



When Is a Cognitive System Flexible? The Variability–Stability–Flexibility Pattern on the Way to Novel Solutions

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Abstract

Creativity and flexibility are considered by many to be inextricably linked. However, the current literature does not offer a clear view about their relationship and flexibility is not a unitary construct in psychological research. In this work, I present a new theoretical approach that considers flexibility a recurrent property in and of the cognitive system and I argue that flexibility is best understood as a link in the variability–stability–flexibility pattern. Investigating this pattern and looking at the dynamic flow from variability to stability and then to flexibility in the functioning of the cognitive system can lead us to better grasp how the system arrives at novel solutions in creative problem solving.

Keywords: creative problem solving; flexibility; pattern; property.

Introduction

Why do humans seem to be special? Some argue that it is because we can adapt quickly and invent new things. These two behaviors have been present since the beginning of our species, but despite being investigated in several scientific domains over the last two centuries, we have no clue yet about what exactly enables us to perform them. In other words, there is little understanding, let alone agreement, in the literature about what flexibility, creativity, and innovation are.

In this paper, the focus will be on flexibility, which can be seen as being at the heart of human achievement (Carr, Kendal, & Flynn, 2016), because it helps humans to identify and follow new ways of seeing things or solve problems. I will start with pointing out the lack of clarity in the current studies on flexibility and creativity; a new theoretical proposal regarding flexibility will then follow, one in which flexibility is seen as a link in the variability–stability–flexibility pattern that characterizes the functioning of most processes in the cognitive system. In the end, I will discuss the implications of this proposal. Understanding what mechanisms are involved in the emergence of flexibility, creativity, and innovation would help us explain a whole plethora of human behaviors, from artistic creations to everyday solutions and scientific discoveries.

The Need for Conceptual Clarity in the Study of Flexibility and Creativity

More and more recent studies point to several flaws in our field, and more specifically to the need of agreed-upon views about the concepts we study in psychology (Aldao, Sheppes, & Gross, 2015; Carr et al., 2016; Dietrich & Kanso, 2010; Ionescu, 2012; Simonton, 2016; Ziegler, Stoeger, & Vialle, 2012). Overton (2015) asserts that vocabulary matters and shows that in general in the field of human development, there is the need for more conceptual clarity. In the same vein, I start this paper with the assumption that the field of creativity would move forward faster if there were more agreement and clarity about the mechanisms that lead to creativity. For example, how can we say that flexibility is a *sine qua non* condition for innovation and then not have an agreed-upon definition of flexibility? Or how can we say that we should foster creativity and innovation when we do not agree on what exactly these two terms mean?

If we consider flexibility, the literature offers us at least four views (see Figure 1, Panel A; see also Ionescu, 2017, for a more detailed description). First, some authors equate cognitive flexibility to the ability of shifting (Chan, Shum, Touloupoulou, & Chen, 2008; Cragg & Chevalier, 2012; Diamond, 2006; Garon, Bryson, & Smith, 2008; Vandierendonck, Liefoghe, & Verbruggen, 2010). Under this view, flexibility is considered to be the ability to shift attention from one rule or task to another. Second, in creativity studies it often represents a measure in the Alternative Uses Task, namely the number of types of ideas one can come up with (Dietrich & Kanso, 2010). Third, in personality studies, flexibility is associated with “openness to experience” (Chung, Su, & Su, 2012; Kalbitzer et al., 2009). Fourth, in different research areas, flexibility is seen as a property of the investigated processes. For example, authors speak about flexible language (Naigles, Hoff, & Vear, 2009), flexible categorization (Ionescu, 2007; Ross & Murphy, 1999) or flexible emotions (Hollenstein, 2015). After reading about these views one is left with an essential question: which one is required for creativity and innovation to emerge? Furthermore, are all of these necessary? And if yes, how to combine them? One solution maybe to change the lenses through which we look

at flexibility. The next section proposes a new perspective with the hope that this will lead us eventually to more conceptual clarity in order to understand how we arrive at novel solutions when confronted with intriguing problems.

