Chapter 4
Emotions: The Spinal Cord of the Creative Thinking Process

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Abstract In reviewing the huge effort made by the psychological research in defining the main components of the creative process and of the creative potential, rarely we encounter models and theoretical frameworks considering emotional reactions as main determinants of the creative process, except of the widely and broadly defined concepts of motivation and mood. Emotional phenomena are usually intended as strong (intrinsic or extrinsic) forces able to influence the creative thinking process, and in particular the cognitive processes sustaining idea generation. In this chapter, we maintain that emotional phenomena are not simple influencers of creative thinking, but that they are the spinal cord of the creative process. In considering emotions the core of the process, we sustain that emotional reactions are the *conditio sine qua non* by which the creative thinking process can occur, or, in different words, the necessary (although not sufficient) determinant of the process. On the basis of the above, taking into account different theoretical approaches to the study of emotions and adopting a dynamical systems framework, we intend to explain the role of emotions in the dynamic emergence of the creative thinking process.

4.1 Introduction

Sometimes we appear to forget that human beings are intrinsically and fundamentally emotional animals. Or better, we want to forget it. We strongly feel the necessity to define ourselves as logical and self-defined cognitive actors. This despite the

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empirical and experimental evidences demonstrating that our thoughts and our actions are characterized in any moment by limited cognitive resources (see for example Ariely and Norton 2008; Kahneman 2011; Tversky and Kahneman 1983). Psychological research on creativity is no exception. In reviewing the huge effort in finding the main components defining the creative process and the creative achievement (e.g., Jauk et al. 2014; Hélie and Sun 2010; Lubart 2001), rarely we encounter models and theoretical frameworks considering emotional reactions as main determinants of the creative process, except for the widely used and broadly defined concepts of motivation and mood (Amabile 1983; Amabile et al. 2005; Davis 2009; Zenasni and Lubart 2002). Emotional phenomena are usually intended as strong (intrinsic or extrinsic) forces able to influence the creative thinking process, and in particular the cognitive thinking process sustaining idea generation. They are essentially intended as mediators and moderators of the thinking process. Only recently some valuable works explained the role of specific emotions on creative performance (Baas et al. 2012; Silvia and Brown 2007), or the separate influence of affective valence and affective arousal on creative thinking (De Dreu et al. 2008), suggesting an intrinsic importance of the emotional experience in the control of the creative thinking process.

In this chapter, we suggest that emotional phenomena are not simple influencers of the process, but that they are the spinal cord of the creative thinking process. In this effort, we will concentrate on the individual thinker, leaving extension to social creativity for future work. In considering emotions the core of the process, we posit that emotional reactions are the *conditio sine qua non* the creative thinking process can happen, or, in different words, the necessary (although not sufficient) determinant of the creative thinking process. In formulating this strong assumption, we do not want to suggest that creative processes occur whenever emotions are present in human life. Human creativity cannot emerge without access to knowledge, without interactions with social norms, without the use of some forms of intelligence, without divergent movement in the thinker's mind space, or without evaluation abilities. All these elements together, however, may not be sufficient for the generation of an original and effective idea in a human mind if we do not include emotional phenomena into the process. In other words, we propose a change of point of view in looking at creativity, a shift from a cognition-driven to an emotion-driven point of view. This new perspective is intended to be included in a dynamical systems framework, which would interpret the creative process as a self-organized system controlled and driven by the emotional experience, as we will discuss in the body of this chapter.

The first step into this new proposal will be to outline the complexity of the emotional phenomena as well as their roles for human beings. The aim of this explanation is to enter inside the dynamics of the emotional phenomenology, in order to comprehend its multi-componential nature. The appraisal theory will be in particular used as an explicatory approach to understand the emergence of emotions as a consequence of self-organized interrelations between different components, and in particular between cognitive and affective elements. The dynamical system theory will be the natural framework hosting this explanation. The same theoretical framework will also serve as an interpretative scenario guiding the explanation of the

creative thinking process as a complex dynamic system. To this purpose the DIMAI model of creative thinking (Corazza and Agnoli 2015) will be used as a reference model. DIMAI, in particular, represents an acronym for five mental states, which define, according to Corazza and Agnoli (2015) the creative thinking process: *Drive, Information, Movement, Assessment, Implementation.* Within this scenario the role of emotions for the emergence of creative thinking will be highlighted. How emotions can control the creative thinking process and drive the emergence of potential new and effective idea will be outlined. To this purpose, different examples will be provided on how several components defining emotional reactions are able to drive and control the shifts between different mental states within the creative thinking process. Some key questions within the study of creative thinking will be addressed through these examples. However, it worth highlighting that, given the complexity characterizing the dynamic relationships between emotions and creative thinking, this exemplification is not planned to give a comprehensive explanation of these dynamics, but it is meant to provide a first illustration of the theoretical and explanatory utility of an emotional dynamical approach to the study of creative thinking. Finally, considerations on the impact of this new approach on the research and education of creative thinking will be provided.

