Leader for Creativity : Modelling and Experimenting Defixation-oriented Leadership

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« Science in itself is morally neutral; it becomes good or evil according as it is applied »

Aldous Huxley

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À Hamza et Maryam,

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Chapter I: Introduction & Main Research Issues

In chapter I, we go through a brief review of the research context & problem of our research thesis, the research questions, the research objectives that were set for this thesis, the research methodology used to answer research questions, and we end the chapter with the structure of the Ph.D. thesis.

I. Abstract of the Ph.D. Thesis: "Leaders for Creativity: Modeling and Experimenting Defixation-oriented Leadership"

What is creative leadership? Who are creative leaders? How do they manage innovation?

The literature review on creative leadership presents **two distinctive figures of creative leaders: the innovators, and the facilitators**. The first ones are innovative geniuses and visionary entrepreneurs. They come up with creative ideas, they are revolutionary and drive their teams according to their visions. Late Apple's Steve Jobs or Tesla's Elon Musk are perfect illustrations of this first class of creative leaders. The second types of creative leaders are perfect administrators, mediators, and facilitators of the innovative process. They manage the set of factors that foster creativity by creating the appropriate conditions and climate, by motivating their teams through incentives and rewards, by encouraging their teams to take risks, or by recruiting creative members among their teams. IDEO's David Kelley or Google's Larry Page would perfectly fit in this second category of creative leaders.

But the questions are: **from where do these two figures of creative leadership arise? Are there other figures of creative leadership? Are these figures of creative leadership sufficient to confront the challenges faced by their teams in the innovation process?**

Today, the advances in the comprehension of the underlying mechanisms of creativity from both cognitive psychology perspective (with a better comprehension of phenomena such as cognitive biases against creativity), and design perspective (with the formalisms to defy these phenomena and overcome these cognitive biases against creativity) have opened different perspectives for new potential figures of creative leaders. **What are exactly these new figures of creative leadership? How to highlight and uncover these new figures? Why are they so important for today's organizations?**

II. Introduction to the Research Context & Problem: Fixation, a Key Challenge for Creative Leaders in an Innovation-Dependent Economy

1. Fixation versus Creativity: A Double Cognitive-Design Issue

In today's world, **creativity is considered a highly appreciated, not to say indispensable element**. In almost every occupation, there is a place for a certain level of creativity and innovative thinking required. Creativity has been described as the capacity to generate ideas that are both novel and useful (Amabile, 1996), and constitutes one of the key cognitive skills that individuals use daily in various contexts. Indeed, the creativity of employees has constantly been seen as the fundamental element for organizations' success and continuous development.

However, generating creative ideas is not an easy task, and despite the favourable conditions and necessary resources available in organizations to innovate, most employees have been facing serious difficulties to constantly generate creative ideas. One origin of these obstacles occurring during innovation processes is well known in the domain of cognitive psychology. Indeed, **cognitive psychology studies have highlighted the negative role played by cognitive biases during innovation processes.** Cognitive biases are individuals' tendencies to reason in certain ways that can lead to systematic deviations from a standard of rationality (Haselton, Nettle, & Murray, 2005). These cognitive traps restrain individuals' capacity to generate creative ideas and solutions to problems.

Such cognitive biases against creativity generally occur during the very early stages of the innovation process, most precisely during the stage of creative ideation. However, it is worth taking into consideration that these biases do not only occur during ideation but may also arise along the different stages of the innovation process. **One of the most common and major of these cognitive biases against creativity is no doubt the fixation effect**, which is originally called functional fixedness (Duncker & Lees, 1945; Jansson & Smith, 1991), "mechanization of thought" (Luchins, 1942) or sometimes also referred to as a "mental set". In what follows, we will refer to this phenomenon as fixation.

Fixation has been considered a central topic of study in numerous fields, ranging from cognitive psychology to other domains such as mechanical engineering, design sciences, and recently management sciences. **Fixation's definition differs according to sectors' perspectives**. From a psychological point of view, it is a "mental block against using an object in a new way that is required to solve a problem" (Duncker & Lees, 1945). In creative ideation literature, it is frequently described as the fact that some knowledge and obvious solutions are spontaneously activated in individuals' mind during a context of creative ideation, and consequently constrain individuals' ability to

generate more creative ideas and solutions (Agogué et al., 2014a; Cassotti, Camarda, Poirel, Houdé, & Agogué, 2016b).

Due to its growing importance, **overcoming fixation (or defixation) became a key topic of study for several researchers** across multiple disciplines such as design, engineering, cognitive psychology, or management.

2. Can Leadership Defixate?

Over the last decades, leadership has repeatedly been known to play a fundamental role in innovation processes (Denti & Hemlin, 2012). Highly creative leaders such as Steve Jobs, Thomas Edison or Mark Zuckerberg have transformed the way we use and see things, and have no doubt impacted our everyday life. However, such exceptional figures of creative leaders – that are capable of leading their firms for innovation – are not countless, and **today's traditional forms of creative leaders seem to be inadequate to confront the cognitive traps faced by their teams.**

Contrarily to one might think, it is worth pointing out that despite the fact that existing methods for overcoming fixation have ignored the role played by leadership, **in almost all existing defixation methods, we could model a figure of leader that is implicitly present before or during the ideation process**, and that plays a direct or indirect role to help individuals (designers, engineers, experts, etc.) bypass the cognitive obstacles against creativity.

For the above-mentioned reasons, uncovering the role of leadership for defixation is becoming a principal challenge, and more precisely designing new forms of creative leadership capable of driving their teams to "think out of fixation" in order to achieve successful innovations is a key research and industrial challenge. Despite this fact, **to date, few studies successfully attempted to determine the precise role of leaders for defixation.** In other words, very little is known about the role that should be played by leaders for defixation in creativity situations.

Therefore, the research questions become more precise and defined: **Are today's existing figures of "creative leaders" adequate to help their teams overcome these cognitive traps against innovation?** More precisely, do current creative leadership models play an explicit role of "defixator" for their teams? If not, how can creative leaders lead their teams in a way to overcome fixation effects occurring during creative ideation contexts? The research problem and question could be illustrated according to the figure below.

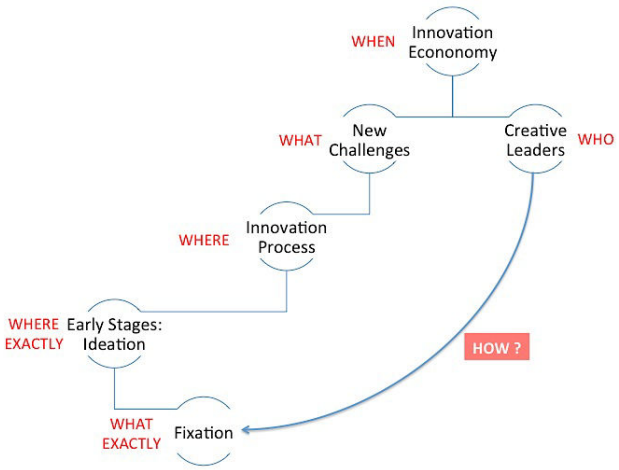


FIGURE 1: RESEARCH CONTEXT & PROBLEM

On one hand, in the literature of leadership, **numeral studies have lately paid attention to the role of leadership for creativity, without particularly paying attention to the cognitive biases against creativity**, not because it is not a priority but rather due to the difficulty to accurately treat this question. As an indication of this fact, famous leadership journals (such as the Leadership Quarterly for instance), have dedicated various studies linking leadership to creativity but – as we will show in the literature review – no studies linking leadership to fixation.

Moreover, today's existing figures of creative leadership could seem at first sight not to be appropriate enough to help their teams overcome the critical cognitive biases they face during creative ideation. In other words, **current standard models of creative leadership do not play an explicit and clear role of "defixator" for their teams**, most probably because the cognitive dimension behind these creative leadership styles is not well highlighted, or seems to be hidden among multiple traditional variables of the creative leadership equation (such as motivation for example).

