Chapter 15
From Dynamic Processes to a Dynamic Creative Process

Marion Botella and Todd Lubart

Abstract Since Wallas' (*The art of thought*. Harcourt, Brace and Company, New York, 1926) four-stage model, the sequential perspective on the creative process may be questioned. The creative process as a dynamic phenomenon is examined in this chapter. In order to understand how the creative process is dynamic, we start by examining the nature of dynamic processes in other fields such as education, cognitive science, health and social psychology. Based on the understanding of these dynamic processes, we develop hypotheses and observations on the dynamics of the creative process. This approach involves new methods to assess the complexity of the creative process.

15.1 Introduction

The creative process corresponds to "a succession of thoughts and actions that leads to original and adapted creations" (Lubart et al. 2015, p. 111). Two levels can be used to describe it (Botella et al. 2016): the *micro* level, which describes the mechanisms underlying the generation of ideas such as associative, divergent and convergent thinking (Guilford 1950; Martindale 1981, 1999; Mumford and Porter 1999; Runco 1991, 1999; Simonton 1980, 1990, 1999); and the *macro* level, which refers to the major stages of the process sequence (Amabile 1988; Busse and Mansfield 1980; Carson 1999; Doyle 1998; Goswami 1996; Lubart 2000–2001; Ochse 1990; Osborn 1953; Runco and Dow 1999; Treffinger 1995). However, authors do not agree on the name of stages, their number (from 3 to 9 stages) and their sequence. The most common model is also one of the first: the four-stage model of Wallas (1926) with preparation, incubation, illumination and verification. Cropley and Cropley (2012) note that the original version included seven stages: preparation,

M. Botella (✉) · T. Lubart
Institut de Psychologie, Laboratoire Adaptation Travail-Individu, Université Paris Descartes, Paris, France
e-mail: marion.botella@parisdescartes.fr

activation, generation, illumination, verification, communication and validation; and Sadler-Smith (2016) notes five stages, adding an intimation stage between incubation and illumination.

Even if there is still no consensus in the scientific literature, authors have explored factors involved in the creative process. These process dimensions include domain knowledge or expertise, personal motivation, personality characteristics, personal feelings, emotions and affects, product constraints, and environmental characteristics (Cropley et al. 2013; Runco and Dow 1999; Russ 1999; Shaw 1989, 1994).

15.1.1   What Is Dynamic?

Etymologically, the word "dynamic" comes from the Greek *dynamikós*. The adjective "dynamic" refers to a force, power or motion characterized by or producing change or progress; especially one that motivates, affects development or stability; thus, dynamic is opposed to *static.*

Is the creative process dynamic? From 1935, Patrick in her descriptive studies of artists, scientists and other engaged in creative work noted overlaps between Wallas' stages, especially between preparation and incubation (Patrick 1935, 1937, 1938). Vinacke (1952) believed that individuals can go back and move quickly from one stage to another, sometimes giving free rein to their thoughts and other times relying on their critical thinking. According to Vinacke, the ability to move from one stage to another of the creative process is essential, probably facilitating access to cognitive and affective processes. Armbruster (1989) even considered "there is a danger in using Wallas's model, because it implies that the process of creativity is linear" (p.178); the creative process is much more interactive and redundant. There is communication between the stages. Krashen (1984) found that the best writers do not follow a linear approach, but have many feedback loops returning to previous steps. In 1981, Ainsworth-Land (1981) was the first to title a paper "*The dynamics of the creative process*". To answer the question of whether the creative process is dynamic, we will first explore some dynamic processes in diverse fields such as education, cognitive sciences, health psychology and social psychology. The goal here is to explore the nature of dynamic processes and then bring this to bear on the creative process in order to define better and specify what is a dynamic creative process.

15.2   Dynamic Processes

Simonton (2001) described talent development as a dynamic process, based on the combination of multiple components such as physical, physiological, cognitive and dispositional traits. According to Simonton (2001), the domain-specific manifestation of talent will be due to the varieties of combinations of genetic components. Thus, individuals with very different profiles can have the same talent. Considering

the non-additive (but multiplicative) emergent combination of the components, Simonton (2001) suggested that exceptional talent would be extremely rare and exhibit a skewed distribution. Based on empirical evidence from Waller et al. (1993), Simonton (2001) postulated that talent shows low heritability. In this approach, the dynamic process is a combination of multiple components.

15.2.1   Dynamic Learning

In a recent case study, learning a foreign language was described as a dynamic process and analyzed based on Complex Dynamic Systems (Sun et al. 2016). The authors explained that children's developmental learning is not linear but involves complex interactions with the environment. Based on previous work (Molenaar 2013; Molenaar and Campbell 2009; Van Geert and Steenbeek 2005) and the Complex Dynamic Systems perspective, Sun and collaborators (2016) argued that development is a real-time self-organizing process in which the system evolves from successive interaction of fluctuation and stability. Especially considering the learning of a foreign language, the authors described it as an open dynamic language characterized by a dependence on initial conditions, complete interconnectedness between various components, non-linearity, internal reorganization (learning capacity and adaptability for example), environmental interaction, internal and external resources (such as input from the teacher), attractor states, iteration, variation and emergent properties. In their case study, a 3-year-old boy during his first 5 months, named Jimmy, was observed. In the beginning, Jimmy used mainly body language to be understood. Then, over time, Jimmy started to be more flexible, using a verbal response and nonverbal behaviors. Sun and collaborators (2016) illustrated the flexibility and adaptation to the environment by the fact that Jimmy changed his developmental trajectory when a new teacher came. The verbal responses of Jimmy were also influenced by the teacher's repetitions. For Sun and collaborators (2016), a dynamic process is thus characterized by its regularity, complexity, and flexibility.