4.2 Emotions: Multi-componential Controllers

But what are emotions? A broad definition has been proposed by Scherer (2009, p. 3459), who claims that: "emotion is a cultural and psychobiological adaptation mechanism which allows each individual to react flexibly and dynamically to environmental contingencies". Under this definition reside four basic attributes of emotions, which are uncontrovertibly accepted in the emotion literature (Frijda and Scherer 2009): (i) emotions emerge when something relevant happens to the organism, having a direct relation with its goals, values, or general well-being; (ii) emotions prepare the organism for important events, producing states of *action readiness* (Frijda 2007); (iii) emotions engage the entire person, requiring action suspension or urging action accompanied by preparatory tuning of the somato-visceral and motor systems; (iv) emotions bestow control precedence on the states of action readiness, in the sense of giving priorities in the control of behaviours and experiences.

Therefore, emotions are organism's controllers which entail the involvement of five distinct components (Scherer 1987, 2001): appraisal, i.e., a cognitive component; action readiness, i.e., a peripheral efference component; goal-oriented motivation, i.e., a motivational component; overt actions, i.e., a motor expression component; and subjective feelings, i.e., a phenomenological component. We observe emotion when an episode interrelates and synchronizes all or most of these components in response to the evaluation of external or internal stimuli relevant to the organism well-being. Clearly, these attributes highlight the intrinsic overlap between cognition and emotion. Years of research proved that emotional and

cognitive phenomena are often separated only for conceptual reasons, but that they are most of the time hardly distinguishable from one another. The inextricable overlap between cognitive and emotional phenomena has led to the modern constructivist theoretical frameworks, which state that emotions are not special mental states, but rather that they are continually modified constructive processes involving basic psychological ingredients, which are not specific to emotion (Feldman Barrett 2017; Gross and Feldman Barrett 2011).

If we had to find a basic role exerted by emotions in human and animal life, we could sustain that they are the multi-componential controllers of our relationships with the world. Starting from the most basic approach/avoidance behaviours, reacting with promptness to safe/unsafe stimuli from the world, emotions allow to understand (or to estimate) the nature of those stimuli, to act with respect to the stimuli, and to communicate to the external world our disposition towards those stimuli. In other words, emotions are emergent acts of meaning-making in our relation with the world (Gross and Feldman Barrett 2011).

4.2.1 Appraisal Theories and Stimulus Evaluation Check

Let us consider an example of this controlling role exerted by emotions over our relationship with the world. The example is offered by the appraisal approach. Appraisal theories of emotions propose that emotions are adaptive responses which emerge from the evaluation of features of the environment that are important for the individual's well-being (Moors et al. 2013). While the first approaches within this theoretical framework (Lazarus 1982, 1984) essentially tried to explain emotions through cognitive processes, basically emphasizing the supremacy of cognition over emotion, the following propositions within this framework tended to describe the emergence of the emotional phenomena through the use of dynamic elements. Contemporary appraisal approaches are componential in nature in that they view emotions as involving changes in several organic components and systems. Emotions are therefore processes where changes in one component feed back to other components. For example, changes in the appraisal of an event may produce changes in the physiological response, which, in turn, can lead to a change in the appraisal itself, both directly and indirectly (through other components).

Here we will in particular refer to the stimulus evaluation check approach proposed by Scherer (2001), which considers the appraisal as a process of multilevel sequential checking. This theory explains the differentiation of emotional states as the result of a specified sequence of Stimulus Evaluation Checks (SECs). SECs are a set of criteria underlying the assessment of the significance of a stimulus for the organism (Scherer 2001), which are organized according to four appraisal aims: relevance, checking how relevant is the event for the organism; implications, checking the consequences of the event and how much it can impact organism wellbeing; coping potential, checking the coping abilities to face the event and its consequences; normative significance, checking the meaning of the event with respect to

individual's self-concept and social norms. For the purposes of the present chapter, we will limit our action to consider the first appraisal objective, relevance, which, as we will see, is not irrelevant for creativity.

An organism is constantly scanning the environment to check whether the occurrence (or the lack of occurrence) of an event requires deployment of attention, more information processing, interruption of an on going activity, etc. Our relation with the (external or internal) environment is organized according to a progressive incremental complexity following specific evolutionary patterns and sequences, starting from a very basic somato-sensorial level to more complex conceptual levels (Leventhal and Scherer 1987). Relevance checking makes no exception. At the most primitive level in the appraisal of relevance, a *novelty check* can be found. Starting from sensory-motor processing, any sudden stimulus is likely to be detected as novel and attracting attention (the classic orientation response). Beyond this basic level, novelty evaluation can differ greatly for different species, individuals, situations and depends from previous experience and familiarity with the stimulus. On the most complex level of processing, novelty check can be based on predictability evaluations (based on the observation of regularities from the world).