Manifestly, there is growing evidence in the literature review of leadership that **the existing forms of creative leadership incorporate certain cognitive dimensions that seem to play an implicit and indirect role of defixation for their teams**. However, much focus should be placed on these defixating procedures made by creative leaders. In other words, we could say that the underlying cognitive mechanisms of defixation are not well emphasized in creative leadership models, and not clearly demonstrated in the literature.

On another hand, in the literature review related to defixation processes, it is very clear that **developing tools, methods and managerial procedures for defixation has always been a priority for researchers in diverse areas**. For example, recent findings demonstrated that overcoming fixation

could be made through expansive examples, i.e. examples of ideas and solutions that are outside the fixation effect, and that help increase the creative generation capacities of individuals (Agogué et al., 2014a). Other studies showed that we could overcome fixation by reframing problems (Zahner, Nickerson, Tversky, Corter, & Ma, 2010), providing analogies (Bonnardel, 2000; Moreno, Yang, Hernández, Linsey, & Wood, 2015; Tseng, Moss, Cagan, & Kotovsky, 2008), providing open and abstract goals (Ward, Patterson, & Sifonis, 2004; Zahner et al., 2010), or even enabling incubation (Smith & Blankenship, 1991).

In the field of innovative design, several researchers have identified creativity stimulation techniques to overcome cognitive biases against creativity (Kowaltowski, Bianchi, & De Paiva, 2010). For instance, **innovative design methods like the Concept-Knowledge theory** (Hatchuel & Weil, 2003)**, and KCP method** (Hatchuel, Le Masson, & Weil, 2009) **are well recognized to help individuals and teams not only identify but also bypass fixation in contexts of innovative design,** respectively at the individual and collective levels.

At first sight, and by going through all these diverse creativity stimulation methodologies, one could inaccurately consider that they do not require any type of leadership, and that **these "leaderless" defixation methodologies seem to be simply reduced to simple instructional processes**. Moreover, this would be an excellent indication for management and creativity theorists claiming that creativity does not necessarily require "leadership" control. In other words, it would be perfectly consistent with the idea that creativity flourishes from certain levels of freedom and autonomy. However, by looking much deeper into these defixation procedures; we could model a very particular type of leader (with very specific managerial actions and competencies), hidden behind these instructional means.

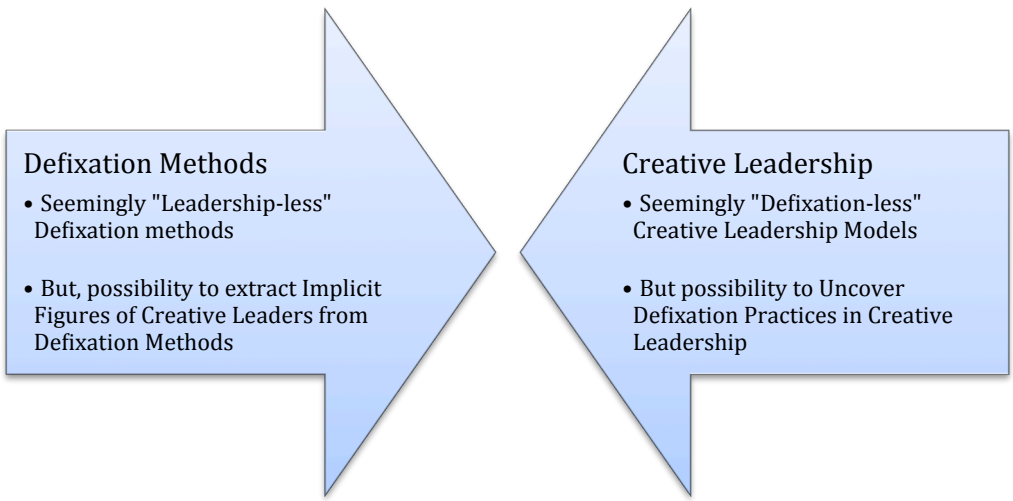


FIGURE 2: THE RELATIONSHIP BETWEEN DEFIXATION METHODS & CREATIVE LEADERSHIP

To illustrate the above-mentioned fact, studies on the role of expansive examples as a defixation procedure (Agogué et al., 2014a) model figures of leader that have the competence not only to identify fixation but also to provide their teams with examples of solutions outside fixation, as well as a certain level of legitimacy to impose the given expansive example on their teams. Therefore, it is worth mentioning that **although most defixation methodologies seem at first glance to be leaderless, they implicitly hide an important role of leadership with specific means of actions, competencies and strategies**. The figure above illustrates this issue from both defixation and leadership perspectives.

III. Research Questions: How To Set Up New Forms Of Leadership That Can Help Their Teams Overcome Fixation: A "Defixator Leadership"?

Based on the above research context and problem, the principal research question is summarized as follows:

How to set up new figures of creative leadership that could play the role of "defixator" for their teams?

In order to set up and construct these figures of defixator leaders, three major variables (extracted from the evolutionary tree of leadership theories that we will present later) should be taken into consideration (see the three characteristics of defixator leaders in the figure below):

1. The **means of actions of these figures of defixator leaders**, which means the managerial tools, stimuli, and actions they use. In point of fact, this first sub-question would consist of examining what are defixator leaders' means of action, i.e. what should be defixator leaders' management tools and actions to manage fixation/defixation processes? And what leadership practices should they use to enable defixation?
2. The **minimal competencies of these figures of defixator leaders**. Indeed, in order to defixate, defixator leaders should have certain competencies, or at least minimal competencies. Such competencies could be related to cognitive abilities of defixator leaders, their capacity to recognize certain things, to detect other things, etc. As a matter of fact, this second sub-question would consist of determining what should be defixator leaders' cognitive capacities to help their teams defixate, i.e. what should be their skills to defixate their teams?

3. The **contingent strategies of these figures of defixator leaders** are as well an indispensable variable. Basically, defixator leaders could be effective in certain situations, and with certain types of followers. However, they could fail in other situations, and with other types of followers. For this reason, the third sub-question would consist of better understanding how should defixator leaders' behave in front of teams with varying levels of expertise? In other words, what would happen if defixator leaders were less (or more) competent than their teams?

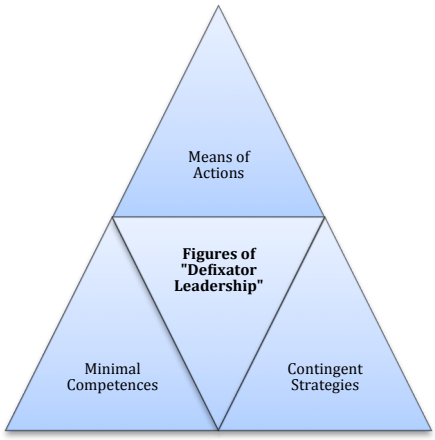


FIGURE 3: CHARACTERISTICS OF DEFIXATOR LEADERSHIP

Hence, in line with the above, the principal research question includes four narrower sub-questions that could be divided as follows:

1. **What are defixator leaders' means of actions?**
2. **What should be defixator leaders' minimal competencies?**
3. **What are defixator leaders' contingent strategies?**

IV. Research Objectives: Set Up Figures Of "Defixator Leaders" Based On Ideation's Cognitive Approaches

In this thesis, we attempted to **bring into light new figures of defixator leaders by bridging the existing research gap between creative leadership literature and defixation literature**. Throughout our work, and in order to set up these precise figures of defixator leaders, we decided to fix specific research objectives:

- **Designing the minimal profile of defixator leaders**. In fact, one of the standard models of creative leadership is the innovator. Innovators are lone geniuses that have the creative ideas themselves and drive their teams according to their visions. One of the main challenges of our research work was to implement figures of defixator leaders that are not necessarily innovators (do not generate the creative ideas themselves, are not the lone geniuses behind the innovation). There are three principal reasons for this choice:
    - The first one is that **no leader can possibly have all the answers and solutions for all problems**. Figures of innovator leaders (such as Steve Jobs or Thomas Edison) are no doubt extremely effective but very hard to find because of their high levels of expertise and personality. Today leadership has passed from an individual into a more shared approach, in which leaders have to empower their followers and delegate some of their responsibilities (decision-making, evaluation, recruitment, etc.) to them.
    - The second one is that **minimal profile of defixator leaders could easily be reinforced with further variables** (such as charisma to inspire followers, or incentives to motivate followers, or creative thinking skills to stimulate and challenge followers, etc.).
    - The third one is that by designing the minimal profile of defixator leaders, **the necessary managerial conditions required for defixation could be easily extracted**. This minimal profile of defixator leader could help organizational leaders to integrate basic managerial practices for defixation within their organizations.
- **Involving defixator leaders intensively in the innovation process**. In fact, another standard model of creative leadership is the facilitator. Facilitators are not highly involved in the innovation process but simply manage and handle the contextual factors for creativity. They create a creativity-supportive climate, a culture of innovation within their teams, they motivate their teams, etc. Another challenge of our research work was to implement figures of defixator leaders that are highly involved in the innovation processes, and not simply facilitating it.
- **Disclose the contingency nature of defixator leaders,** by adapting their behaviours according to the cognitive skills of the teams they manage. What are exactly the contingency variables? How to enlighten them? As a matter of fact, leadership scholars emphasized the importance of the situational and contingency theories of leadership in the sixties, in which they focused more on the behaviors that the leader should adopt given situational factors, providing that a leadership style which is effective in a certain situation may not be equally

effective in another. For this reason, it is important to design new figures of defixator leaders that would adapt to different teams with varying levels of expertise.

- **Neutralizing most of the classical variables inherited from creative leadership literature.** Leaders give incentives to their teams, leaders create creativity-supportive environments, leaders recruit creative individuals to stimulate creativity among team members, leaders provide their team with creative ideas or with relevant resources, etc. Most of these variables have different cognitive effects on their teams' creativity. However, we don't know how they could affect the defixation processes of their teams. In order to isolate and enlighten the effect of the defixation process, we had to neutralize most of these classical leadership organizational variables. In other words, we could say that another objective of our research work consisted of shedding light on the "cognitive influence" of leaders rather than the classical "social influence" of leaders.
- **Designing a leadership-driven ideation model by bringing into light the leadership characteristics present in the defixation processes literature** (instructional processes, legitimacy, defixation strategies, cognitive abilities, etc.). In fact, designing figures of defixator leaders requires first modelling the process of ideation, then integrating into this model the precise means of actions of these figures of leaders, and finally validating this model experimentally. Moreover, the model could help us to identify what competencies are required by the leaders to defixate, as well as developing contingent strategies for defixation by simulating this model in various situations.
- **Generating precise leadership rules and strategies for defixation based on experimental settings**. As a matter of fact, the literature on creative idea generation has put aside the role of leaders during defixation processes. One research objective would be to shed light on the critical role leaders could play for defixation.
- **Contextualizing the experimental-based rules of leadership for defixation in organisational settings, using classical leadership organisational practices. In fact, very little is known about the role leaders should play for defixation in organisational contexts. Another research objective would be to understand how leadership classical organisational practices could be tailored in organisations for defixation purposes.**

V. Research Methodology: Shaping "Defixator Leaders" Through Theory-driven Experiments

To answer these research questions and fulfill our research objectives, **we adopted a specific research method in management sciences mixing "theory-driven experiments" with empirical research method and empirical studies of innovative leaders**.

The theory-driven experimental method is usually applied to design experimental procedures in cognitive psychology. Theory-driven experiments' methodology relies on random assignment and laboratory control to ensure the most valid and reliable results. We chose this particular research method among others because **answering research questions required having highly controlled settings, in order to neutralize most of the typical variables of creative leadership literature** as we have explained in the research objectives.

Given the above, we first built a **theoretical model of "leadership-driven ideation"**, based on both design and probability theories. Secondly, we used this theoretical model to **define the necessary means of actions and competencies required for leaders to accomplish specific defixation objectives**. We then conducted a series of experiments that enabled us to **shape the principal characteristics of figures of defixator leader**. Gradually in each experiment, we provided our figures of leaders with specific means of actions, and minimal competencies possible to play this role of defixator.

The research method we proposed articulates between the role of leadership for defixation at the individual and group levels (laboratory) and its more realistic implications at the organizational level (organization). As illustrated in the figure below, theory-driven experimental research method highlights the hidden cognitive dimension regarding the role of leaders for defixation (step 1). The model of defixator leaders enables us to have contingent rules for leadership-driven defixation (step 2). Finally, getting back to an empirical research method post-experiments remains essential to fill the gap between the artificiality of the experimental outcomes, and its more realistic implications in organizational contexts (step 3).

Using this research method, we were able to define the precise and contingent roles of leaders for defixation could be extracted from the experiments. Moreover, we attempted to search in the biographies of great leaders, as well as in other empirical studies, for empirical evidence that could confirm or refute these experimental-based rules. **The articulation between the experimental field and the empirical field helped to redesign new figures of leadership that could handle fixation at the individual and organizational level.**

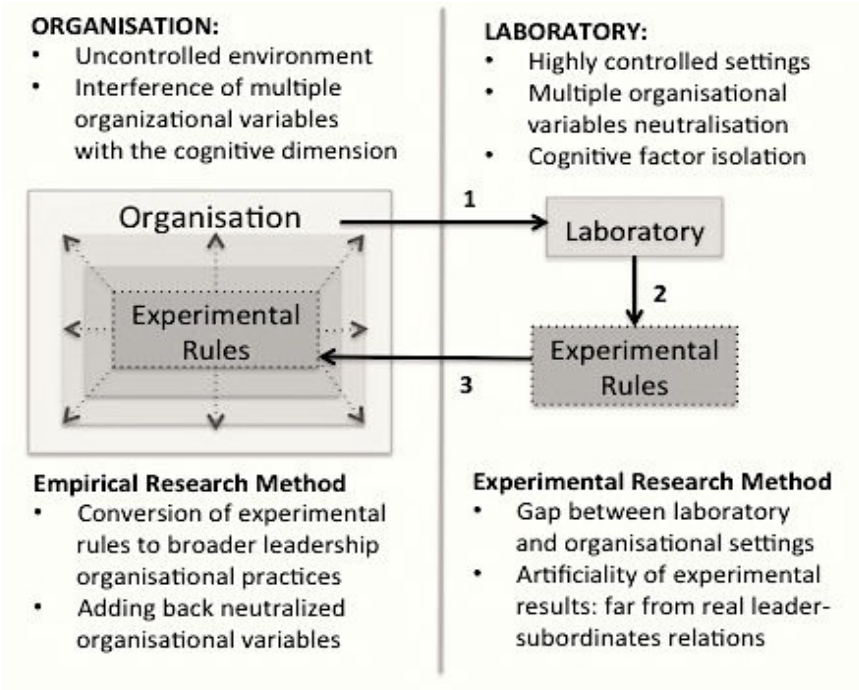


FIGURE 4: THE INTERPLAY BETWEEN LABORATORY & ORGANIZATION SETTINGS

VI. Structure of the Ph.D. Research Thesis: Synopsis

The Ph.D. thesis is structured into nine chapters as illustrated in the synopsis below. In chapter I, we presented an introduction to the Ph.D. research thesis, which included a **brief review of the research context, problem, questions, objectives, and methodology**.

Chapters II and III represents the step 1 of our research method. In chapter II, we introduce **why fixation is a crucial challenge for future creative leaders**. In fact, in a new context of innovation economy, where firms innovate or die, we show that a new critical challenge appears for tomorrow's creative leaders: the role of defixator, i.e. how leaders should manage the process of defixation in context of creative ideation.

In chapter III, we **examine in the literature review whether or not creative leaders play the role of defixators**. First, we define the concept of leadership and then compare creativity and leadership. We then present the standard models of creative leadership: the innovator and the facilitator. Given these standard models, we look further into creative leadership styles and their underlying cognitive dimension.