15.2.2   In Cognitive Science

Ward and Wickes (2009) considered that graded category structure is dynamic through the accessibility of exemplars and the rating of typicality. They examined this dynamic process manipulating the accessibility of exemplars. In this study, 228 students had to complete a 20-item pleasantness rating task with 5 fruits, 5 tools and 10 filler items. Then, participants had to complete a creative generation task in which they had either to imagine a fruit from another planet or to imagine a tool used by an intelligent species on another planet. Results indicated a primed accessibility effect: participants reported more fruits than tools when they had to imagine

an alien fruit whereas they reported more tools than fruits when they had to imagine an alien tool. Indeed, Ward and Wickes (2009) showed the dynamics of category structure and its influence on creative generation. As it is possible to manipulate the accessibility of exemplars (primed effect), graded category structure is considered dynamic rather than static.

15.2.3 In Health Psychology

Yaniv (2012) described role reversal as a dynamic phenomenon. Role reversal is a method used in psychotherapeutic interaction to help two individuals to understand the point of view of the other, switching their role. Based on Kellermann (1994), Yaniv (2012) underlined the dynamics and interaction between the three stages of the role reversal process (empathic role taking, action reproduction and role feedback). For him, these three stages are interdependent. In the first, empathic role taking, individuals start to imitate the other from superficial imitation to a deeper and personal imitation. Then, in the action reproduction stage, individuals try to reproduce with their own subjectivity the other. Finally, in the last stage of role feedback, individuals exchange on how each other is seen. The work by Yaniv (2011) suggests that the dynamics of this process will be due to the involvement of empathy and creativity. Indeed, empathy activates self-other awareness and self-regulation of emotions and creativity inhibits partially focused attention. Both combined contribute to the dynamics of the role reversal process.

15.2.4 In Social Psychology

Leadership Foti et al. (2008) considered leadership perception as a dynamic phenomenon because of several factors such as "cognitive knowledge structures of followers, the context in which leader behaviors are embedded, and multiple pieces of information occurring simultaneously and over time" (p. 178). For these authors, the dynamics of leadership perception could be explained by connectionist and catastrophe theories. The connectionist approach is mainly used to model social stereotypes, leadership perceptions and skills. Each element of knowledge is not isolated but connected to many others. So, this theory explains that representations of leadership from memory are not static but constantly recreated based on the representations activated by all the interconnected elements and the context. Additionally, catastrophe theory explains the attractions and trajectories between the mental representations. According to this theory, the representation can fluctuate across time.

Dynamic Collaborative Process Multiparty collaboration operates when parties are able to see the problem from another point of view and to go through it to search for a solution (Gray 1989). The psychodynamics of collaborative processes was also

studied (Prins 2006), considering the mutual influence of organizational structure on and by individual and collective processes. Prins (2006) analyzed the dynamic process "by taking into account subjective data, observations, as well as the context and history of the collaborative and its partners" (p. 351). Based on the scientific literacy, Prins (2006) considered that understanding the dynamics of such a process involves studying simultaneously the system and world views, objective and subjective experiences, accepting the ambiguity of the process studied. In her case study, Prins (2006) observed a group developing network organization in the domain of foster care during 1 year. She showed that each member had a specific point of view on the project and its outcome. Every interaction and meeting contributes to the subjectivity of participants and the collaboration, leading to evaluate each participant and also the dynamics of the group. The dynamic emerges from mutual influences between network's elements.

Bakker et al. (2013) studied the dynamics of creative project teams according to the time frame. In this experiment, the authors constructed teams of three students working together during 45 min to complete a creative project. Then the teams were randomly assigned to two experimental groups: either the team members will never work again together or they will work all together during the 1 year program. Students were informed about the assigned groups before the 45 min first task. Bakker and collaborators (2013) assessed the time orientation, task immersion, team conflict and cohesion, and processing of information at the end of the first task. The results showed that, compared to teams with longer time frame, teams with shorter time frame were more oriented toward the present, less immersed in the task, showed a tendency ($p < .10$) to prefer heuristic processing, and had less team conflict. So, Bakker and collaborators (2013) found different team dynamics during creative project work according to the time frame. In this paper, authors did not indicate if the order of the work process varies according to the time frame. However, Bakker and collaborators (2013) considered that the possibility to change the group collaboration by manipulating the time frame was a sign of a dynamic process.

15.2.5   In Others Fields

Entrepreneurship   For Engel et al. (2017) entrepreneurial networking occurs in conditions of uncertainty because every action changes the network. So, the authors "encourage more research on the dynamic and reciprocal influence between individual cognition and actions, social networks, and entrepreneurial outcomes" (p. 36). Based on a large literature review, they proposed a dynamic process model of entrepreneurial networking under uncertainty including three parts (entrepreneurial uncertainty evaluation, effectual networking, and networking outcomes). Each part can be influenced by exogenous unexpected contingencies. They include also interactions between subcomponents (for example the perceived ambiguity of networking goals interacted with venture goals). Another interesting proposal was a

cyclical model of goal convergence and means explanations from networking outcomes and entrepreneurial uncertainty evaluation. In this work, a dynamic process corresponds to cycles, interactions between parts (or subparts), several possible ways in the process and involvement of individual cognition, actions, networks and outcomes. Engel et al. (2017) illustrated their approach using the example from Ohanian (2014) with "Reddit", which is a startup that recently grew to over 175 million regular monthly users, when the founders of the start-up interacted with investors, who required them to develop a very different idea from their initial one.

Socio-Economic In the economic field, Fusari (2005) argued that the economy is dynamic through innovation, adaptation for profit, and uncertainty. Another dynamic process is the contingent valuation, which is a popular method to evaluate environmental goods in economics (Tisdell et al. 2008). For them, the dynamics in contingent valuation refers to the moment when individuals change their "willingness to pay" response according to the "environmental good (information provision), experiencing the good, and the lapse of time (memory decay) within a single valuation project in a continuous sequence" (p. 1444). In this study, Tisdell, and collaborators (2008) tested how much Australian people will to pay to save a mahogany glider without any information about it (Survey I: \$24.99), and after information provision by a lecturer (Survey II: \$35.67; $t = -1.52$, $p = 0.065$). They tested also an experienced good with participants visiting a park and seeing (or not) the mahogany glider. Results indicate a significant increase of "willingness to pay" when participants saw the glider but a no significant increase when they did not. This illustrates an interactive dynamic which influences attribution of value.