The following evaluation level is based on the *intrinsic pleasantness check*. This check determines the fundamental reaction of the organism, liking/pleasantness feelings, leading to approach behaviour, or dislike/aversion, leading to avoidance behaviour. The intrinsic pleasantness check has been defined by Scherer (2001) as independent from the goals or momentary state of the organism, but as an intrinsic feature of the stimulus itself.

Orthogonal to this check is the *goal relevance check*, which defines the pertinence and importance of the stimulus for the present hierarchy of goals or needs.

These three sequential and different SECs define the relevance of a stimulus for the organism, dynamically and interactively organizing the emotional experience. No modular or predefined experience arises from this dynamic emergence of the emotional experience; on the contrary, emotions emerge as the products of subjective and situational evaluations of the relationship with the (external or internal) world.

4.2.2 Emotions in the Dynamical System Framework

Scherer (2000, 2001) proposes the invariance of the sequence of appraisal checks defining the evaluative or cognitive component of emotions, while bidirectional relationships exist between appraisal, feeling, motivation, action readiness, and expressive components. The relationships between appraisal and the other emotional components define a dynamic interaction in which appraisal sets in motion other components and reacts to feedback from other components, in order to drive the adaptation to a given context or situation (Camras and Witherington 2005). Scherer's approach resides within the dynamical system framework, which represented a true innovation in the study and analysis of emotional phenomena (Fogel

et al. 1992; Lewis and Granic 2000). Emotions emerge in this theoretical framework as self-organized systems of interacting components within contextually situated social interactions. New emotional episodes happen when stable emotional patterns break down as a consequence of a critical change in one of the emotional components.

Emotions are however not chaotic ensembles of components, but recursive and stable emotional structures that can be recognized socially and culturally (e.g., basic emotions such as anger, surprise, happiness, sadness, disgust). Indeed, emotional components self-organize into more or less stable patterns (attractors) that manifest a large number of minor variations. Because of the recursiveness and apparent invariance in some emotional patterns across time and space, some authors argue that self-organization in emotions is hard-wired and finds its roots in evolutionary pre-specified processes (Izard et al. 2000). True emergence in the sense of generation of new forms without pre-specified instructions would seem to be hardly applicable to emotions. On the other hand, self-organization seems to be applicable in the context of cognitive-affective interactions, where appraisal components operate as monitoring systems for the organization of other systems (Camras and Witherington 2005): this will be our working hypothesis.

4.3 The Creative Process as an Emotion-Driven Emergent Process

The study of creative thinking, as defined by an ensemble of components the interactions of which lead to the emergence of potentially original and effective products (Corazza 2016), can highly benefit from the use of a dynamical system framework. In particular, in the following, we will look at the creative thinking process following a series of prescriptive steps proposed by Thelen and Smith (1994, 1998), as a specific strategy of investigation within the dynamical system framework. Using this approach we will discover the dynamic relationship between the emergence of emotional reactions and the emergence of new ideas.

Step 1 of the investigation strategy is to establish a collective variable for the study, which is any observable variable that reflects the state of the system. Through the measurement of this variable, the interrelationships between the lower-order components of the system can be identified. Any collective variable can assume a variety of states that emerge from the interactions between the components of the system and which the system seems to be attracted by. *Step 2* requires the identification of the attractor states which characterize the collective variable across different times and conditions. *Step 3* involves the mapping of temporal stability and changes in the collective variable, either through a microgenetic analysis of the variable in real time or by a longitudinal analysis distributed over a longer period of time. Through this analysis a trajectory is established for the collective variable. *Step 4* requires the identification of the phase transitions (or phase shifts) within this

trajectory, i.e., when the system transitions from one attractor state to another. *Step 5* involves the identification of the factors underlying these transitions; in other words, the control parameters whose quantitative changes destabilize the relationships between the components of the system leading to a phase shift which conduces to the establishment of a new stable pattern of interrelations. *Step 6*, finally, requires the experimental manipulation and investigation of the control parameters in order to explore the dynamics of the system.

4.3.1 Investigating the Creative Thinking Process in Five (Out of the Six) Steps

Step 1

The creative thinking process represents the highly complex collective variable to be studied. The creativity literature presents indeed a long tradition about the modelling of the creative thinking process (Lubart 2001), as a system composed by a multitude of lower order interacting variables. This tradition has been inserted in the cognitive approach to creative thinking. Representatives of this tradition are the four-stages model by Wallas (1926), the articulation of the mental abilities by Guilford (1950), the eight dynamic stages in the model by Mumford et al. (1991), or the Geneplore model (Finke et al. 1992). All these models describe the process leading to the generation of new ideas, passing through different states or stages attracting the thinker's mind. We do not intend here to propose a new model to conceptualize the creative thinking process, but we will enter in this theoretical tradition in order to understand whether a dynamical system framework can offer new insight on the creative thinking process and in particular on the role exerted by emotions in the emergence of new ideas.

