Annotation
on the thesis «The dynamics of working memory load in insight problem solving»

The modern cognitive psychology is actively engaged in studies of working memory, its functions and relationships with other cognitive processes. There are many studies devoted to the research of various aspects of working memory, starting with its components (Baddeley, 2001, 2002; Bayliss et al., 2003; Carlson et al., 1990; Carlson, Sullivan, Schneider, 1989; Colom, Shih , 2004; Engle, Kane, 2004; Kyllonen, Christal, 1990) and ending with the organization of information storage in the form of slots, resources or hybrids (Luck, Vogel, 1997, 2013; Ma, Husain, Bays, 2014). We want to devote the PhD-thesis to studying the relationships between working memory and insight problem solving. The study is heuristic, because working memory is a cognitive resource, whose volume and control systems are used to perform cognitive functions. At the same time, problem solution combines many cognitive processes, the activity and results of which should be reflected in working memory. The manipulation of working memory parameters can provide new information about how the solution is developed, what processes and functions are included in it.

Notwithstanding of long-standing study of the insight, there is no clear idea of what mechanisms underlie this solution type; what processes are included in it; what factors do determine the right answer; are there fundamental differences between insight and algorithmic problems? Current theories (Ohlsson, 1992, 2011; Weisberg, 2015; Fedor, Szathmáry, Öllinger, 2015) have different answers on these questions, which supports the conventional division into specific and non-specific approaches. Approaches' provisions can be translated into terms about interaction between problem solving and working memory. Accordingly the specific approach, insight solution is controlled by special mechanisms and requires fewer working memory resources to execute. It is due to the fact that insight problems do not assume storing a large number of subtotals and steps. Accordingly the non-specific approach, insight solution requires the same amount of working memory resources to perform as the algorithmic problem, because both problem types are controlled by similar mechanisms. Visible differences between problem types are the result of quantitative, but not qualitative changes.

At the moment, there are a number of papers devoted to the research of working memory and insight problem solving. However, there is not consensus between them. On the one hand, there are empirical evidences in favor of the leading role of slave systems (Chein et al., 2010; Chein, Weisberg, 2014; Gilhooly, Fioratou, 2009; Gilhooly, Murphy, 2005) and negative (Beilock, DeCaro, 2007; DeCaro, Van Stockum, Wieth, 2016; Jarosz, Colflesh, Wiley, 2012; Reverberi et al., 2005) or insignificant (Lavric, Forstmeier, Rippon, 2000; Ash, Wiley, 2006) the influence of the central executive in insight problem solving. The data supports the idea of insight specific and insight's difference from algorithmic problem solving. On the other hand, there are evidences that the central executive plays the leading role in the insight implementation and explains two-thirds of the variation in the success of insight solution (Chuderski, 2014; Chuderski, Jastrzebski, 2018; DeYoung, Flanders, Peterson, 2008; Murray, Byrne, 2005; Nęcka, Żak, Gruszka, 2016). Such results contradict the specific approach, and the specialists who received them say that insight problem solving is one of options for algorithmic solutions.

We suppose that the most promising option for resolving existing contradictions is to study the insight dynamics. The study of dynamics avoids the problem of solution heterogeneity. Most authors assume that insight solution is heterogeneous, i.e. consists of several stages (Dunker, 1965; Koehler, 2008; Wallace, 2008; Ash, Wiley 2006; Beeftink et al., 2008; Fedor et al., 2017;

MacGregor, Ormerod, Chronicle, 2001; Newell, Simon, 1972; Ohlsson, 1992; Seifert et al., 1995; Weisberg, 2015). Various cognitive processes occur on each stage of problem solving that can interact in different ways with working memory components. At the moment, there are few researches which are unifying the dynamics of insight and working memory (Markina, Makarov, Vladimirov, 2018; Chistopolskaya, 2017; Lv, 2015; Yeh et al., 2014).

The thesis is aimed at filling the gap in the research of the relationship of working memory and insight problem solving. The study of the insight dynamics was conducted using the method of cognitive monitoring. On the one hand, this method allowed us to obtain data that the insight solution seems to be similar to the algorithmic solution. Insight problem solving is based on the central executive of working memory, and finding the answer is serial, successive process which is affected on the cognitive resource load. On the other hand, insight solution demonstrates the specific nature of the underlying mechanisms. Insight problems load working memory lesser than algorithmic problems. The reason for high load in the end of insight solution is performance of a specific insight operation – a representational change. These results make us look differently at the usual division of specific and non-specific approaches. Insight solution is not a completely specific process, but it contains partial specific stages.

The results can be presented in the form of following conclusions:

1. Working memory is involved in insight and algorithmic problem solving. Problem solving consists heterogeneous cognitive processes. Monitoring of working memory load allows you to investigate these processes, and their combination creates the dynamics of mental problem solving.
2. The working memory load can estimate with the method of cognitive monitoring by tracking the reaction time to the probe-task.
3. The central executive of working memory plays the important role in algorithmic and insight solutions. It is demonstrated the presence of working memory load in both problem types.
4. The pattern dynamics is differed in insight and algorithmic problems. The working memory load for algorithmic problems is associated with amount of computational operations.
5. The dynamics of insight problem solving has two phases. The start phase of solution is associated with non-resource-intensive operations in the form of reading, constructing initial representation, searching in the wrong problem space. The end phase of solution demonstrates high working memory load. It is associated with complex cognitive processes.
6. Insight and algorithmic problems do not differ from each other based on the outwardly working memory load on the last stages. However, the underlying mechanisms are different. In our opinion, the increase of working memory load on the last stages of insight problems is associated with the representational change.
7. The data about important role of representational change obtained by sequentially eliminating alternative explanations such as relationships between the increase of working memory load and fatigue, verbalization and amount of computational operations.

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