15.2.6   In Aesthetic and Creative Fields

Aesthetics Carbon (2010, 2011) examined the dynamics of aesthetic appreciation using the example of car exteriors; the results showed a dynamic aesthetic appreciation linked to curvature ratings of the cars between 1950 and 1999. In 2011, Carbon considered the dynamics of this phenomenon in terms of a highly flexible mechanism explaining why "we can adapt to an ever-changing world" (p. 711) and why "we can identify "streams", "movements" or "periods"." (p.711). He proposed a two-step model with a first stage of confrontation with many innovative exemplars and a second step based on adaptation of them. The dynamic aspect in this model is that the "end" of the aesthetic appreciation process is not really an end. For Carbon (2011), it is just a temporary state (taste) that leads to cycle to a new process: "this process is a dynamic one that never reaches full stability, as experience with new stimuli will always start and revive the process again" (p.715). To illustrate the change of curvature, Carbon (2010) used the example of the Volkswagen Beetle (1960; high curvature) which moved into the Golf I (1974; low curvature) and then Golf V (2003; high curvature again).

Dynamics of Emotions The dynamic relation between emotions and creativity was studied in a game playing situation (Yeh et al. 2016). In this empirical study, the emotions of 266 undergraduates were assessed before and during game play in term of valence (positive or negative), activation (high or low), and regulatory focus (prevention with an expanded attentional scope or promotion with a constricted attentional scope). Regression analyses showed that baseline emotions could not predict creativity; but emotions experienced during the game did. In particular, positive emotions associated with a high activation and a promotion focus facilitated creative thinking whereas negative emotions associated also with a high activation and a promotion focus decreased performance. In this study, the dynamic aspect refers to emotions during game playing, which are more predictable of creativity than emotions at the baseline.

Dynamic External Support Pearson and collaborators considered that creative mental imagery is a dynamic process (Pearson et al. 1999, 2013; Pearson and Logie 2000). In 2015, Pearson and Logie tested the involvement of mental imagery process in creative synthesis through internal and external representations with static or dynamic sketches. In the creative synthesis task, all participants had to follow the verbal instructions to combine letters, symbols and/or number into a new pattern during 6 trials (for example, combine rotated D and J into umbrella). Authors designed four conditions (16 participants per condition): imagery alone (internal representation), drawing-in-air (participants draw with the finger in the air), sketching (external static representation in which participants actually draw on a blank paper) and graphic package use (external dynamic representation using a computer software allowing participants to generate, to rotate, to size the symbols). Participants in the dynamic support condition identified correctly more patterns than in others conditions. Pearson and Logie (2015) explained this result by a reduction in working memory load and by a "greater superiority of external representations for supporting changes to the frame of reference in which synthesized patterns are interpreted" (p. 106). In this study, the dynamic aspect is the possibility to externalize the creation of mental image through software, and so, the possibility to manipulate directly the image during its creation.

15.3   Dynamic Creative Processes

Now that we have seen examples of dynamic processes relevant to research on creativity, we will present some models that focus on creativity. Then, we discuss the creative process in terms of a dynamic phenomenon.

15.3.1 Dynamic Definition of Creativity

Recently, Corazza (2016) proposed a variant to the standard definition of creativity which initially includes only originality and effectiveness. Based on the fact that the product of the creative process can be inconclusive at one time but considered creative later, Corazza (2016) added "potential" offering a dynamic definition of creative: "creativity requires potential originality and effectiveness" (p. 262). This addition makes an important point suggesting that a product is not necessarily finished but it can be a part of a more global creative process as well and can be reevaluated later by estimators. If we combined several definitions of elements of creativity, proposed by Corazza (2016), the creative process is "a process enacted by an agent (a single individual or a group of individuals) in the pursuit of its creative goals (the intention to generate items, pertaining to a specific portion of a knowledge domain at a defined time, showing originality and effectiveness)" (p. 263). So, according to this definition of creativity and especially in terms of the creative process, the dynamic aspect here comes from the inclusion of the temporal dimension.

15.3.2 Emotional Resonance Model

The emotional resonance model (Lubart and Getz 1997) proposes that the emotional aspects of past experiences contribute to access and create associations of concepts. There is an emotional substratum of psychic life – always present and more or less active – that colors our perceptions, our decisions, the memory we have of people we meet, situations lived and objects used in our activities. The emotional resonance model has three components: (1) endocepts, which represent idiosyncratic emotions experienced and attached to concepts or representations in memory; (2) an automatic resonance mechanism, which propagates the emotional profile of an endocept through memory and activates other endocepts; (3) a resonance detection threshold, which determines whether a resonance-activated endocept (as well as the concept or representation to which it is attached) enters working memory.

Each concept or representation in memory is associated with traces corresponding to the emotional experiences experienced by the individual. These traces, called "endocepts" (Arieti 1976; Averill and Nunley 1992), encode idiosyncratic emotions related to concepts, images representing objects, people or situations. These representations are individualized and multidimensional. For example, if the concept "elevator" is activated in memory, its mental representation may be associated with a mixture of boredom, anxiety, fear, or any other type of emotion related to the experiences in elevators.

An endocept is activated when the concept and/or image to which it is linked is also activated. The activation of an endocept propagates the emotional tone of the latter as a wave through memory, following routes which are distinct from those of

cognitive associative networks. If the profile of another endocept is close to the propagated profile, the two endocepts will resonate; the resonance force of each endocept depends on the similarity of its multidimensional emotional profile with that of the transmitter endocept attached to the initial concept. The fact that the resonance between two endocepts is accessible to working memory depends on the sensitivity of the individual to his/her own emotions and the resonance force between two endocepts. For example, an individual who has a high detection threshold may have as much difficulty detecting a link with a strongly resonant endocept as someone who has a low threshold for an endocept that is weakly resonant. Once detected, resonance allows the establishment of an association between two emotionally close concepts, which may otherwise be cognitively distant. The emotional resonance model leads to the creation of an association between a source concept (activated during a task) and another concept that is linked to it in an endoceptual way. From this core, it is possible to develop forms of associations which may be quite idiosyncratic, and therefore original. The dynamic aspect is the creation of transitory resonance patterns, which arise naturally when a concept is activated during problem solving activities.

