true and what is false. The difference between illusions and control problems vanished, but performance on the control problems fell from almost 100% correct to around 75% correct (Yang & Johnson-Laird, 2000). The principle of truth limits understanding, but it does so without participants realizing it. They were highly confident in their responses, usually no less so when they succumbed to an illusion than when they responded correctly to a control problem (Holyoak & Morrison, 2012).

In terms of improving students' metacognitive monitoring, teachers should warn students about the illusion of thinking (i.e., systematic errors in metacognitive monitoring) they might encounter when studying specific types of materials or making specific types of judgments (e.g., the foresight bias). Although students can learn how to overcome the illusion of thinking through experience with the illusion-causing materials, only explicit, theory-based training for such illusion transfers to new instances of such materials (Hacker, Dunlosky & Graesser, 2009; Koriat & Bjork, 2006; Serra & Metcalfe,2009). For this reason, students should be explicitly trained to avoid specific illusion rather than waiting for them to learn from their mistakes. Further empirical work is certainly required here, as simply teaching or warning students about the illusion of thinking is not adequate to ensure that it will not occur. As described by Wilson and Brekke (1994), such as «mental contamination» can be difficult to avoid if one does not feel that it is in fact occurring. Not only will students need to accept that they are prone to specific biases, but they must also learn how to appropriately adjust their metacognitive monitoring judgments to avoid them. Sometimes, however, the question can be framed in such a way that the student will recognize the possibility that they might experience the illusion of thinking. For example, students who are asked whether they will remember information on a test will have a different response than students who are asked whether they will forget information on a test. Framing the question in a different way can facilitate the insight that the student's metacognitive

monitoring might be incorrect (Hacker, Dunlosky & Graesser, 2009; Serra & Metcalfe, 2009).

It is worth noting that metacognitive monitoring is in principle imperfect and can sometimes lead to error or illusion of thinking (Thomas, 2011). Although the presence of illusion of thinking can be a universal feature of students, however, its ability to lead to a non-normative choice depends on the individual to the individual, since heuristic answers sometimes overlap with an autonomous analytic thinking system (System 2 according to D. Kahneman) (Stanovich & West, 2008).

4. Conclusions

The multifactorial nature of the illusion of thinking determines the multidimensional nature of the research of the students' learning activities. Heuristics allow students to solve problems and make judgments quickly and efficiently, saving on decision-making time, but they are also prone to errors.

We consider the illusion of thinking as dysfunctional errors in the information processing system. The illusion of thinking is considered to be particularly worrying in complex systems with their increased uncertainties and where errors of judgment can compound the problem by triggering unseen effects and breakdowns which even undermine safety in some situations. So, in developing tools to support resilient thinking, making students aware of possible illusion in decision making under uncertainty was considered an essential first step. However, being aware of the illusion of thinking does not necessarily make it go away, so further strategies are needed (Bellamy, Chambon, & Guldener, 2018).

The current development of the education system encourages focusing on the illusion of thinking in metacognitive monitoring of the learning activity in university students. The illusion of thinking in metacognitive monitoring

is not sufficiently explored. The question of the extent to which the illusion of thinking can be modified by training deserves more research than it has received. Inasmuch as a critical step in dealing with any type of bias is recognizing its existence, perhaps simply being aware of the illusion of thinking − of its pervasiveness and of the many guises in which it appears − might help one both to be a little cautious about making up one's mind quickly on important issues and to be somewhat more open to opinions that differ from one's own than one might otherwise be (Nickerson, 1998).

At the moment, the following questions remain open: how to teach students to recognize situations with a high degree of probability of admitting errors and how to avoid them? And if it is possible in the process of students' learning activities? These are the main questions we need to answer in our future experimental research.

In our further study, we plan to identify situations in which students assume the greatest number of errors, having made their systematization in order to identify the essential feature. We will try to create a general program («operator») for students by means of metacognitive monitoring, which will help them to reduce the influence of the illusion of thinking in learning activities through a set of operations that will lead to the formation of automated skills.

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