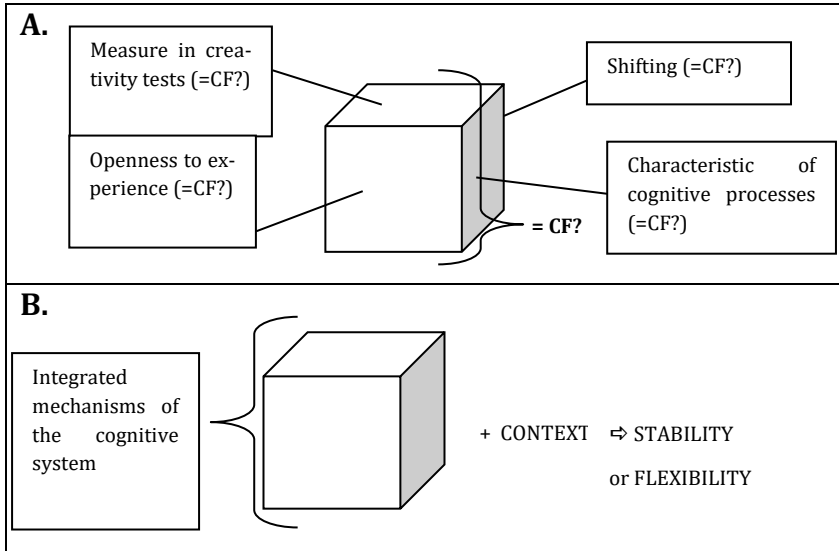


Figure 1. A depiction of: some of the sides of cognitive flexibility in current literature (Panel A); the proposed integration of cognitive (and non-cognitive) mechanisms with context for the emergence of the stability or the flexibility of the cognitive system when solving problems (Panel B). (CF = cognitive flexibility)

When Is a Cognitive System Flexible?

The question that opens this section is a fundamental one because before we can analyze what flexibility is we must describe instances in which the system is flexible. Usually when the system does multitasking, when it changes its behavior according to changing rules, when it finds new solutions or creates something new, it is said that it behaves flexibly (Crone, Bunge, van der Molen, & Ridderinkhof, 2006; Gibson, 1994; Goldstone & Landy, 2010; Leber, Turk-Browne, & Chun, 2008; Monsell, 2003). If one analyzes these instances carefully, one can see that each of them entails a combination or an integration of several processes. For example, in order to find a new solution, one has to activate previous knowledge to make associations between bits of knowledge, to shift perspectives, to use selective and focused attention, to shift attention, to monitor conflictual information, and so on. After all these happen we say that the system was flexible if it found a novel and appropriate solution. In other words, flexibility emerges as a consequence of all these mechanisms working together (Ionescu, 2012).

Furthermore, oftentimes we see that flexibility comes after a time of stability, or that when solving a problem, the system passes from moments of stability (e.g., when working with previous knowledge and known strategies) to moments of flexibility (e.g., when new ways of seeing the problem emerge). As such a pattern emerges, one that starts with variability (when the system tries out anything in order to solve the problem) then passes to stability (when the system knows the appropriate answers and follows them) and finally to flexibility (when the system changes old ways of solving problems to different/new ways; Ionescu, 2017). This pattern can be observed in the development of various processes (e.g., insight problem solving, categorization, language, or theory of mind; Ionescu, 2017) or when solving a particular problem at a particular moment in time. In the latter case, different dynamics of this pattern can emerge, such as going linearly from one state to another or passing nonlinearly from one state to another embedded one into another (see Figure 1 in Ionescu, 2017). More specifically, when we consider the flexibility of the cognitive system in general, we might observe that the route is not simple and linear (e.g., going from variability to stability and then to flexibility), but more circular or embedded (e.g., going from variability to stability and then jumping back and forth from stability to flexibility to stability to flexibility and so on; or showing a larger variability state in which sometimes the system reaches stability and in which sometimes the system gains flexibility).