15.3.3   The Bumper Effect

Greeley (1977) described the dynamics of the bumper effect in the creative process. The Bumper Effect Dynamic (BED) corresponds to a subconscious fit to the internal order and/or conception of the creator. Greeley described this effect as follows: "when you are composing a poem and write a word which stops the movement of thought so you cannot proceed, you cross out that word or sentence, and continue with the thought movement in a different direction. It is as if a" bumper" were preventing you from going astray by guiding and keeping you on the correct path" (p. 261). Here, the author did not explain if the entire creative process is dynamic but he considered that a part, at least, is.

15.3.4   Cycles of Experimentation

Roels (2014) explored the creative process of eight music composers, taking particularly one as an example with pre and post- interviews after the performance. The author considered "experimentation to be a dynamic and transformation between mind and matter" (p. 229). Experimentation involves combining emotional and cognitive processes with actions. The dynamics of the creative process appears when a composer changes ideas ("what the composer thinks, imagines, and feels while composing also changes during the creative process", p. 230), visible through the traces of the actions. According to Roels (2014), to examine one isolated experimentation leads to "absurd observations" (p. 234) and researchers have to observe a

cycle of experiments. For example, the first version of the case study described was to compose a *lamento*; the second version was still a *lamento* but with a slower tempo written through a paper sketch; the third version was a digital copy of the previous one; the fourth version add a viola da gamba; and the final version exchanged it with a cello solo. Roels (2014) explained that the modifications of the production were not very important for this composer maybe because the composer used this composition more as a technical exercise rather than a real composition explaining why the composer did not experiment a lot.

15.3.5   Dynamics of Divergent Thinking

Hass (2017) considered that participants do not complete linearly divergent thinking tasks of alternative uses. The "participants' cognition is dynamic" (p. 234) due to the semantic retrieval process itself. To support this idea, Hass (2017) investigated responses of 226 undergraduates on four thinking tasks of alternative uses. Results highlighted the semantic distance at the beginning of the iteration process to find an original and novel answer. The study suggests that divergent thinking is not linear and the creative process involves divergent thinking. This result was also confirmed by dynamic interactions between brain regions (Beaty et al. 2015), especially default and control networks (Beaty et al. 2016).

15.3.6   Dynamics of Narrative Writing

Some authors examined the dynamics of narrative writing by logging key strokes (von Koss Torkildsen et al. 2016). The dynamics of the process appears in transcription fluency, pausing and revisions. For example, studying 42 elementary children, von Koss Torkildsen and collaborators (von Koss Torkildsen et al. 2016) showed that a large majority of children made local revisions directly on the word as they were typing it. Moreover, the better stories were written by children who transcribed faster and made the most revisions. This study suggests that the dynamics of narrative writing can be linked to the creativity of productions.

15.3.7   Dynamic Creative Process

Lubart (2009) examined creative writing and the role of evaluation of ideas in the creative process of composing a story. University students wrote a story based on a title and the creativity of the productions were rated by experienced judges. During the student's creative process, students received prompts to evaluate their ideas as they were working. These evaluative moments occurred either early in the work

process, late, or at an even pace. The results indicated that early evaluation of work in progress, by the student creators themselves, was linked to more creative stories compared to later evaluations, evenly-paced evaluations or random evaluation in a control condition. In a follow-up study, using naturally-occurring differences in evaluation during story generation, the same benefits for those who engage in early evaluation were observed. These findings suggest that the moment when a sub-process of creative thinking occurs can on average lead to more creative productions. In the case of university students completing a writing task, it is likely that early evaluation led them to recognize that their initial idea was weak or flawed and to make an effort to improve their basic storyline. Thus, the moment when certain sub-processes occur can provoke a dynamic that favors originality.

Since 2011, we have been studying the dynamics of the creative process in art (Botella et al. 2011, 2013), in scriptwriting (Bourgeois-Bougrine et al. 2014), in science-engineering (Peilloux and Botella 2016), design (Botella and Lubart 2015), and music (Glaveanu et al. 2013). Through interviews of experts in various creative fields (Glaveanu et al. 2013), we noted that interviewees had many difficulties to describe their creative process. They can explain the stages, the factors involved in it, but it seems very hard to relate how these stages interact, describe their co-occurrence or mutual influences and success factors linked to the process dynamics. In general, a dynamic creative process occurs when the stages are not sequential; creators "can return to "previous" stages of the process or engage several stages at the same time" (Botella et al. 2011).

We observed, as well, the dynamics of the creative process of art, design and science-engineering students when they had to create for their school projects (Botella and Lubart 2015). In this article, we observed that in all three domains, the creative process is dynamic, stages interact with each other (to define the problem and to search for documents), feedback is possible (from the reflection stage in which participants ask and interact with the work to the definition stage) and the time passed in each stage varies between domains (over time, design students marked the stage of divergent thinking 47% of the global time whereas science-engineering students reported it 29%). Following these studies, we suggested that the dynamics of the creative process can be assessed by repeated self-report of what participants do when creating, using a creative process report diary. In this diary, individuals describe their experience of the creative process by marking what stage(s) they are doing at a specific time (Botella et al. 2017).

15.4   Discussion

In this chapter, several dynamic processes within and outside the creative research field were presented. To begin, it is interesting to note that even if several studies referred to the term "dynamic", it is still not clearly explained. If we try to resume all the examples of dynamic processes, we find that several authors saw it as a component of the process itself (Fusari 2005; Hass 2017; von Koss Torkildsen et al.