In doing so, we will use the DIMAI model (Corazza and Agnoli 2015; Corazza et al. 2016) as a reference to look at the creative process through a dynamical system framework. The DIMAI model represents indeed a functional description of the creative thinking process that could be applied to any knowledge domain. This model will help us to identify the lower-order components of the system as well as the attractors states, the trajectories, and controllers of the process. DIMAI will be therefore here used as exemplary container, in that it has been proposed as a theoretical model that should encompass all the previously mentioned cognitive approaches (Corazza et al. 2016).

From Step 2 to Step 4

In the description of the DIMAI model we intend to define some attractor states in our collective variable (*Step 2*) as well as to map moments of stability and changes into the system (*Step 3*) and the phase transitions (*Step 4*) from one state to another, determining possible trajectories. This will appear as a sort of journey into the thinker's mind, proposing a dynamic model to understand the emerging and realization of new ideas.

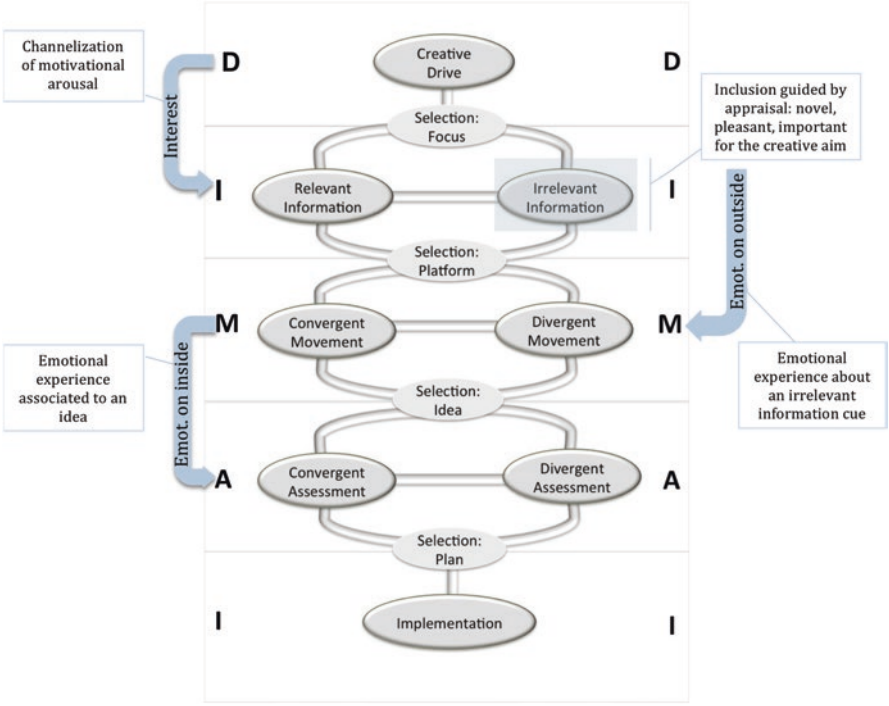

Fig. 4.1 The DIMAI model of the creative thinking process and some examples of possible emotional mechanisms controlling the process

The five mental states of the DIMAI model, *Drive, Information, Movement, Assessment, Implementation* (Fig. 4.1), represent the attractor states which define the creative process, characterizing therefore our collective variable across different conditions and different periods of time. The five mental states can be thought of as recursive states of stability around which the creator's thinking process is organized. The DIMAI mental states should not be however intended as mutually excluding mental states, since they can coexist in parallel and be reiterated. According to this model, during the process the thinker's mind can indeed move between different attractor states in the search of a new equilibrium state.

The first state, *Drive*, involves thinker's main focus area of interest, inside of which the generation of ideas shall take place. In this state the main motivational elements that support the thinker throughout the entire process are stated, defining the action tendencies and the starting arousal level which will be essential to put effort in the generation of a new idea.

In the moment in which these action tendencies are directed towards a specific area of interest, an immediate activation of the attractor state of *Information* occurs, which consists in the activation or gathering of all knowledge elements related to that focus area. *Information* attracts the thinker's mind toward the knowledge about the focus area (which is stored within the thinker's memory, but which is also recruited through an active search). Knowledge elements include meaning,

symbology, and/or the physical representation of items related to the focus area. Clearly, the more the thinker has previous knowledge and/or expertise in the selected focus area, the richer the collection of information will be. This kind of information directly activated into the thinker's mind or collected from the state of the art in the focus area is defined as *relevant*, to stress the "semantically direct" connection to the focus. Along with *relevant information*, the DIMAI model includes also the introduction into the thinking process of *irrelevant information*. This kind of information has no apparent relation with the focus area or with the relevant information. It represents a spark, a possible inspiration, forcing the thinker to accommodate the process accordingly to this extraneous or peripheral element, consequently reorganizing the knowledge structure, which leads to the possible generation of new perspectives. Irrelevant information can come from any element surrounding the thinker, even from random causes (Agnoli et al. 2015).