Taking things one step further, we might also want to consider the role of context for the emergence of flexibility. Flexibility is present “when abilities are well tuned to changing demands” (Ionescu, 2017, p. 6). When analyzing problem-solving, we can speculate that finding new solutions might rely on a fine tuning between what the system already has (e.g., knowledge, abilities) and the way it pays attention to what the problematic situation asks for, or to the context. If this link functions well, flexibility emerges and the system solves the challenge successfully (see Panel B of Figure 1).

Considering all the aforementioned aspects, let us analyze how we can use this pattern to better understand creativity and innovation. When we are faced with novelty, be it the need to solve a difficult problem or the need to create something, the cognitive system has to use all the resources it can to find the solution. In other words, it will use mechanisms such as shifting, working memory, inhibition, and conflict monitoring together with its knowledge base (from long term memory) and it will try to change perspectives according to the task demands. These mechanisms are combined dynamically in either the state of variability (trying out various ways to solve the problem) or stability (staying with previous solutions) or flexibility (envisaging and changing ways of solving). All these states, no matter if they follow linearly or not, help us better grasp the interaction of the mechanisms enumerated above. As a consequence, by trying to sketch a more general picture of what the system does when it creates (i.e., the aforementioned states and what they entail) we might be better able to see the dynamics of creativity and innovation.

In order to study all the above assumptions, one could investigate improvisation. When improvising, one passes quickly through these states and we could analyze, on the one hand, the dynamics of these states, and on the other hand, the role of stability for flexibility. More specifically, we could analyze whether the pattern is linear and whether one always needs stability before flexibility. At a more general level, we could arrive at a learning account that explains how the system becomes flexible. By analyzing the integration of mechanisms (and not only the mechanisms taken separately) we could arrive at a more accurate picture of flexibility and the dynamics of the creative process. It might be that because there is no single ability that we can call flexibility, all we will be able to educate in the end is the readiness for flexibility. If we want to borrow from how gifted people learn and work, we can speculate that they are immersed in their domain of interest (Ionescu, 2014)—they play with ideas (variability), then repeat endlessly everything in their domain (stability) until they are better at using their knowledge and abilities flexibly. The implications for teaching may be profound: in this era of technology there is the risk that children do not form sufficiently well-organized knowledge bases to support flexibility. If we only focus on innovation, they might be at risk of not having the basic knowledge with which they might innovate. As such, investigating this pattern can have broad implications that might be helpful for understanding and fostering innovation.

Concluding Remarks

The present paper has argued that in order to reach the conceptual clarity needed for a science to mature, we need to carefully analyze the concepts that we use. In the context of creativity and innovation, I have analyzed the concept of flexibility and proposed that if we consider it a property of the cognitive system and look at it in the more general pattern of variability–stability–flexibility, we might be able to better grasp the dynamics of all the mechanisms that are in play when we create. This is only a first step toward disentangling the process of creation. Thorough experimental studies are needed to prove these assumptions—studies in which we also take into account the contextual challenges when investigating creativity and innovation (Gummerum & Denham, 2014).

If we look again to Figure 1, we can say that in order to understand flexibility maybe we first need to think out of the sides of the box (i.e., out of the one-sided current views of flexibility, namely the squares of the cube in the figure), and then to think outside the box (i.e., out of the cognitive system—the cube in the figure—to include the complex interactions with context). In this way, looking at this overarching pattern might help us widen our perspective and observe important aspects that are not visible when we only look at small components.

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First response to “When is a Cognitive System Flexible? The Variability–Stability–Flexibility Pattern on the Way to Novel Solutions” by Pinar Oztop

The current paper suggests understanding the role of flexibility in creativity and innovation as a cognitive system that integrates flexibility with variability and stability.