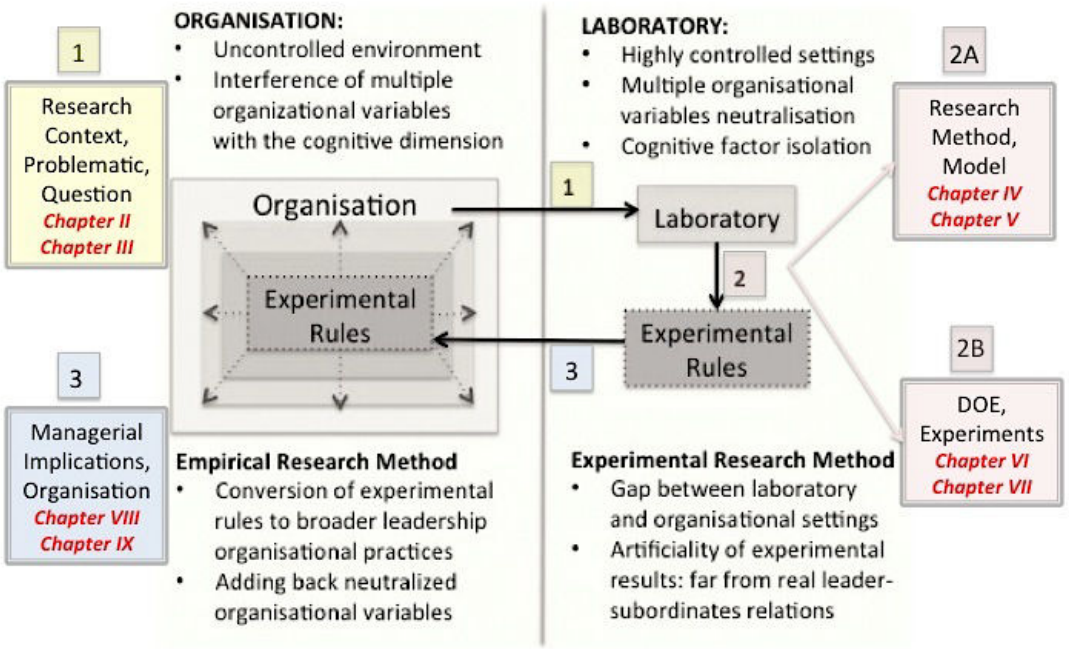


FIGURE 5: SYNOPSIS OF THE THESIS

Chapters IV and V represent the step 2A of our research method. In chapter IV, we take advantage from the existing literature on defixation processes to uncover the implicit figure of leadership present in it, and this as a starting point for our main research question on **how to set up new forms of defixator leaders**. In this chapter, we then list our sub-research questions, our research objectives, as well as our specific research methodology.

In chapter V, **we propose a leadership-driven ideation model**. We begin by modeling ideation based on design theories, then "sequential ideation" based on probability theories. Then, we introduce the role of defixator leaders based on this ideation model. Finally, we design an instrument to measure creative ideation performance.

Chapters VI and VII represent the step 2B of our research method. In chapter VI, based on leadership-driven ideation model, we and introduce the creativity task for our series of experiments, **gradually build each of the four figures of defixator leaders, and present the general hypothesis for each figure**.

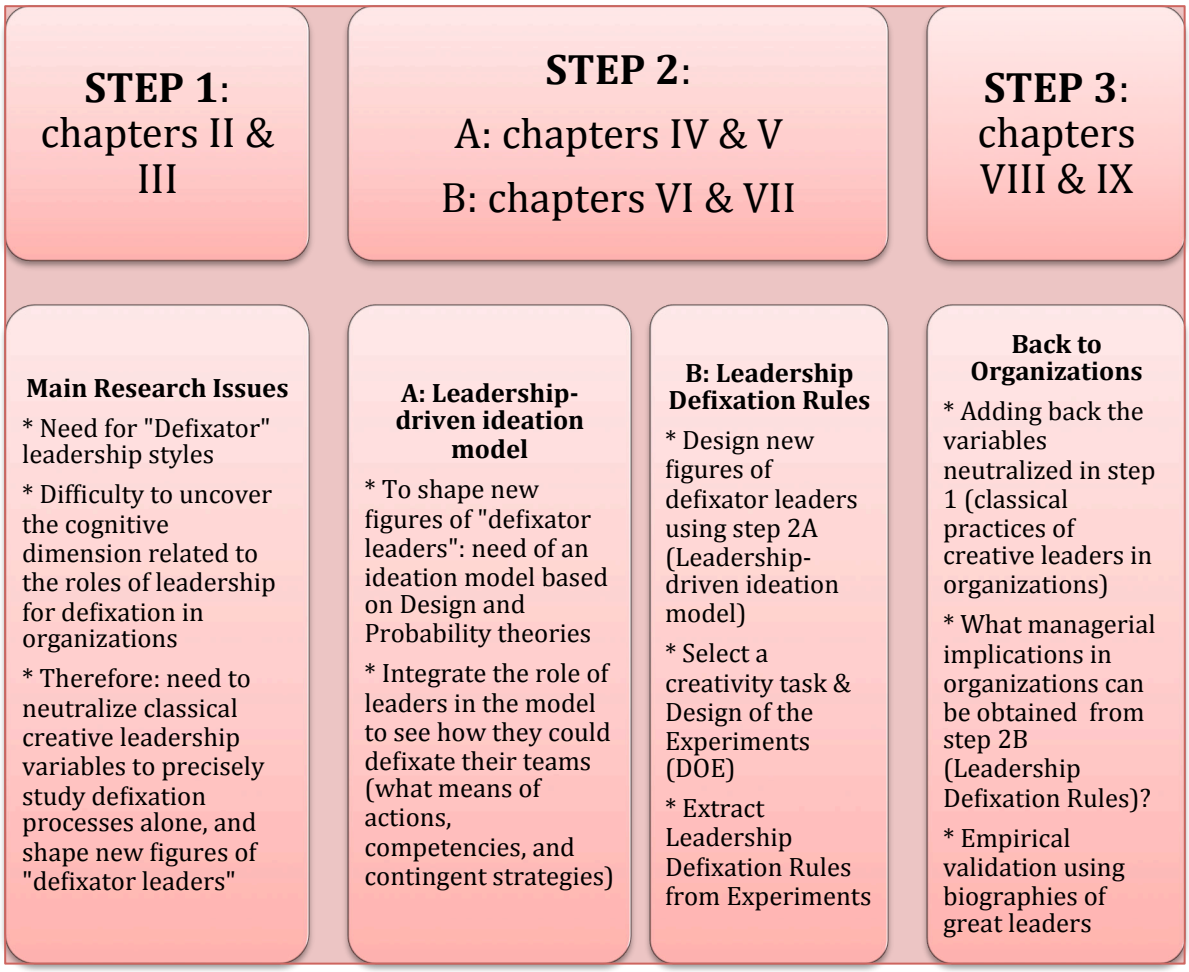
In chapter VII, we experiment each of the four figures of defixator leaders presented in the previous chapter. In this chapter, we present **the statistical results in terms of fluency/flexibility/originality, fixation/expansion scores, as well as transition probabilities parameters** based on our instrument to measure creative ideation performance presented in chapter V. We finally discuss our principal results.

Chapters VIII and IX represent the step 3 of our research method. In chapter VIII, we present the characteristics of the new figures of defixator leaders, their features, and the standard figure of defixator leadership. We end the chapter by demonstrating **how we could revisit leadership for defixation in organizational contexts using our laboratory-based experiments** (step 3 of our research methodology presented in chapter IV).

We end our thesis dissertation with chapter IX, which **concludes with the major contributions of our research thesis, the limitations, the future perspectives, and the thesis-related publications**.

VII. Summary of Chapter I

Below is a summary box presenting the key points of chapter I in the form of a more detailed synopsis of the thesis as presented in the previous section:



Chapter II: Fixation: A Major Challenge for Creative Leadership

In chapter II, we introduce why fixation is a main challenge for future creative leaders. In fact, in a new context of innovation economy, where firms innovate or die, we show that a new critical challenge appears for tomorrow's creative leaders: the role of defixator, i.e. how leaders should manage the process of defixation in context of creative ideation.

I. Research Context: The Innovation Economy

1. Creativity: A Fundamental Constituent of the Innovation Economy

FIGURE 6: FRONT PAGE HEADLINES OF THE BUSINESS WEEK - 75TH ANNIVERSARY

Becoming faster, smarter, and increasingly complex, today's world emphasizes the need for creativity and innovation (Dess & Picken, 2001). Creativity is nowadays considered a highly appreciated, not to say indispensable element. **In almost every occupation, there is a place for a certain level of creativity and innovative thinking required (Shalley & Gilson, 2004)**. The creativity of employees constitutes a fundamental element for organizations' success and continuous development (Bruch & Ghoshal, 2003).