The disequilibrium state produced in information processing by irrelevant information leads the thinker's mind toward the next attractor state, *Movement*. This state defines the search of new meanings within information, exploring the complex network of alternatives, through interpretation, inquiry, insight, and so on. Movement can be convergent or divergent, the former searching for the best possible consequence, the latter exploring multiple alternatives into the information network.

This state moves towards the generation of one or multiple potential new ideas, attracted towards the evaluation of their effectiveness and novelty, i.e., towards the next attractor state, *Assessment*. The Assessment state can take on a convergent modality, which evaluates the utility and effectiveness of the new idea with reference to the initial focus, or a divergent modality, which evaluates the idea independently from the starting focus, applying a multiplicity of judgment criteria. *Assessment* and *Movement* interact iteratively in order to refine the raw idea attracted towards the realization and externalization of the idea, resulting in the final attractor state, *Implementation*, where and when the idea is organized and represented to the external world (in the form of words, a real product, etc.).

Step 5

In the description of the mental states and of the possible trajectories followed by the thinker's mind during the generation of a new idea, the factors that can explain the transitions from one attractor state to another remain to be explained. Here, in particular, we propose that the control parameters whose quantitative changes destabilize the relationships between the components of the system leading to the establishment of a new equilibrium state can be collected under the unified explanatory umbrella represented by emotions. We indeed believe that even if emotions can be defined within a specific and unitary psychological construct, their complex dynamics allow to take into account the extremely different conditions leading to transition shifts within the creative thinking process. In this view, emotions assume the role of controllers of the creative thinking process driving the thinker's mind back and forth iteratively along different attractor mental states. The transition from one mental state to another is therefore permeated with a new emotional meaning.

4.4 Emotions as Controllers of the Creative Thinking Process

In the next sections, we will offer some examples on how quantitative changes in emotional reactions can explain the transition shifts between the different mental states defining the process. When does motivational focus start attracting information from memory and when does it require an active search of new information? When is information enough to start moving across information and why does specific information prime a sudden restructuring of the knowledge leading to a new unexpected idea? Why do some specific alternatives generated within the thinker's mind attract the need to understand, through conscious assessment, whether they can solve the initial creative drive? These are only some of the questions that can be faced and explored assuming that state shifts are controlled by components defining emotional reactions. Let us therefore try to answer to these questions proposing some hypothetical explanatory scenarios derived from an emotional dynamical approach to the process. This will help us to exemplify the involvement of different emotional components and the interaction between them in different moments of the creative process.

4.4.1 Motivational Tendencies and Arousal

Opening with the first question, asking when the motivational focus start attracting information from memory, we can assume that the *Drive* state is mostly defined by creative motivational forces, i.e., by the thinker's motivational tendencies to act on the world in a generative way. These motivational forces find an activation, driving the thinker's creative behavior, only when they find a resonance with a specific attentional focus, which arouses the thinker's action tendencies toward a specific direction. In an interactive modality, motivational tendencies act on the world through a constant attentive alert in the search for relevant events/stimuli, and through a feedback reaction, attention, which focuses on a specific area, channels motivational forces, arousing the process in a specific direction. This emotional dynamic immediately activates in the thinker's memory all information related to that specific focus area as well as the need to collect more information on the focus. In other words, interest emerges in the thinker's mind driving her/his first creative acts.

Emotional reactions belonging to the individual seem therefore to be discriminant variables in explaining this first phase shift. This assumption can explain the huge individual differences characterizing people's creative interests. What can be attractive for a specific person, might not be even perceived by another person. Only when individual action tendencies match a specific external or internal focus, the individual creative drive can activate the process, or, rather, a sufficient level of arousal can be reached to sustain the entire creative process. This proposition finds

in part support from research on the synergic interaction between extrinsic and intrinsic motivation, which showed that the impact of extrinsic forces on creativity is determined in an interactive manner by the nature of the task, the receptor of the reward (individual or group), the personality traits of the involved individuals (individualistic or collectivistic), and the level of intrinsic motivation (Agnoli et al. 2018b; Amabile 1993; Eisenberg 2002). In this view, quantitative changes in motivational forces, in terms of the channelization of the spread affective arousal in the direction of a specific attentive focus, can explain the phase shift from the *Drive* mental state to the *Information* mental state (see Fig. 4.1).

