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The impact of age and training on creativity: A design-theory approach to study fixation effects

Marine Agogué [a,b,*], Nicolas Poirel [b,c], Arlette Pineau [b], Olivier Houdé [b,c], Mathieu Cassotti [b]

[a] Centre de Gestion Scientifique, Mines ParisTech, France
[b] Laboratoire de Psychologie du Développement et de l'Education de l'Enfant – Université Paris-Descartes, France
[c] Institut Universitaire de France, France

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ABSTRACT

Despite diverse studies grasping at different aspects of fixation in creativity and design reasoning, the underlying mechanisms of fixation, i.e. the processes that interfere during creative reasoning and that lead to being fixed on a small number of unvaried solutions, are still unclear. Specifically, there is a need to understand more precisely the link between some activated knowledge and the solutions that are consequently explored, in order to model the fixation that occurs during design reasoning. This paper aims at examining the nature of fixation in creative contexts, and the impact of age and training on creative skills. In this paper, we propose a theoretical framework to model fixation based on C-K design theory, in which fixation is characterized as a set of restrictive heuristics activated in a creative reasoning. We apply our framework to a creative task and confront this theoretical approach with a set of experiments. In two studies, we show how age and education impact individuals in different ways regarding fixation and how the proposed framework allows making sense of this variety of fixation in design processes. We conclude by proposing three capabilities that are required to both understand fixation and overcome it: restrictive heuristics development, inhibitory control and expansion.

1. Introduction

There are today large expectations towards innovation and creativity. The impact of age and teaching on developing creative skills has become a crucial stake, as being creative is a quality that is more and more sought in our society. However, generating and developing new ideas might not be as easy as it seems, and people often struggle in creative settings. Creativity is not an innate quality and requires developing sophisticated reasoning skills. Those cognitive processes that support idea generation still need to be precised, all the more so as both conscious and unconscious processes can occur (Ritter, van Baaren, & Dijksterhuis, 2012).

More precisely, studies have highlighted how people are likely to face cognitive difficulties during creative situations. Looking at one aspect of many regarding creativity, Jansson and Smith (1991) have shown that the first explored solution in a design task influences heavily the exploration of new solutions. This phenomenon is characterized as fixation effect, i.e. "*a blind, sometimes counterproductive, adherence to a limited set of ideas in the design process*". If literature builds often on

* Corresponding author at: Centre de Gestion Scientifique (CGS), Mines ParisTech, 60 Boulevard Saint Michel, 75272 Paris Cedex 06, France. Tel.: +33 1 40 51 92 01.
E-mail address: marine.agogue@mines-paristech.fr (M. Agogué).

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this notion of fixation in design processes (Chrysikou & Weisberg, 2005; Linsey, Tseng, Fu, Cagan, & Wood, 2009; Perttula & Liikkanen, 2006; Purcell & Gero, 1996) and even proposes practical methodologies to overcome fixation effects (Hatchuel, Le Masson, & Weil, 2011; Linsey et al., 2009; van der Vlugt & Wieringa, 2002), the nature of the very mechanisms that lead people to being fixed on some ideas or solutions still remains to be explored. The modelling of the concept of fixation effect remains vague: it is mostly described as the spontaneous and unconscious activation of some knowledge regarding ways of solving a given design task (Smith, Ward, & Finke, 1995).

Despite those diverse studies grasping at different aspects of fixation in creativity and design reasoning, the underlying mechanisms of fixation, i.e. the processes that interfere during creative reasoning and that lead to being fixed on a small number of unvaried solutions, are still unclear. Specifically, there is a need to understand more precisely the link between some activated knowledge and the solutions that are consequently explored, in order to model the fixation that occurs during design reasoning. Indeed, if research has provided insights on the existence of the phenomenon of fixation, there remains a need to clarify the mechanisms underlying fixation. Studies on fixation indeed require a theoretical framework to be able to model the path-of-least-resistance, i.e. the path of fixation, as well as paths out of fixation. Moreover, a theoretical framework of design fixation should account for the different fixations that can occur and provide a model explaining the specificities of fixation.