The Dual Pathway of Creativity Model by Nijstad, De Dreu, Rietzschel and Baas (2010) argued that creativity is a function of both cognitive flexibility and cognitive persistence. In this model, the flexibility pathway represents achieving creativity through problem-solving or producing different ideas in broad range of categories and shifting between these categories. The persistence pathway represents achieving creativity through a more systemic exploration of an extensive amount of information and persistence in only a limited range of categories. The two pathways are not described as negatively related, but are instead seen as complementary. It is acknowledged that creativity can also result from switches from more flexible to more systematic modes. The current paper defines stability as the opposite of flexibility. What Nijstad et al. (2010) argues is that persistence can help turn stability into flexibility. It would be advised to implement this point in the current paper’s cognitive system of flexibility. Is stability just a phase inside the cognitive system that is ideally expected to lead to flexibility, or is stability a dynamic phase that supports systematic thinking, which is also necessary for flexibility? I would like to understand more about the inter-relations between these different phases of the cognitive system and the different ways in which the system can integrate these phases.

The dynamics of the proposed cognitive system can vary according to the task, domain, culture, and the age of the person. The author briefly mentions the role of context and gives the example of problem-solving. This is a valuable point which can be elaborated by also referring to divergent thinking, artistic thinking or design thinking. How does a cognitive system of flexibility vary according to the demands of different tasks? Context can also be approached from the point of domain: how does a cognitive system of flexibility function in artistic, organizational or educational domains? The author also states that improvisation can be a unique context for observing flexibility. Further elaborations with a focus on the nature of improvisation and how/why it can provide such a valuable context for understanding the flexibility of a system would bring valuable insights. Is it the momentarily, unpredictable flow of actions, or is it the richness of variation in improvisation that links with the proposed system?

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Second response to “When Is a Cognitive System Flexible? The Variability–Stability–Flexibility Pattern on the Way to Novel Solutions” by Kathryn B. Francis

In this proposed holistic model of innovation and creativity, the author discusses how a pattern of variability, stability, and flexibility can, as cognitive states, provide a picture of how we arrive at novel solutions in creative problem-solving.

This paper provides a valuable contribution to the literature surrounding creativity and Cognitive Innovation in that the author presents a broad definition of ‘flexibility,’ encompassing varying conceptualizations from the literature and proceeds to successfully unite them within a cognitive framework for creative problem-solving.

In the three-step pattern proposed, variability, stability, and flexibility are connected in both linear and non-linear mappings to link available methods, tried methods, and new methods of problem-solving. Through this characterization, the author refers to the potential for a learning account to explain how this pattern might integrate to explain the dynamics of creation. Following from this, I wonder whether the three-tiered pattern proposed could incorporate an additional state or stage that explicitly accounts for learning, allowing for successful shifting in future instances of creative problem-solving? In this sense, the model might act like a continuous feedback loop, through which reinforcement learning mechanisms enhance the factors that steer our readiness to be flexible. It would also follow that this circular feedback mechanism increases the breadth and quality of stable states. Given that both flexibility and adaptability have been linked to the “darker side of creativity” (e.g., deception, criminality; e.g., Runco, 2014; Gino & Ariely, 2012), it might also be constructive to explore how these self-regulatory processes contribute to both adaptive and maladaptive features of creative thinking, thus extending the application of this model into social domains.

The broader spectrum account of the mechanisms underlying creative problem-solving presented in this paper endorses and follows from the notion that creativity is a complex (Mumford, 2003; Runco, 2014); for any researcher studying creativity, this is undeniable. While the author presents a model that views creative problem-solving at this complex process level, future discussion rests in where the individual might sit in this picture, or how their personality might shape the processes and outcomes of such a model. Is the creative individual the person who is most proficient at being flexible in a given context? Does the pattern assume that creativity and innovation are processes that can be nurtured in anyone, or do individual differences in learning affect ability? After all, the term “flexibility” is often encompassed in summaries of the creative individual (Stein, 1975), which begs the question of how the variability–stability–flexibility pattern unifies person, process, and outcome.

Overall, the pattern proposed by the author offers a compelling story of creative problem-solving. Emphasizing the need to clarify the concepts of creativity and flexibility, the author argues that “the field . . . would move forward faster” (Stein, 1975, p. 283) if we were able to underpin these concepts and their relationships to one another. This approach offers some headway in achieving this, with extensive potential application in other domains.

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