The role of the channelization of motivational drive into different attentive and emotional focus areas, which define the individual interests, is evident in the case of many past artists or inventors who grew up together but who were separated by their different interests. A classical example are the lives of Paul Cezanne and Emile Zola, who were close friends throughout their youth and who shared a common undefined passion, as Zola wrote: "certain secret affinities, the still vague promptings of a common ambition, the dawning consciousness of possessing greater intelligence…" (Zola 1886/1993, p. 31). This common ambition (their common drive) was however attracted and pointed in different directions, towards writing in the case of Zola and towards painting in the case of Cezanne. Their different interests led therefore their common drive towards different directions and, finally, towards different lives.

4.4.2 Appraisal Checks

In the attempt to analyze which are the affective components controlling the phase shift from *Information* to *Movement*, let us adopt the appraisal approach. The fundamental question here regards why some information elements from the environment lead to restructuring the thinker's information structure. Why is some information more effective in increasing the probability for a creative idea to emerge? In their seminal work, Goldenberg et al. (1999) showed for example that in the advertisement domain specific methods to handle information are needed to enhance this probability, while randomness is essentially ineffective in this sense. But we could also wonder why in the legendary episode was exactly an apple leading Newton to come up with his theory of gravity and not, for example, the wind in the trees or a random object falling from his hand? We do not have certainly the ambitious goal of answering to these big questions, but what we are going to do is to use an appraisal approach to look at these questions from a different perspective.

Scherer's stimulus evaluation check approach (2001) seems particularly suitable to analyze these questions, since it can help understanding the selection of stimuli on the basis of their relevance. Relevance is here defined on the basis of three sequential SECs that find a precise contextualization within a specific motivational and attentional drive as well as within a specific information network activated

within the thinker's mind. The same checks indeed can lead to totally different evaluations if inserted in a different context. It is therefore important to highlight that during the creative process cognitive appraisal interacts with specific motivational tendencies and affective arousal as well as with a specific thinkers' knowledge structure. The first SEC (*novelty check*) scans environment in the search for novelty, i.e., in the search of unfamiliar, unexpected stimuli. All elements responding to this check are able to attract attention. This SEC takes into account the knowledge structure activated within the thinker's mind and detects all elements which are not related to this structure. The second SEC (*intrinsic pleasantness check*) determines then the thinker's reaction toward the novel stimulus, establishing the fundamental like/dislike reaction of the organism toward this stimulus. This SEC is particularly important since it charges the organism with a further arousal source directed toward the stimulus, in order to prepare the organism to approach or to avoid this stimulus. The final SEC is the *goal relevance check* which delineates the importance of the stimulus for the momentary hierarchy of thinker's goals or needs.

It is here important to discriminate between the notion of relevance and irrelevance described within the DIMAI model and the notion of relevance as defined within Scherer's approach (2001). Relevant information is defined in the DIMAI model as the set of items related to the specific focus area, i.e., the state of the art of the knowledge on that specific area. Irrelevant information is instead all information which is not usually included in this state of the art. The distinction between these two forms of information is defined through the first SEC into an appraisal approach. Relevance is instead defined within this latter approach as the organism's aim to maintain the status quo or to reach the desired goals through the active investment of more extensive resources (Scherer 2001). Through this evaluation new energy is actively invested from the organism into the process. We maintain that this new source of energy is able to destabilize the relationships between the components defining the *Information* mental state (in particular the thinker's knowledge structure), leading to a new form of equilibrium, to a new mental state.

We can however assume that only when an information cue passes through all three SECs, it can bring its energy within the process. In particular the last SEC seems to be discriminant in this sense. To attract attention a stimulus should be novel (not familiar), to attract energy it should be charged by a sort of pleasantness or unpleasantness, but to be included in the creative thinking process it should be important for thinkers' motivational goals. These three SECs could explain the mechanisms which are at the basis of the inclusion into the process of only some information cues and not instead of all information coming from the environment (see Fig. 4.1). Moreover, the affective charge deriving from the relevance evaluation can explain the feelings of discomfort or pleasant surprise sometimes emerging when a new extraneous element bursts into the thinking process, producing a temporary restructuring of our knowledge structure. This does not mean that all elements breaking into the process can produce a fruitful (in terms of creative) restructuration of the thinker's knowledge, but we can assume that they can give further energy to the thinking process to explore new paths never considered before.

Classical examples of the restructuring brought about by external elements come from insight episodes described in classical anecdotes of discovery. Many of these anecdotes are based on the ability of an inventor to capture or to be captured by some information in the environment that seemed to be apparently irrelevant and that all other people have discarded or not even noticed. We can hypothesize that this ability is indeed guided by a constant appraisal of environmental information. The discovery of penicillin by Alexander Fleming is paradigmatic in this sense. In looking at a petri dish containing a culture of bacteria which had become moldy, he noticed that the bacteria around the mold had been destroyed. This selective encoding of the environment (Sternberg and Davidson 1999) could be based on the three aforementioned SECs: the destruction of bacteria by the mold was not familiar, it was pleasantly new, and essentially it matched with the motivational goals of Fleming, whose main interest and motivational focus was the discovery of new antibacterial agents. Passing through these three SECs, that apparently irrelevant information captured Fleming's attention and restructured his knowledge structure, and later that of the entire medicine.