Creativity has usually been described as the ability to generate ideas that are both novel and useful, while innovation extends this definition, and involve taking those creative ideas and carrying them through to implementation (Amabile, 1983). Creativity has become a fundamental constituent of the so-called "innovation economy", which has come to replace knowledge-dependent economy. In fact, the economic benefit resulting from creativity is undeniable. The more innovations (products/services) are generated in markets, and the more job opportunities are

created in societies, which then result in economic growth. Therefore, creativity and innovations stand today as one of the principal motors that drive the world economy.

To illustrate this new phenomenon, the world's best-selling magazine **Business Week has published a special issue entitled "innovation economy" in honor of its 75th birthday, highlighting in it the achievements of great innovators such as Apple late CEO Steve Jobs or the World Wide Web inventor Tim Berners-Lee**, and presenting in its edition a variety of inspiring strategic innovation articles such as "Building an Idea Factory".

Within this new economy, it is worth pointing out that innovation is more than a goal for organizations, rather it is perceived as a fundamental philosophy and culture that should be encouraged at the governmental levels. Indeed, this new **innovation economy came to shift the focus of governments and societies to encourage creativity, to develop novel and useful business models, as well as innovative products and services**.

2. Innovating or Dying: A Threat to the Survival of Firms within the Innovation Economy

In light of this rise of the so-called "innovation economy", organizations are committed to continuously innovate in order to compete with each other in the business scene. However, in most of the cases, innovating is not only a requirement for firms but rather an unavoidable obligation (Jagersma, 2003; Tushman & O'Reilly, 1996). **Nowadays, every organizational leader is aware that his/her business should be innovative in order to subsist.**

There are numerous examples of companies that failed to innovate and consequently disappeared from the business scene. During the decade 1990-2000, Nokia was no doubt the number one mobile maker and the principal brand people used to own. In the early 2000s, Samsung and Apple strongly expelled the Finnish company from the smartphone industry, until it had disappeared completely from the business scene. Nokia is not the only example; indeed **the list of innovation failures is long and comprises numerous giant companies such as BlackBerry, Kodak or Blockbuster** (Binns, Harreld, O'Reilly, & Tushman, 2014).

Counterexamples also exist. **3M and Apple are two excellent examples of companies that succeeded to achieve amazing achievements, after passing by extremely critical failure times**. It is only the crucial role of their great creative leadership that saved these companies from chaos. These

leaders succeeded in implementing within their companies a true and effective innovation culture, as well as new product development systems that reward and encourage creativity.

Consequently**, if businesses want to compete in the market within this new innovation-dependent environment, they should learn, find and adopt new methods to "think outside the box"**, or more precisely generate ideas beyond the box, ideas that would be the future successful innovation (product or service). In fact, to do that, they should be more flexible, and more creative to quickly adapt to the demands of this new and fast-changing market.

Besides, this requires businesses to improve their ways of doing things, change the existing paradigms that have shown its limitations, to encourage creativity among their employees, to redirect their research and development strategies towards "research, innovation, and development" (Hatchuel, Le Masson, & Weil, 2001). Most importantly, this requires first **rethinking the essence of leadership, its new roles to adapt to these fast and competitive innovation-based markets.** It requires giving new shapes to leadership, in such similar ways that management is today reshaped with novel concepts to better adapt to the future (Denis, 2014).

3. Rethinking The Essence of Leadership for Innovation: From Creative Leadership to Leading for Creativity

To cope with the above-mentioned environmental factors changing fast*,* where competitive markets and businesses are changing so rapidly that companies are either innovating or expiring, **there is a need for a new vision of creative leadership**. This new vision would come to replace the classical figure of creative leadership where the leader is creative and has all the answers, and replace it with an adequate figure of creative leadership where the leader manages and leads creative processes without being the lone genius.

For these reasons, and by considering leadership as a key and central factor to foster creativity among followers, **many efforts have been made by management scholars throughout the last decades to shape different forms of leadership that could strongly manage and control the necessary conditions for creativity** (Amabile & Gryskiewicz, 1987).

Creative leaders nowadays should play a key and determinant role in this new innovation economy. Creative leaders should have the necessary managerial means to enable the stimulation of creative ideas among their teams. They should push their organizations towards success through endless and constant innovation. Most importantly, **creative leaders should have the ability to**

identify the new challenges required by this new economy, and learn to play new and more adaptive roles to help their teams confront these challenges.

As a matter of fact, innovation economy requires rethinking the essence of leadership (Davenport, Leibold, & Voelpel, 2007) to adapt it to their new challenges. For this reason, **redesigning the art of leading people towards the generation and production of creative outcomes stands no doubt as a fundamental requirement for this new economy**. But what are the principal challenges faced by leaders of innovation in this new innovation economy? What are the key obstacles faced by leaders of innovation?

II. Research Problem: New Types of Challenges for Tomorrow's Creative Leaders in Early Innovation Processes

1. Confronting the Struggles of the Early Innovation Stages: Ideation

Innovation is a relatively long multistage process, comprising stages such as idea generation, evaluation, development or implementation. According to Oxford dictionary, innovation means the introduction of something new, such as a new product, service or process into the marketplace. The early stage of the innovation process is usually considered to be ideation.

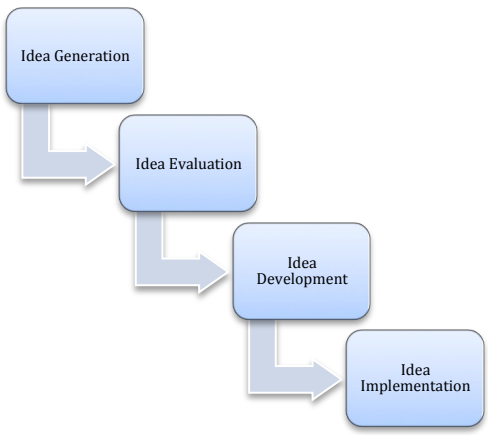


FIGURE 7: INNOVATION PROCESS STAGES

Ideation or idea generation is the process of coming up or bringing into being new ideas, while creative ideation consists of coming up with creative ideas, i.e. ideas that are both novel and useful (Amabile, 1996). The concept "idea" is vague and unclearly defined in the literature of idea management (Sukhov, Magnusson, & Olsson, 2015). Divergent thinking theorists usually consider

ideas as “representations”. Runco et al. suggest that “ideas have great generality (across domains) and sensitivity (varying with each individual's cognitive capacities)” (Runco & Chand, 1995).

Even if creative ideation is habitually perceived as the opening stage of the innovation process, in which the generated, evaluated, selected, developed and implemented creative idea becomes the future innovation (product or service); it is worth pointing out creative ideation is more generally **a generic phenomenon that is reproduced in each of the stages of the innovation process**.

In the problem-solving literature, ideation is the initial stage in which individuals are required to come up with as many possible alternatives to a particular problem. **The most famous ideation method is recognized as brainstorming**. Brainstorming is a group creativity technique popularized by Alex Faickney Osborn in his book Applied Imagination (Osborn, 1953). It consists of collectively produce ideas and solutions to a particular problem. According to the rules of Osborn (Osborn, 1957), individuals performing brainstorming sessions should: generate as many ideas as possible, withhold criticism of ideas, freewheeling (welcome wild ideas), and combine on ideas of others. The Brainstorming rules according to Osborn should help ideators to generate ideas in a stimulating, constructive, and uncritical atmosphere. Studies have shown that brainstorming instructions help to increase ideation compared to other conditions without these instructions (Agogué, 2016; Parnes & Meadow, 1959).

However, ideating is not an easy task, and **despite the favourable conditions and necessary resources available in organizations to innovate, most firms have been facing serious difficulties in the early innovation process, when their employees are required to generate creative ideas**. These barriers against the generation of creative ideas have been well identified and studied in the domain of cognitive psychology, and is called fixation.