2016). For Fusari (2005), economy is a dynamic process through innovation, adaptation for profit, and uncertainty; for Hass (2017), the dynamics of divergent thinking is due to the semantic retrieval itself; and for von Koss Torkildsen et al. (2016), the dynamics of the narrative writing appears in transcription fluency, pausing and revisions. A process can also be dynamic according to the accessibility and rating of its components (Ward and Wickes 2009). For others, a process is dynamic because of the combination of multiple components (Simonton 2001; Sun et al. 2016; Yaniv 2012).

Sun and collaborators (2016) proposed that a dynamic process occurs in real-time, and is self-organizing, evolving from successive complex interactions with the environment. This concept of a dynamic interaction between a person and his/her environment was sketched in early work by Kurt Lewin (1935). In the same vein, Prins (2006) defined a dynamic collaborative process by the mutual influence of organizational structure on and by individual and collective processes. This idea is echoed in Gruber's (1988, 1989) evolving systems approach to creativity, with ongoing interactions between a person's knowledge, purpose and affect "subsystems" which may amplify deviations and favor unique, original behavior. Furthermore, a dynamic process occurs within a temporal frame (Bakker et al. 2013; Corazza 2016) and depends on various information that is available simultaneously and unfolding over time (Foti et al. 2008). Nevertheless, Carbon (2010, 2011) suggested that the "end" is just a temporary state that can move to a new process due to new stimuli. So, a dynamic process is cyclic (Carbon 2010, 2011, 2012; Engel et al. 2017; Roels 2014).

According to all these authors, we can propose a definition of the term "dynamic" for the creative process: **the creative process is dynamic by its components itself, their organization, their combination, the successive interactions it maintains with the environment, the unfolding nature of a phenomenon over time and its cyclical nature**. So, a dynamic creative process is opposed to *static* and *linear* process (see Fig. 15.1). In Fig. 15.1, we contrast an essentially linear description of the creative process such as Wallas (1926) with a more dynamic description such as Botella et al. (2011). Here, we see clearly that linearity involves moving from one stage to another without any other possible way whereas a dynamic description involves many interactions between stages.

From this definition, we can consider that stages of the creative process occur in a dynamic way and interact with each other. The stages of the creative process correspond to micro-processes and their organization and combination correspond to a macro-process (Botella et al. 2016). The successive interactions with the environment and the time frame reinforce the importance of developing tools such as the Creative process Report Diary. Indeed, the CRD respects ecological validity – avoiding, as far as possible, placing the individual in "artificial" conditions (Brewer 2000) – and takes into account the time frame by repeated measures.
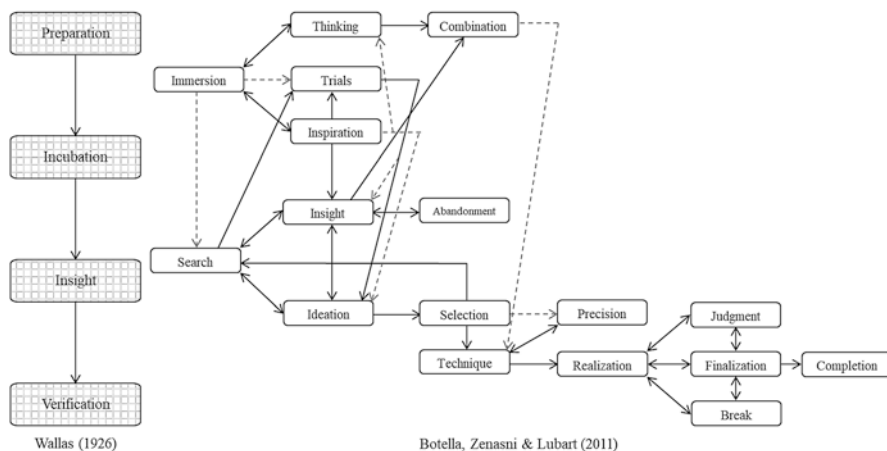
Fig. 15.1 Contrast between a linear approach (Wallas 1926) and a dynamic approach of the creative process (Botella et al. 2011)

Note. **In the dynamic model, the solid lines indicate the main transitions observed with art students between the stages; dotted lines indicate frequent transitions (Botella et al. 2011).**

15.5   Conclusion

From the presentation of some dynamic processes in diverse fields such as education, cognitive sciences, health psychology and social psychology and with a definition of what is a dynamic creative process, we can now formulate suggestions for educational practice:

– The creative process is not linear and Krashen (1984) found that the best writers do not follow a linear approach. Additionally, the better stories were written by participants who transcribed faster and made the most revisions (Lubart 2009; von Koss Torkildsen et al. 2016). According to these considerations, an educational practice could be to invite students to produce quickly something and to work again after to specify their idea by going back to previous stages. Combining emotional and cognitive processes, the teacher could provide cycles of experimentation to students (Roels 2014).

– For Carbon (2010, 2011), aesthetic appreciation is just a temporary state that leads to a new process. In this way, the teacher could invite the students to reinvest old products, to reevaluate them or to use them as a source of inspiration.

– The dynamic creative process is a combination of multiple components. Developing creativity could involve enhancing factors such as domain knowledge or expertise, personal motivation, personality characteristics, personal feelings, emotions and affects, product constraints, and environmental characteristics (Cropley et al. 2013; Runco and Dow 1999; Russ 1999; Shaw 1989, 1994), based on a multivariate approach (Lubart et al. 2015). Considering more especially the emotional resonance model (Lubart and Getz 1997), another suggestion for

educational practice would be the generation of emotions to facilitate the activation of endocepts and the association of ideas. In the same vein, Yeh and collaborators (2016) showed that positive emotions associated with a high activation and a promotion focus facilitated creative thinking. A part of the training could be dedicated to training emotions. Corazza (2016) has already proposed to develop an educational program on frustration from the inconclusiveness of the process.

– Because the dynamics of the creative process are too difficult to explain directly in interviews with the creator, researchers could use Creative process Report Diary (CRD) to improve knowledge on it. The CRD could also be used in class when pupils or students are creating to improve their metacognition about their own process. It is an easy tool to implement with adults (Botella and Lubart 2015; Botella et al. 2011) and even with pupils when it is presented visually with pictures (Didier et al. 2016). More globally, the use of tool could be a way to enhance the teaching of creativity. Pearson and Logie (2015) had shown that software externalizing the creation of mental images reduce working memory.

