Thinking Skills and Creativity 14 (2014) 98–106

Contents lists available at ScienceDirect

Thinking Skills and Creativity

journal homepage: http://www.elsevier.com/locate/tsc

How can we gain insight in scientific innovation? Prototype heuristic is one key

Dan Ming[a,b,1], Dandan Tong[a,b,1], Wenjing Yang[a,b], Jiang Qiu[a,b,*], Qinglin Zhang[a,b,*]

[a] Key Laboratory of Cognition and Personality (Southwest University), Ministry of Education, Chongqing 400715, China
[b] Faculty of Psychology, Southwest University, Chongqing 400715, China

ARTICLE INFO

Article history:
Received 30 May 2014
Received in revised form
12 September 2014
Accepted 20 September 2014
Available online 5 October 2014

Keywords:
Insight
Scientific innovation
Prototype Heuristic Theory
Representations connection
Relationship mapping

ABSTRACT

Insight can be the first step toward creating a groundbreaking product. The Representation Change (RC) Theory and the Progress Monitoring (PM) Theory and other theories of insight have been verified through numerous studies, but they indeed are not so perfect. We put forward a Prototype Heuristic Theory of insight and explored its cognitive mechanism by this study. Based on this theory, insight would occur as soon as the critical heuristic information contained in prototypes was suddenly obtained to play an orientational role in the process of searching the right problem solution searching space. The process of prototype heuristics consists of two stages: "representations connection" stage and "relationship mapping" stage and the core process was the representations connection. Furthermore, high semantic similarity between required-function of problems and feature-function of prototypes was the prime condition for representations connection. We also developed the RC Theory and PM Theory in some extent based on our Prototype Heuristic Theory.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

In the process of problem solving, we sometimes encountered an impasse followed the initially purposeful thinking—a state of mind in which the problem solvers become stuck and have no idea of what to do next after all options have been explored (Schooler, Fallshore, & Fiore, 1995; Lin & Wang, 1994, Qiu & Zhang, 2008; Schooler, Ohlsson, & Brooks, 1993). If fortunately, a new idea or option will, in some cases, suddenly and unexpectedly come to mind after continued concentration on the problem. This phenomenon is so-called the *insight*, usually accompanied by an "Aha" experience (Gick & Lockhart, 1995; Smith, 1995). Recently empirical studies of insight were mainly conducted from the information-processing tradition focused on process factors which included the size of search spaces for problems, branching, the length of solutions, the specificity of the goal state, and the motive power to find a solution (MacGregor, Ormerod, & Chronicle, 2001; Ormerod, MacGregor, & Chronicle, 2002). Controversy remains as to the cognitive mechanism of insight problem solving, in spite of a shared point of the information-processing heuristics. Among these theories, there are two overarching models: the Representation Change (RC) Theory (Kaplan & Simon, 1990) and the Progress Monitoring (PM) Theory (Knoblich, Ohlsson,

* Corresponding authors at: Faculty of Psychology, Southwest University, No. 2, TianSheng Road, Beibei District, Chongqing 400715, China. Tel.: +86 23 6836 7942/6825 2660.
E-mail addresses: qiuj318@swu.edu.cn (J. Qiu), zhangql@swu.edu.cn (Q. Zhang).

[1] These authors have contributed equally to this work.

http://dx.doi.org/10.1016/j.tsc.2014.09.006
1871-1871/© 2014 Elsevier Ltd. All rights reserved.

Haider, & Rhenius, 1999). The RC Theory proposes that when problem solvers change their searching strategy space from wrong problem spaces to the right problem space or the meta-level problem space, insight may occur. The PM Theory attempt to explain the cognitive process of insight in the framework of mean-end analysis. In this theory, in the process of problem solving, problem solvers should abandon those means which are not gradually close to the target state and then seek alternative moves to shorten the distance from the current state to the goal state (solving problems). The RC Theory and the PM Theory were verified through numerous studies (Chronicle & Ormerod, 2001; Chronicle, Ormerod, & MacGregor 2004; Jones, 2003; Knoblich et al., 1999; Knoblich, Ohlsson, & Raney, 2001; MacGregor et al., 2001; Ormerod et al., 2002). However, the RC Theory did not make it clear how people can find the right problem space after they change their strategy searching space into the meta-level problem space. Leaving wrong problem spaces was just the necessary but insufficient condition of solving problems successfully. It would be quite hard to find the right problem space staying in the meta-level problem space, which we proposed heuristics play an important role in (Luo, Du, et al., 2013). The PM Theory has not elaborated in which way people can detect that new and more efficient means after abandoning those means which are not gradually close to the target state. Except for algorithms searching method and random searching method which cannot lead to insight, heuristics method is a key (Luo, Du, et al., 2013). Accordingly, we would answer these unsolved questions about the second stage in these two theories to explore two classical theories further.