2. Fixation: A Cognitive Bias to Creative Ideation

Explanations and enlightenment regarding the obstacles to creativity are well known and studied in cognitive sciences’ contexts. **Various studies in cognitive sciences have underlined the negative role of cognitive biases to creativity.**

The most famous one is called functional fixedness or fixation effect (Jansson & Smith, 1991), which is the fact that some existing knowledge or known solutions are spontaneously activated in individual’s minds, therefore constraining the ability of individuals to generate more creative ideas in contexts of creative ideation.

This mental block hinders the ability of individuals to see certain objects in different ways in spite of solving particular problems. Indeed, this is why it is usually referred to as "a blind adherence to a set of ideas and concepts" (Jansson & Smith, 1991). In other definitions fixation is described as: "**something that blocks or impedes the successful completion of various types of cognitive operations, such as those involved in remembering, solving problems, and generating creative ideas**" (Smith, Paulus, & Nijstad, 2003).

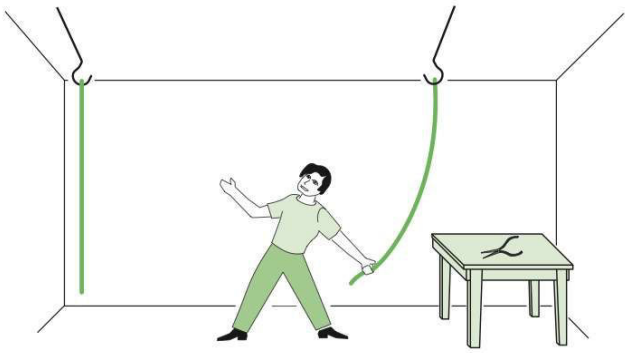


FIGURE 8: TWO CORD PROBLEM, (MAIER 1931)

One of the first tasks (but not the most famous one) that illustrated fixation is called the "two cord problem" (Maier, 1931). Participants were given two cords tied to the ceiling, as well as a pair of pliers. Individuals were asked to tie together the free ends of these two cords, knowing that the cords are short and cannot be held in the hands at the same time so that one can easily tie them together. One solution to this problem was simply to tie the pliers to one of the cord to form a pendulum that will swing to reach the second one. **In this "two cord problem" experiment, most participants were "fixated" to their existing knowledge of pliers and their conventional uses in their minds and consequently were unable to look at it alternatively as a pendulum for example (to solve the problem)**.

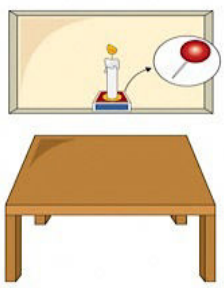


FIGURE 9: CANDLE PROBLEM, (DUNCKER, 1945)

One decade later, psychologist Karl Duncker measured the influence of fixation effects on individuals' problem-solving capabilities. He developed a problem-solving test is called the "candle

problem" (Duncker & Lees, 1945), which consists of fixing a candle on a wall in a way it doesn't drip wax onto the table below. Participants who performed this test were placed in a room and were only allowed to use a book of matches, as well as a box of thumbtacks to fix the candle. **In this "candle problem" experiment, most subjects were fixated and blocked to the typical use of the box of thumbtacks, and weren't able to think unconventionally by emptying the box, and fixing it directly on the wall using thumbtacks, in order to put the candle onto it** as shown in the figure below.

Over the past decades, **cognitive science studies have underlined the obstructive function of fixation in the context of creative idea generation**, demonstrating that previously acquired and existing knowledge in individuals' minds fixate them, and therefore restrain their aptitude for the generation of creative ideas (Agogué et al., 2014a; Jansson & Smith, 1991; Smith, Ward, & Schumacher, 1993). In other words, these studies have considered that reducing the effects of fixation would help individuals to become more creative.

However, it is important to point out that fixation does not only occur in the early stages of the innovation process (ideation) but may also emerge in a variety of shapes along the different stages of the innovation process. In an interesting report from an international workshop on design fixation, Crilly et al. pointed out that most studies "are fixated on one kind of fixation", referring to the fact that **the majority of studies that have studied fixation are "ideation fixation-oriented"** (Crilly & Cardoso, 2017).

In addition, it is also worth mentioning that **fixation does not only manifest itself at the individual level**. Fixation is also found at group levels such as group (Kohn & Smith, 2011) when individuals are exposed to the ideas of others; or even at the organizational level (Stempfle, 2011) when established paradigms and practices could enhance organizations' resistance to change.

In line with the above, one critical question in this regard is **how creative leaders could overcome cognitive traps such as fixation effects?** Another question would consist of examining whether the existing forms of creative leadership adequate to cope with these phenomena?

III. Research Need: A New Type of Leadership to Manage Fixation

1. Leading Ideation for Creativity: Need for New Forms of "Defixator" Leaders

Nonetheless, as indicated in the previous section, fixation is no doubt a principal barrier to the innovation process. Providing tomorrow's leaders with the ability, requisites and managerial tools to defixate their teams in the early innovation process stages is crucial within the context of the

innovation economy. In line with the above, **there is growing interest both for the research and industrial fields to design new forms of creative leaders, designed specifically to play the role of "defixators" for their teams.** In what follows, the term "defixators" will be used to designate these new forms of creative leaders.

For the academic research field, **proposing new forms of defixator leaders will contribute to the scientific community related to fields such as leadership, creativity, management and cognitive psychology**, and will enhance our understanding of how to manage creative processes creatively. Indeed, a new model of defixator leaders will enable the research field to have a better understanding of the cognitive biases against creativity and will provide better managerial tools to surpass them.

For the industrial field, proposing a model of defixator leader will provide heads of innovation in organizations with better tools to drive innovation in general. **This model should guide them practically on how to better manage and lead ideation sessions, on how to train ideation leaders to accurately identify cognitive biases against creativity**, and finally but not least on how to overcome these cognitive traps, and force their employees to be more creative and generative.

2. Revision of Leadership Identity: Need to Shift the Focus From Social Influence to Cognitive Influence

Moreover, leadership is defined as "a process of social influence in which an individual (the leader) is able to enlist the support of others (followers) in the accomplishment of a common task" (Chemers, 2014). Since the definition of leadership is principally centred on its "social influence" on followers, and that defixation requires "cognitive influence" on individuals to attain a specific goal (which is overcoming fixation effects); there is a need to redesign leadership for defixation. Indeed, **the traditional concept of leadership should be redefined in a way to shift its focus from social to cognitive influence**.

This shifting from social influence to cognitive influence in the redefinition of "defixator leaders" should break the dominant design of the concept of leadership; it should revise the identity of leaders (Hatchuel & Weil, 2009), their means of actions, their competencies, their practices, as well as their managerial tools. It should open the way to new and unexpected variables to appear; new variables leadership scholars did not take into account before when developing leadership models, such as the cognitive capacities of followers for example (their capacity to defixate themselves, their capacity to reason outside the box, to resist certain heuristics).

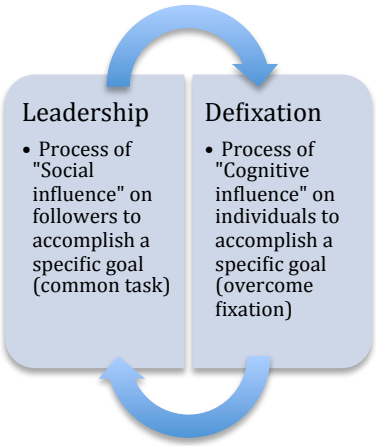


FIGURE 10: REDEFINITION OF LEADERSHIP FOR DEFIXATION

Our intent in the next chapter is to answer the following questions: **how to set up these new forms of defixator leaders?** How to shed light on their cognitive influences on followers? In order to answer these questions, we must first answer major questions: how to benefit from existing creative leadership models to redesign leadership for defixation? Do existing creative leadership models play the role of defixator for their teams?