– Sun and collaborators (2016) described a process evolving from successive interaction of fluctuation and stability. In the same vein, Foti and collaborators (2008) described the perception of leadership by information occurring simultaneously and over time. The Bumper Effect Dynamic (Greeley 1977) prevents individuals from going astray by guiding and keeping them on the correct path. Based on these studies, we can imagine the teacher offering help when the process is too stable, by adding other constraints, by stopping an incorrect path, or changing the rhythm of the class for example.

– Based on Ward and Wickes (2009), the teacher could adjust the information given at the beginning of the teaching session to activate the accessibility of exemplars. The teacher could also propose exercises favoring the semantic distance between ideas (Hass 2017). More globally, based on the work of Tisdell and collaborators (2008), teachers could provide only a little information about the theme of the program, invite a lecturer or propose a living experience to encourage students to generate ideas and to be involved.

– Based on Yaniv's (2012) work on psychotherapeutic interactions, role reversal could be a method to help individuals to understand the creative process of others. As described by the author, first, the creator starts to imitate the other; second, the creator tries to reproduce the other with his or her own subjectivity; and finally, the creator exchanges the creative process. A better understanding of the creative process of others could give some ideas to improve one's own process.

– The creator is not alone during the creative process, especially in learning contexts. The teacher could invite students to enhance their social networks outside the class (Engel et al. 2017) or to collaborate during the class (Gray 1989). Moreover, the teacher could use constraints as Bakker and collaborators (2013) who proposed that team members will not work together again or that they will work all together during a 1 year program.

To conclude, the linear 4-stage model of the creative process (Wallas 1926) seems far from dynamic. However, the creative process appears to have an important

dynamic structure. It is challenging to specify the components of the creative process, their organization, their combination, how they are influenced by the environment according to the time frame and also according to the creative domain studied. We suggest, however, that this dynamic approach is needed to capture the complex, idiosyncratic and seemingly unpredictable nature of the creative process and to develop potentially original and effective training.

References

Ainsworth-Land, G. (1981). The dynamics of creative process — Key to the enigmas of physics. *The Journal of Creative Behavior, 15*(4), 227–241. https://doi.org/10.1002/j.2162-6057.1981.tb00297.x.

Amabile, T. M. (1988). A model of creativity and innovation in organizations. *Research in Organizational Behavior, 10*, 123–167.

Arieti, S. (1976). *Creativity: The magic synthesis*. New York: Basic Books.

Armbruster, B. B. (1989). Metacognition in creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 177–182). New York: Plenum.

Averill, J. R., & Nunley, E. P. (1992). *Voyages of the heart: Living an emotionally creative life*. New York: Free Press.

Bakker, R. M., Boroş, S., Kenis, P., & Oerlemans, L. A. G. (2013). It's only temporary: Time frame and the dynamics of creative project teams. *British Journal of Management, 24*(3), 383–397 https://doi.org/10.1111/j.1467-8551.2012.00810.x.

Beaty, R. E., Benedek, M., Kaufman, S. B., & Silvia, P. J. (2015). Default and executive network coupling supports creative idea production. *Scientific Reports, 5*, 10964. https://doi.org/10.1038/srep10964.

Beaty, R. E., Benedek, M., Silvia, P. J., & Schacter, D. L. (2016). Creative cognition and brain network dynamics. *Trends in Cognitive Sciences, 20*(2), 87–95. https://doi.org/10.1016/j.tics.2015.10.004.

Botella, M., & Lubart, T. (2015). Creative processes: Art, design and science. In G. E. Corazza & S. Agnoli (Eds.), *Multidisciplinary contributions to the science of creative thinking* (pp. 53–65). Singapour: Springer.

Botella, M., Zenasni, F., & Lubart, T. (2011). A dynamic and ecological approach to the artistic creative process of arts Students: An empirical contribution. *Empirical Studies of the Arts, 29*, 17–38. https://doi.org/10.2190/EM.29.1.b.

Botella, M., Glaveanu, V., Zenasni, F., Storme, M., Myszkowski, N., Wolff, M., & Lubart, T. (2013). How artists create: Creative process and multivariate factors. *Learning and Individual Differences, 26*, 161–170.

Botella, M., Nelson, J., & Zenasni, F. (2016). Les macro et micro processus créatifs. In I. Capron-Puozzo (Ed.), *Créativité et apprentissage* (pp. 33–46). Louvain-la-Neuve: De Boeck.

Botella, M., Nelson, J., & Zenasni, F. (2017). It is time to observe the creative process : How to use a creative process report diary (CRD). *Journal of Creative Behavior*. https://doi.org/10.1002/jocb.172.

Bourgeois-Bougrine, S., Glaveanu, V., Botella, M., Guillou, K., De Biasi, P. M., & Lubart, T. (2014). The creativity maze: Exploring creativity in screenplay writing. *Psychology of Aesthetics, Creativity, and the Arts*, 8(4), 1–16.

Brewer, M. (2000). Research design and issues of validity. In H. Reis & C. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 3–16). Cambridge: Cambridge University Press.

Busse, T. V., & Mansfield, R. S. (1980). Theories of the creative process: A review and a perspective. *Journal of Creative Behavior, 14*(2), 103–132.

Carbon, C. C. (2010). The cycle of preference: Long-term dynamics of aesthetic appreciation. *Acta Psychologica, 134*(2), 233–244. https://doi.org/10.1016/j.actpsy.2010.02.004.

Carbon, C.-C. (2011). Cognitive mechanisms for explaining dynamics of aesthetic appreciation. *I-Perception, 2*, 708–719 https://doi.org/10.1068/i0463aap.

Carbon, C. C. (2012). Dynamics of aesthetic appreciation. *Human Vision and Electronic Imaging XVII, 8291*(A), 1–6. https://doi.org/10.1117/12.916468

Carson, D. K. (1999). Counseling. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of creativity* (Vol. 1, pp. 395–402). New York: Academic.