This paper aims at examining the nature of fixation in creative contexts, and the impact of age and training on design fixation. We propose a theoretical framework to model fixation, based on C-K design theory. Indeed, C-K theory offers a modelling of creative reasoning by separating two spaces, the knowledge space and the concept space, which allows to account for the links between different knowledge bases and the possible design paths that can be explored using the pockets of knowledge. We expose in this paper such a theoretical framework that allows us to characterize the nature of fixation mechanisms. We then use a creative task where the aim is to design a way to drop a hen's egg from a height of 10 m so that it does not break. We choose this familiar task because it requires minimal engineering expertise and allows many possible solutions. We apply our framework on this task to characterize the possible fixation effects. We conduct two studies to explore the impact of age and education on fixation. In each study, different populations (with various age in the first study and different education background in the second study) are given ten minutes to generate as many solutions as possible to the creative 'egg task'. We show how different populations in terms of age and training can be fixed in different ways and how the proposed theoretical framework allows making sense of this variety of fixation in design processes. We conclude by proposing three capabilities that are required to both understand fixation and overcome fixation: restrictive heuristics development, inhibitory control and expansion.

2. Fixation effect, a cognitive phenomenon in design

In the field of cognitive psychology, scholars have clarified those obstacles that most people are likely to face in creative situations (Abraham & Windmann, 2007; Kohn & Smith, 2011; Smith et al., 1995). They show how some activated knowledge can constrain the ability to generate creative ideas. For example, creative problem solving can be inefficient when the solution requires subjects to generate an atypical object function and when the object's typical function has been primed (Adamson, 1952; Duncker, 1945). In the psychology literature this effect is labelled as the functional fixedness. Other studies (Smith et al., 1995) have highlighted how the first ideas to be considered during creative idea generation can constrain the ideas that are subsequently generated. Furthermore studies have shown how different populations can be affected in different ways by this fixedness: Defeyter and German (2003) have for instance shown how young children are not affected by functional fixedness, in the same way older ones are. In a different setting, Bonnardel and Marmèche (2004) have underlined how experts can be more biased than novices in design situations, in line with work on the impact of domain-related knowledge on creative idea generation (Wiley, 1998).

Besides, other disciplines have looked into the impact of cognitive bias on reasoning. Expanding to design literature is all the more interesting as bridging engineering design and cognitive psychology literature has proven its fecundity to describe mechanisms occurring during creative design process (Howard, Culley, & Dekoninck, 2008). Many factors can influence creative design processes. In their seminal paper experimenting on the obstacles during creative reasoning, Jansson and Smith (1991) have shown that the first explored solution in a design task influences heavily the exploration of new solutions. This phenomenon is called fixation effect, and defined as a tacit unconscious stickiness to a limited scope of ideas during a creative design process. This study stressed how individual designers can be trapped by an existing (or an obvious) solution, which constrains the generation of alternative solutions. This fixation effect is described as due to the existence of precedents in design situations, generally in the form of visual representations. Design literature builds on the notion of fixation in design processes in various settings. Using a complementary perspective, Purcell and Gero (1996) also explored cognitive bias in design situations: they showed how fixation and conformity effects can occur in design processes, when individuals have to design new objects (products or services) in order to accomplish specific functions. They specifically studied the link between fixation and domain specific knowledge. Besides the nature of the stimuli that can reinforce fixation can take various forms: it can be problem-relevant information given to participants (Tseng, Moss, Cagan, & Kotovsky, 2008), as well as non verbal pictorial information (Cardoso, Badke-Schaub, & Luz, 2009). Moreover, several authors have proposed practical methodologies to overcome fixation effects, ranging from design methodologies (Hatchuel et al., 2011), to the use of analogies (Linsey et al., 2009; Smith et al., 2010; Youmans, 2011), of expansive examples (Agogué, Kazakçi, Weil, & Cassotti, 2011) or of improvisation (Lewis & Lovatt, 2013).