IV. Summary of Chapter II

Below is a summary box presenting the key points of chapter II:

- Innovation economy came to replace knowledge economy
- The creativity of employees, i.e. their ability to generate ideas that are both novel and useful, constitutes a fundamental element for organizations' success in the innovation economy
- If businesses want to compete in the market, their leaders should learn, find and adopt new methods to get their employees "think outside the box"
- However, fixation imposes key constraints on employees' creative ideation capacities
- To confront fixation, leadership should be re-focused on its cognitive influence, and on how it could manage teams to overcome fixation
- There are research and industrial needs for new forms of leaders that can help their teams overcome fixation
- How to set up these new forms of "defixator" leaders? But let's first explore whether today's creative leaders play a role of defixator for their teams.

Chapter III: Do Today's Creative Leaders Play a Role of Defixator?

In chapter III, we examine in the literature review whether or not creative leaders play the role of "defixators" for their teams. First, we define the concept of leadership, and then compare creativity and leadership. We then present the standard models of creative leadership: what we labeled "the innovator" and "the facilitator". Given these standard models, we look further into creative leadership styles, and their underlying cognitive dimension.

I. Conceptual Evolution of Leadership

1. Leadership Definitions: A Process of Social Influence

To better understand how today's creative leadership models could play a defixator role for their teams, one must go through a brief review of what is leadership, who studied it and then present the principal models of leadership and their relations to creativity according to the literature review. Therefore, the introductory questions are: **What is leadership? Who are creative leaders? How do they drive their teams for innovation?**

According to Bass and Stogdill's handbook of **leadership was first interestingly seen as a myth believing that people necessitate some sort of hierarchies in their societies, and need to designate certain institutionalized chiefs or elected rulers to lead them** (Bass & Stogdill, 1990). Lewis confirmed this intrinsic necessity of people to be ruled, stating that even when communities do not have these type of rulers or chiefs to lead them, there will always emerge leaders who will play important leadership roles in groups (Lewis, 1974).

Bass and Stogdill describe how the concept of leadership is a phenomenon present in all the periods of our ordinary life (Bass & Stogdill, 1990). Indeed, the authors explain that in our early life, we learn from paternalistic leadership styles. Becoming older we then meet educational leadership styles at school, college, and university. In our daily life, we could meet symbolic leadership styles such as sports stars, religious priests, political leaders, famous artists, charismatic friends, etc. Even during our working path, we follow several types of leadership depending on our working career (politics, academic, military, social sciences, business, etc.) and our hierarchical managers' styles.

Formerly, **leadership was believed to be innate but studies have shown that leadership is a learnable process involving different social, educational, and environmental factors that can develop leadership potential** (Kouzes & Posner, 2010). Interestingly, this means that any individual can learn to be a leader, can learn to make his/her followers creative, and can even learn to defixate them.

It is worth mentioning that leadership is not a recently discovered concept. **According to Bernard Bass (Bass & Stogdill, 1990), very early principles of leadership could be discovered with the emergence of civilizations**, beginning from Ancient Egyptians 2300 B.C. (with the instructions of Ptahhotep, an ancient Egyptian Vizier attributing authoritative qualities to Pharaoh), Chinese civilization 551 B.C. (with Confucius and Lao-Tzu introducing the moral example of leadership, and describing the responsibilities of leaders, and how they should conduct themselves), as well as Greeks and Romans civilizations authors and philosophers (introducing the subject of leadership from an administration perspective). Moreover, numerous authors and artists like Machiavelli and Shakespeare have as well taught the subject of leadership especially during the Renaissance period (Corrigan, 1999).

Leadership is no doubt a very ambiguous concept that has "as many definitions as who have tried to define it", according to one of the most prominent leadership scholars Richard Stogdill. In fact, most people know what leadership is, and are capable to recognize the characteristics of a leader but would be unable to accurately define it. For this reason, in what he called "the crisis of leadership", Burns stated that leadership is one of "the most observed and least understood" phenomenon on earth (Burns, 1978).

Although leadership has multiple definitions depending on the perception of leadership theorists (Stogdill, 1974a), it is generally described as "**a process of social influence in which an individual (the leader) is able to enlist the support of others (followers) in the accomplishment of a common task**" (Chemers, 2014). In other words, a leader is someone who can influence his/her team to achieve certain organizational goals, and at the same time has some kind of authorities on them.

The factor "influence" is extremely critical to accurately understand leadership. Indeed, some leadership researchers argue that a leader is not necessarily the one in higher hierarchical position (Bennis & Nanus, 1985) but the one who has the ability to influence others. **Influence is the principal element that differentiates leaders from managers. A manager could be a leader but a leader is not necessarily a manager.**

This confusion between leaders and managers is the principal reason that explains why most studies usually stereotype leaders as being the hierarchical chiefs (organization's CEOs for instance). However, leaders should be perceived from a much broader perspective. In fact, leaders could also be considered as being followers to other leaders in an organization, or as being emerging and influential individuals inside a team who haven't got any form of hierarchical superiorities or legitimate power on others. Similarly, it is also important to note that followers are not necessarily hierarchical subordinates. Interestingly, we could have some cases in which managers find themselves followers to particular brilliant, charismatic or influential members in a team they are supposed to manage and lead.

In line with the above, **the concept of leaders should take into account these above-mentioned aspects, and should be perceived as a much broader concept**, since it is a process examining a particular exchange between two parties (leaders who are not necessarily hierarchical superiors, and followers who are not necessarily subordinates) in a particular common context and situation in which they both have mutual interests in achieving shared goals.

2. Leadership Evolutionary Studies Tree: A Poor Interest in Creativity

The conceptual evolution of leadership has been a topic of interest for leadership scholars. Studies on leadership have produced diverse theories all sorted according to a varying number of leadership study eras (Bolden, Gosling, Marturano, & Dennison, 2003; Brungardt, 1997; Daft, 2014; Van Seters & Field, 1990; Yukl, 1994). **Despite the complexity of exactly delineating leadership study eras throughout the history, several leadership scholars have made the effort to classify the major eras of leadership studies according to the major leadership theories that were developed in these periods**.

Among these multiple eras, we could today identify **most important leadership study eras as follows: personality and traits, power and influence leadership, behavioral, situational, contingency, transactional, and transformational leadership eras**. Other leadership eras (such as the ambiguity era for instance) are often cited as well but are less studied and highlighted by leadership scholars. Below is a representation of the evolutionary tree of leadership studies according to Van Seters and Field (Van Seters & Field, 1990).

Van Seters and Field assert that the very beginning era of leadership studies – considered to be the **personality and trait era** –began prior to the 1960s (Van Seters & Field, 1990). **According to the authors, leadership scholars and researchers were focusing principally on the study of the**

personality and traits of great Leaders in history, believing in that period that people who simply duplicate their personalities, or reproduce certain of their trait patterns would become comparable great leaders. This era ended very quickly (1975) when scholars of that period realized that no single or group of traits could be associated with great leaders (Zaccaro, Kemp, & Bader, 2004).

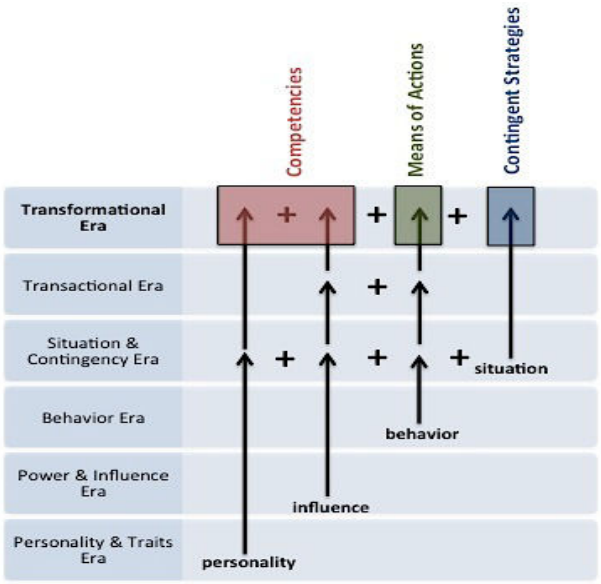


FIGURE 11: EVOLUTIONARY TREE OF LEADERSHIP INSPIRED FROM (VAN SETERS & FIELD, 1990)

The authors describe the second leadership study era, as **power and influence era. It devoted itself to the relationship existing between leaders and followers, analyzing leaders' effectiveness in terms of their amount of power** (Van Seters & Field, 1990). Raven analyzed the different Leadership type of powers, as legitimate, reward, expert, referent and coercive (John Jr & Raven, 1959). In fact, this era did not take into consideration followers' need and thus was inappropriate with the business's world of that time. Scholars slightly developed theories of that time by trying to remove coercion but without denying the dominance of leaders.