Corazza, G. E. (2016). Potential originality and effectiveness: The dynamic definition of creativity. *Creativity Research Journal, 28*(3), 258–267. https://doi.org/10.1080/10400419.2016.1195627.

Cropley, D. H., & Cropley, A. J. (2012). A psychological taxonomy of organizational innovation: Resolving the paradoxes. *Creativity Research Journal, 24*(1), 29–40.

Cropley, D. H., Cropley, A. J., Chiera, B. A., & Kaufman, J. C. (2013). Diagnosing organizational innovation: Measuring the capacity for innovation. *Creativity Research Journal, 25*, 388–396.

Didier, J., Botella, M., Attanasio, R., & Lambert, M.-D. (2016). Construction of notebook to observe the creative process of young students during complex solving problems in educational context. *31st International Congress of Psychology*, July 24–29, Yokohama, Japan.

Doyle, C. L. (1998). The writer tells: The creative process in the writing of liberation fiction. *Creativity Research Journal, 11*(1), 29–37.

Engel, Y., Kaandorp, M., & Elfring, T. (2017). Toward a dynamic process model of entrepreneurial networking under uncertainty. *Journal of Business Venturing, 32*(1), 35–51 https://doi.org/10.1016/j.jbusvent.2016.10.001.

Foti, R. J., Knee, R. E., & Backert, R. S. G. (2008). Multi-level implications of framing leadership perceptions as a dynamic process. *Leadership Quarterly, 19*(2), 178–194. https://doi.org/10.1016/j.leaqua.2008.01.007.

Fusari, A. (2005). A model of the innovation-adaptation mechanism driving economic dynamics: A micro representation. *Journal of Evolutionary Economics, 15*(3), 297–333. https://doi.org/10.1007/s00191-005-0246-z.

Glaveanu, V., Lubart, T., Bonnardel, N., Botella, M., de Biaisi, P.-M., Desainte-Catherine, M., Georgsdottir, A., Guillou, K., Kurtag, G., Mouchiroud, C., Storme, M., Wojtczuk, A., & Zenasni, F. (2013). Creativity as action: Findings from five creative domains. *Frontiers in Psychology, 4*(April), 176. https://doi.org/10.3389/fpsyg.2013.00176.

Goswami, A. (1996). Creativity and the quantum: A unified theory of creativity. *Creativity Research Journal, 9*(1), 47–61.

Gray, B. (1989). *Collaborating: Finding common ground for multiparty problems*. San Francisco: Jossey Bass.

Greeley, L. (1977). The bumper effect dynamic in the creative process: The philosophical, psychological and neuropsychological link. *The Journal of Creative Behavior, 20*(4), 261–275.

Gruber, H. E. (1988). The evolving systems approach to creative work. *Creativity Research Journal, 1*, 27–51.

Gruber, H. E. (1989). The evolving systems approach to creative work. In D. Wallace & H. E. Gruber (Eds.), *Creative people at work: Twelve cognitive case studies* (pp. 3–24). New York: Oxford University Press.

Guilford, J. P. (1950). Creativity. *The American Psychologist, 5*, 444–454.

Hass, R. W. (2017). Tracking the dynamics of divergent thinking via semantic distance: Analytic methods and theoretical implications. *Memory and Cognition, 45*(2), 233–244. https://doi.org/10.3758/s13421-016-0659-y.

Kellermann, P. F. (1994). Role reversal in psychodrama. In P. Holmes, M. Karp, & M. Watson (Eds.), *Psychodrama since Moreno: Innovations in theory and practice* (pp. 263–279). London.: Routledge.

Krashen, S. (1984). *Writing: Research, theory, and applications*. Torrance: Laredo Publishing.

Lewin, K. (1935). *A dynamic theory of personality: Selected papers*. New York: McGraw-Hill.

Lubart, T. I., & Getz, I. (1997). Emotion, metaphor, and the creative process. *Creativity Research Journal, 10*(4), 285–301.

Lubart, T. I. (2000–2001). Models of the creative process: Past, present and future. *Creativity Research Journal, 13*(3–4), 295–308.

Lubart, T. (2009). In search of the writer's creative process. In S. B. Kaufman & J. C. Kaufman (Eds.), *The psychology of creative writing* (pp. 149–165). New York: Cambridge University Press.

Lubart, T. I., Mouchiroud, C., Tordjman, S., & Zenasni, F. (2015). *Psychologie de la créativité [psychology of creativity]* (2nd ed.). Paris: Armand Collin.

Martindale, C. (1981). *Cognition and consciousness*. Homewood: Dorsey.

Martindale, C. (1999). History and creativity. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopaedia of creativity* (Vol. 1, pp. 823–830). New York: Academic Press.

Molenaar, P. C. M. (2013). On the necessity to use person-specific data analysis approaches in psychology. *European Journal of Developmental Psychology, 10*, 29–39.

Molenaar, P. C. M., & Campbell, C. G. (2009). The new person-specific paradigm in psychology. *Current Directions in Psychological Science, 18*, 112–117. https://doi.org/10.1111/j.1467-8721.2009.01619.x.

Mumford, M. D., & Porter, P. P. (1999). Analogies. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopaedia of creativity* (Vol. 1, pp. 71–77). New York: Academic.

Ochse, R. E. (1990). *Before the gates of excellence: The determinants of creative genuis*. Cambridge: Cambridge University Press.

Ohanian, A. (2014). *From PlayStation to Y Combinator: The Reddit origin story, part 2*. Okhuysen: American Express Open Forum.

Osborn, A. F. (1953/1963). *Applied imagination* (3rd ed.)*.* New York: Scribners.

Patrick, C. (1935). Creative thought in poets. *Archives of Psychology, 178*, 1–74.

Patrick, C. (1937). Creative thought in artists. *Journal of Psychology, 4*, 35–73.

Patrick, C. (1938). Scientific thought. *The Journal of Psychology, 5*, 55–83.