4.4.3 The Role of Awareness

A further pressing question is related to how an idea emerges among the virtually infinite alternative ideas that a thinker could produce. In the attempt to analyze this question, we will in the following consider the role of awareness in the emotional experience, i.e., what is usually intended as feelings.

Feelings are typically considered from the common sense to be what emotions are all about. Obviously the question is not so simple. Emotions mostly reflect nonconscious appraisal processes, state of action readiness, psychophysiological responses, which largely occur without an aware experience of their occurrence (Frijda 2005). The same holds for the processes described in the previous paragraphs. Most of them occur without a conscious experience by the thinker. Emotion experience can have indeed different forms, as any other experience. Which form it takes depends on the role of attention, and on thinker's direction of attention (Lambie and Marcel 2002). We have for example two main forms of consciousness, characterized by absence or presence of focal attention. Moreover, attention can be directed either towards the world or towards oneself. Even if during a creative act many specific emotional experiences come into the process, we can try to characterize different forms of emotional experiences into different mental states.

In the case of the focalization of motivational forces on a specific focus area, the thinker can move from a first to a second order of experience. While in the first order of experience there is no separate awareness of here and there, of self and object, the second order of experience involves a focal attention (Frijda 2005). During an emotional experience of the first order the thinker is not aware of her/his feeling, it is an immersed condition, such as in the case of the feeling of being motivated to be creative, which is not related with a specific focus and that most of the time is totally

unaware to the thinker. The focalization on a specific focus area moves the thinker's experience to a second order level, which can shift and extend to awareness the intense emotional forces directed toward that specific area. In other words, the emotional experience become reportable only when focused attention intervenes canalizing the affective experience into a perceptible thinking area/object (Frijda 2005). The life of Van Gogh gives us an outstanding example of the importance of the aware realization of our creative focus, to effectively invest on that specific area of interest. This emerged for example in 1880, when Van Gogh realized that all his undefined "driving force behind" his "feeling for beauty", which led him to try different professional experiences, had to finally and definitively result in becoming a "true painter" (Jansen et al. 2009). The aware investment of his driving force towards painting gave rise to some of the most incredible pieces of art humanity has ever seen.

The thinker becomes therefore aware of a personal interest toward a specific focus area. However, this emotional experience is usually characterized by a general feeling distributed on a wide and broadly defined network of semantically related information, defining the focus area of interest. Through the appraisal process described in the previous paragraph, an analytical attentive analysis of information begins. Attention tends to be focalized on one or more specific aspects of the world. When an important information (as evaluated through sequential appraisal SECs) emerges into thinker's consciousness, an emotional experience related to that specific information emerged. The emotional experience becomes in this case an affective meaningful perception of the world (Frijda 2005) and in particular of a specific information which emerged to be relevant for thinker's goals (see Fig. 4.1). In this way, appraisal processes become conscious and an aware feeling toward the information emerges. The information emerged to be attractive, repulsive, surprising, etc. As described by Frijda (2005), the emotional experience is indeed *about* something, not just *of* something. The aware shifting of attention towards an information which apparently does not pertain to our thinking process allows to charge that information with an affective arousal. The aforementioned example of Fleming's episode leading to the discovery of penicillin seems to indicate a shift of awareness from an internal thinking process to an external entity (the bacteria around the mold), which was charged with an affective meaning deriving from the personal motivational goals of the inventor. This information emerged therefore to be attractive and surprising, leading Fleming to explore the phenomenon more in depth.

Moving from *Information* to *Movement* attention turns to be focalized on the self, in the attempt to explore possible alternative ideas inspired by this new information breaking into the process. An internally directed appraisal process checks many alternatives into the thinker's mind. Attention is no more object-centered but becomes thinker-centered, and experience changes accordingly. During this exploration however the thinker might need a signal that has effects even if he/she is engaged in an open-defined cognitive exploration and that can alert a large variety of response processes, including the pre-specified goal settings and purposive behaviours, and cognitive activities like conscious assessment (Frijda 2005). This signal is provided by the emergence of an emotional experience into awareness as

soon as an alternative is appraised as relevant to the creative purpose. The main function of feelings during the *Movement* state could be therefore to open the door to consciousness and to the more elaborate functional properties usually ascribed to it. Through an emotional experience associated to a specific idea generated into the thinker's mind, the specific idea becomes aware and can be consciously evaluated in reference to thinker's creative goals. This does not however mean that the idea would be necessarily effective in solving creator's drive (Corazza 2016).