Moreover, those existed classical insight problems (e.g. candle problem, two-ring problem, match problem and so on) mainly stayed in “knowledge-poor” field, problems from which just requires common world knowledge (Bereiter, 2009; Lappin & Leass, 1994), thus it can hardly be applied to tests in “knowledge-rich” field, problems from which requires domain-specific knowledge (Glaser, Chi, & Farr, 1988; Schauble, 1996), such as scientific innovation problems. How does people with domain-specific knowledge get insight has been little investigated, probably because their current amount of knowledge in certain domains is hard to control.

Heuristics has proved to be a powerful way in gaining insights that yield effective problem representations and solutions. In the classical theory of “blind variation and selective retention” (BVSR) which is similar to natural selection in evolution explaining the development of creative thought proposed by Donald Campbell in 1960, the main point is that BVSR was responsible not just for creativity, but also for discovery and “heuristics” was laid importance on (Campbell, 1960). This theory was elaborated by Dean Keith Simonton later who offers extensive and compelling support underlying creative cognition (Jung, Mead, Carrasco, & Flores, 2013; Simonton, 1999). In the first stage based on BVSR, the most common processes that yield blindness involved associative richness, defocused attention, behavioral tinkering, and heuristic search (Simonton, 2011). Though applied heuristic method is more mindful and intentional in application, each of them constitute a blind ideational variant at a metacognitive level of operation (Simonton, 2011). Wigglesworth (1955) has noted this strategy in terms of “pure” scientists in scientific problem solving. Usually, in the processes of numerous scientific innovations, scientists are apt to seek for the solution relentlessly till an insight occurred, which usually after a heuristic prototype being activated (Luo, Du, et al., 2013). Illustrate with examples, Luban invented saw inspired by thatch with tooth edges and Watt catched inspiration for inventing steam engines when he saw the boiling water push the cover away from the kettle. These phenomena demonstrate the importance of heuristic method in scientific innovations. As the above analysis indicates, based on the practical experiences, we try to propose a theory of insight called the Prototype Heuristic Theory and have conducted a series of researches based on this theory (e.g. Hao et al., 2013; Luo, Du, et al., 2013; Luo, Li, et al., 2013; Tong, Li, et al., 2013; Tong, Zhu, et al., 2013). Insight would occur as soon as the critical heuristic information contained in prototype was suddenly obtained to play an orientational role in the process of finding the right problem searching space to solve problem. The term “prototype” here is distinct from that same word in traditional cognitive psychology. We defined the term “prototype” as the object containing the heuristic information to solving insight problems but superficially semantic irrelevant with insight problems. The experimental materials (as described in Section 2) we collected consist of technical problems and heuristic prototypes. Each heuristic prototype has a key “feature-function” along with a “certain construction”. To solve each technical problem is mainly to achieve a “required-function”. The key to achieving the “required-function” is to find such an “unknown construction” (illustrated in the following example).

Take the technical problem of *how to design spacesuits* as an example. The technical problem is: Scientists were attempting to find a special material for the space suit that would be not only hard enough to bear air pressure but also can be bent freely to do extra-vehicular activity. How can such a material be found? In this scientific problem, the “required-function” is being not only hard enough but also can be bent freely. People will ponder this problem over and over again till maybe when they caught sight of *shrimp shell* at table and noticed that the shell of shrimp body is just quite hard and can be bent (“feature-function”) due to its ring connection (“certain construction”). At this moment, people will be enlightened to solve that certain problem. In detail, in this process of gaining insight, based on our Prototype Heuristic Theory, we proposed there were two stages contained in it: the “representations connection” stage and the “relationship mapping” stage. Firstly, after people formed the semantic representations of both problems and prototypes, when problem solvers had discovered the similarity between representations of required-function in a problem and feature-function in a prototype, the connection between representations of the technical problem and the prototypes would occur. Secondly, followed the first stage, the relationship between certain construction and feature-function of the prototype will be mapped into the representation of technical problem, which is so-called the “relationship mapping” stage to achieve the prototype heuristics. Illustrated with an example, in the problem just mentioned “*how to design spacesuits*”, when problem solvers noticed the features of *shrimp shell* (quite hard and can be bent due to its ring connection construction) which are similar to the required-function of “*how to design spacesuits*” problem, the connection between representations of the problem and shrimp shell occurred.

Download English Version:

https://daneshyari.com/en/article/375553

Download Persian Version:

https://daneshyari.com/article/375553

Daneshyari.com