Pearson, D. G., & Logie, R. H. (2000). Working memory and mental synthesis. In S. O'Nuallan (Ed.), *Spatial cognition: Foundations and applications* (pp. 347–359). Amsterdam: John Benjamins Publishing.

Pearson, D. G., & Logie, R. H. (2015). A sketch is not enough: Dynamic external support increases creative insight on a guided synthesis task. *Thinking and Reasoning, 21*(1), 97–112. https://doi.org/10.1080/13546783.2014.897255.

Pearson, D. G., Logie, R. H., & Gilhooly, K. (1999). Verbal representations and spatial manipulation during mental synthesis. *European Journal of Cognitive Psychology, 11*(3), 295–314. https://doi.org/10.1080/713752317.

Pearson, D. G., Deeprose, C., Wallace-Hadrill, S., Burnett Heyes, S., & Holmes, E. A. (2013). Assessing mental imagery in clinical psychology: A review of imagery measures and a guiding framework. *Clinical Psychology Review, 33*(1), 1–23. https://doi.org/10.1016/j.cpr.2012.09.001.

Peilloux, A., & Botella, M. (2016). Ecological and dynamical study of the creative process and affects of scientific students working in groups. *Creativity Research Journal, 28*(2), 165–170. Retrieved from. https://doi.org/10.1080/10400419.2016.1162549.

Prins, S. (2006). The psychodynamic perspective in organizational research: Making sense of the dynamics of direction setting in emergent collaborative processes. *Journal of Occupational and Organizational Psychology, 79*(3), 335–355. https://doi.org/10.1348/096317906X105724.

Roels, H. (2014). Cycles of experimentation and the creative process of music composition. *Artistic Experimentation in Music: An Anthology*, 231–240.

Runco, M. A. (1991). *Divergent thinking*. Westport: Ablex Publishing.

Runco, M. A. (1999). Divergent thinking. In M. A. Runco & S. R. Pritsker (Eds.), *Encyclopaedia of creativity* (Vol. 1, pp. 577–582). New York: Academic.

Runco, M. A., & Dow, G. (1999). Problem Finding. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopaedia of creativity* (Vol. 2, pp. 433–435). New York: Academic.

Russ, S. W. (1999). Emotion/affect. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopaedia of creativity* (Vol. 1, pp. 659–668). New York: Academic.

Sadler-Smith, E. (2016). Wallas' four-stage model of the creative process: more than meets the eye ? *Creativity Research Journal, 27*(4), 342–352. https://doi.org/10.1080/10400419.2015.1087277

Shaw, M. P. (1989). The eureka process: A structure for the creative experience in science and engineering. *Creativity Research Journal, 2*(4), 286–298.

Shaw, M. P. (1994). Affective components of scientific creativity. In M. P. Shaw & M. A. Runco (Eds.), *Creativity and affect* (pp. 3–43). Westport: Ablex Publishing.

Simonton, D. K. (1980). Intuition and analysis: A predictive and explanatory model. *Genetic Psychology Monographs, 102*(1), 3–60.

Simonton, D. K. (1990). Creativity in the later years: Optimistic prospects for achievement. *The Gerontologist, 30*, 626–631.

Simonton, D. K. (1999). *Origins of genius: Darwinian perspectives on creativity*. London: Oxford University Press.

Simonton, D. K. (2001). Talent development as a multidimensional, multiplicative, and dynamic process. *Current Directions in Psychological Science, 10*(2), 39–43. https://doi.org/10.1111/1467-8721.00110

Sun, H., Steinkrauss, R., van der Steen, S., Cox, R., & de Bot, K. (2016). Foreign language learning as a complex dynamic process: A microgenetic case study of a Chinese child's English learning trajectory. *Learning and Individual Differences, 49*, 287–296. https://doi.org/10.1016/j.lindif.2016.05.010.

Tisdell, C., Wilson, C., & Swarna Nantha, H. (2008). Contingent valuation as a dynamic process. *Journal of Socio-Economics, 37*(4), 1443–1458. https://doi.org/10.1016/j.socec.2007.04.005.

Treffinger, D. J. (1995). Creative problem solving: Overview and educational implications. *Educational Psychology Review, 7*(3), 301–312.

Van Geert, P., & Steenbeek, H. (2005). Explaining after by before: Basic aspects of a dynamic systems approach to the study of development. *Developmental Review, 25*, 408–442.

Vinacke, W. E. (1952). *The psychology of thinking*. New York: McGraw-Hill.

von Koss Torkildsen, J., Morken, F., Helland, W. A., & Helland, T. (2016). The dynamics of narrative writing in primary grade children: Writing process factors predict story quality. *Reading and Writing, 29*(3), 529–554. https://doi.org/10.1007/s11145-015-9618-4.

Wallas, G. (1926). *The art of thought*. New York: Harcourt, Brace.

Waller, N. G., Bouchard, T. J., Jr., Lykken, D. T., Tellegen, A., & Blacker, D. M. (1993). Creativity, heritability, familiarity: Which word does not belong? *Psychological Inquiry, 4*, 235–237.

Ward, T. B., & Wickes, K. N. S. (2009). Stable and dynamic properties of category structure guide imaginative thought. *Creativity Research Journal, 21*(1), 15–23. https://doi.org/10.1080/10400410802633376.

Yaniv, D. (2011). Revisiting Morenian psychodramatic encounter in light of contemporary neuroscience: Relationship between empathy and creativity. *Arts in Psychotherapy, 38*(1), 52–58. https://doi.org/10.1016/j.aip.2010.12.001.

Yaniv, D. (2012). Dynamics of creativity and empathy in role reversal: Contributions from neuroscience. *Review of General Psychology, 16*(1), 70–77. https://doi.org/10.1037/a0026580.

Yeh, Y. c., Lai, S. C., & Lin, C. W. (2016). The dynamic influence of emotions on game-based creativity: An integrated analysis of emotional valence, activation strength, and regulation focus. *Computers in Human Behavior, 55*, 817–825. https://doi.org/10.1016/j.chb.2015.10.037.