The breaking into consciousness of an emotional experience associated to an idea is highly evident in the insight phenomenon, when a solution or idea is usually accompanied by an intense emotional reaction. This experience has been well documented in recent research that showed that insight is associated to the activation of Nucleus Accumbens, a subcortical area associated to reward (Floresco et al. 2001; Haber and McFarland 1999; Tik et al. 2015, 2018). According to the hypothesis here proposed, therefore, the main role in controlling the phase shift from *Movement* to *Assessment* might be ascribed to the emergence into consciousness of an emotional experience which brings into awareness a specific idea triggering that experience (see Fig. 4.1).

The coupling of an emotional experience with a specific idea or series of ideas generated as a consequence of a personal motivational drive is well defined by Lubart and Getz (1997) when they describe emotional-based mechanisms leading to the generation of new ideas. In particular, they describe a resonance-detection mechanism that controls whether an activated pattern into the thinker's mind enters in resonance with her/his goals, letting it passing into conscious working memory. This experience has been described by past creators as a mechanism that allowed the selection and emergence of their creative ideas. Poincaré (1921/1985) for example was aware that creativity involves a selection mechanism, which he identified as "emotional sensibility" (p. 29), allowing only aesthetically pleasing mathematical ideas to pass into his aware consideration.

4.5 Conclusions: The Sixth Step

In the previous paragraphs we offered a general overview of the role of emotions into the creative thinking process from a dynamical system point of view, as well as some particular exemplifications on the role of specific emotional components in the emergence of creative mental states.

It will not have however escaped the attentive reader that in paragraph 3.1 only five of the six steps described by Thelen and Smith (1994, 1998) have been considered. The sixth step in the investigation of a dynamic system requires an active experimental investigation of the control parameters in order to understand the dynamics of the system. We do believe that this step represents a challenging goal for the future research on creativity. Through this step it will be possible to understand the real empirical validity of the approach proposed in this chapter and whether emotions can be really intended as control parameters into the creative

thinking process. Specific experimental paradigms as well as dedicated analysis methods should be developed, building on the valuable micro-analytic research approaches already described in the creativity literature (e.g., Glăveanu and Lahlou 2012). The high complexity of the dynamics involved in the process requires both a parcelled approach to explore the role of single emotional components in the emergence of the creative process and a holistic approach, to understand how the different emotional components interact with specific elements defining the creative behaviour.

Some evidence on the role of emotions as control parameters within the creative thinking process seem already to have emerged from research. Silvia for example described a model of aesthetic emotions (Silvia 2005a, b), which connects emotional responses to art to the cognitive processes that underline emotions, *de facto* explaining how appraisal mechanisms can drive the assessment of artistic ideas. Moreover, in a recent study (Agnoli et al. 2018a) we demonstrated how affective components (and in particular affective arousal) can interact with the attentive processing in determining creative performance. Specifically, we demonstrated that emotional attitudes, defining regularities in how a person feel, regulate, and perceived emotions (i.e., trait emotional intelligence) can drive the creative process through the management of the attentive and emotional resources beneficial to creative thinking.

Beside the impact on the experimental approach to the analysis of creative thinking, we believe that the theoretical framework here proposed can offer new insight also to the education of creativity. Sensitivity to emotions, emotion regulation, perception and awareness of emotions should be included within the educational approaches to creativity. If we believe that the creative process is a mental activity paved by emotional experiences, some of which of intense negative nature, we should give to the young generation the instruments to recognize and manage these experiences in order to take benefit from them during the creative process. The frustration deriving from the low cost-benefit ratio of the creative process, because of the too high investment of energy as compared to the low probability of success, is one of the first causes for the disinvestment from creative activities (von Thienen et al. 2017). Moreover, the powerful negative emotions (sadness, anger, depression, etc.) deriving from negative evaluations of our creative products are disincentives in the undertaking of creative activities.

The management of all these emotional variables should be contextualized within the education of creativity and not allowed to vary according to emotional individual differences. Particularly, we believe that educational programs, along with the teaching of creative thinking abilities and methods, should also consider the inclusion of specific training for the management of the emotional impact of creative activities in everyday and academic/professional contexts. If we do not take into account the emotional burden intrinsic to thinking and acting creatively, we risk that much creative potential will be wasted. The training of adaptive emotional behaviors and traits in schools could give students new and effective tools to regulate and manage the affective charge of creative decisions and acts. As said before, emotional intelligence emerged indeed in recent research to be a fundamental

predictor of higher creative performance, especially under creative frustration situations. Specific and reliable trainings do exist for increasing emotional intelligence and specific emotional abilities (e.g., Hodzic et al. 2017). If the teaching of creative thinking were coupled with these methods aimed at the education of the intelligent use of the emotional experiences rising during the creative process, new generations may be more prone to take the risk and to cope with the frustrations associated to thinking and acting creatively. We indeed strongly believe that new educational avenues can be traced adopting an emotional approach to creativity, and further potential can be thereby spotted to face the challenges of the future.

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