The third era was called **behavior leadership era. It focused mainly on what great leaders do**, examining the difference behaviors existing between good and bad leaders (Van Seters & Field, 1990). This era gave birth to today's well-known managerial grid model (Blake, Mouton, & Bidwell, 1962), which rate leaders using a 9x9 matrix according to their concern for production and their concern for people, deriving from it theories X and Y (McGregor, 1960). Scholars of that period recognized that this era was too complex and imprecise as in real life; leaders do not directly cause followers' behavior but rather could reinforce desired followers behavior using appropriate leader behavior.

Realizing the growing importance of the factors beyond leader-members relationship, such as the situation, the nature of followers, their objective and their need, the fourth era was called **situation and contingency era, which dated from the 1960s to the 1970s. This era saw numerous key leadership theories stating leadership dependence to personality, influence, behavior and situations** (Van Seters & Field, 1990). Situational theories focused more on the behaviors that the leader should adopt given situational factors, whereas contingency theories took a broader view supporting the concept that a leadership style effective in a certain situation may not be equally effective in another. In other words, contingency theories focused on how leadership fits the context. The most famous ones are the contingency theory (Fiedler, 1964) placing the leaders in the most suited situations or training them to change the situation to match their styles, the path-goal theory (House, 1971) focusing more on how leaders could assist followers to provide them with aiding conditions for their success, the situational theory (Hersey, Blanchard, & Johnson, 1988) affirming that there is no best leadership style, and the normative theory (Vroom & Yetton, 1973) analyzing which decision-making behavior is the most appropriate depending on the situation.

Power and influence era was fortified again in the period from the 1980s to the 1990s with the **transactional era, introducing the leader-member exchange theory** (Graen & Uhl-Bien, 1995), **which studied how transactions made between leader and member could affect their relationship** (Van Seters & Field, 1990). Later on, in the same era, social exchange theory (Hollander, 1980) attributes equitable exchange relationships, with no domination on the part of the leader or the follower.

A transitional era of ambiguity then appeared in the studies of leadership (Van Seters & Field, 1990). In that specific period, empirical studies were made to test all the previous theories that were developed until the transactional era, being aware of the **complexity of the concept of leadership with the increasing number of variables added to the leadership equation, recognizing it perhaps as being only a perceptual phenomenon in the mind of observers** and not a concept (Green & Mitchell, 1979).

Fortunately, leadership studies emerged again with the **transformational era, which improved all previous eras with the introduction of the importance of intrinsic motivation** (Bass, 1991; Bass & Avolio, 1993). In fact, this period saw the emergence of significant leadership theories: among others the charismatic theory transforming those who see the vision and give them a stronger sense of purpose.

In the **current era of leadership studies, countless theories like among the most famous ones: integrative theory** (Chemers, 2014), **authentic theory** (Avolio & Gardner, 2005) **and**

complexity theory (Uhl-Bien, Marion, & McKelvey, 2007), have also emerged after being derived from the above-mentioned studies. However, classification of the actual leadership study period is quite multifaceted depending on the personal perspective of scholars and their domain of expertise.

It is worth mentioning that beginning from the contingency era (in which the study of the situations and contingent variables became pivotal when developing leadership styles), scholars described **leadership according to at least three particular variables: leaders' means of actions (which was labeled in the category "behavior"), leaders' competencies (labeled in the category "personality" and "influence") and leaders' contingent strategies (labeled in the category "situation")**. The figure above illustrates this fact.

However, **in most of these leadership study eras, leadership scholars seem to have directly integrated creativity in the broader and larger concept of "efficiency"**. But recently, being a subject of interest among scholars from different disciplines ranging from neurosciences to management, and as a direct consequence of its growing importance, leadership theorists and academics have finally begun to add the element creativity as an imperative variable of the conceptualization equation of today's leadership definition.

In fact, **scholars would not really employ the term creativity until very recently but would rather describe a leadership model as being performing well or effective**. However, if we look further into the term performance or efficiency used in leadership, we could find in them sub-variables such as creativity. In a meta-analysis of more than 350 studies of great leaders in history, Stogdill described "originality in problem-solving" among the principal characteristics and traits of these great leaders (Stogdill, 1974b).

3. Leadership Styles: "Creativity-less" Types

Leadership style can be defined as the perceived behavior that the leader displays when trying to influence the activities of his/her team (Biggerstaff, 2012). Leadership has multiple types and styles that can be classified broadly by their behaviors towards their followers and their decision-making styles. It is important to note that **a leader is hardly belonging to only one specific type of leadership but is rather a mixture and combination of different types of leadership**. Moreover, the same leader could use different styles in different situations.

Lewin et al. examined three leadership styles related to the relations of power existing between leaders and followers, which are: autocratic, democratic and laissez-faire types (Lewin,

Lippitt, & White, 1939). These three styles could easily be identified according to their decision-making types and behaviors.

Autocratic leaders are easily known by their unilateral and authoritarian decisions, as they command work processes and constrain significantly followers' participation. They are recognized as the least type of appreciated leaders for followers. On the contrary, **democratic leaders involve followers through joint and cooperative decision-making**, after facilitating consensus and agreement with their teams, and usually realize tasks collectively. Finally, **laissez-faire leaders (known as the most passive type of leadership style) are recognized by their delegated decision-making style**, or even sometimes their decision avoidance, and thus usually create a comfortable work climate that could easily lead to chaos and disorder. Other recent leadership types exist as well in the rich leadership bibliography. **Transactional leaders are characterized by their cold social exchange with followers, depending on rewards and punishments as transaction exchanges to ensure followers' fulfillment**, based on job descriptions to complete well-defined goals (Weber, 1947). Transactional leadership continues to subsist well among leadership types, and still has a significant place in contemporary leadership theories.

Moreover, recognized as an extension of transactional leadership, transformational leadership is more than a leadership style. Transformational leadership is a process that changes and transforms people, whereby followers feel trust and appreciation towards their leaders. It is recognized today as one of the most promised leadership types in the evolutionary tree leadership theories (Van Seters & Field, 1990). **Transformational leaders behave according to the following factors: idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration** (Bass & Avolio, 1993).

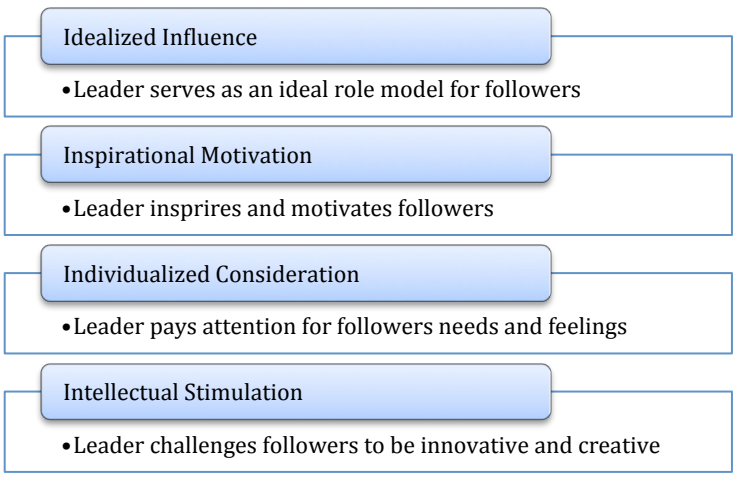


FIGURE 12: THE 4 I'S OF TRANSFORMATIONAL LEADERS, (BASS & AVOLIO, 1993)

Recently, and among various new leadership types that emerged lately throughout the last decade, **new types of leadership like servant** (Greenleaf, 1977)**, rotated** (Erez, Lepine, & Elms, 2002)**, authentic** (Avolio & Gardner, 2005)**, and virtual** (Avolio, Kahai, & Dodge, 2001) **or e-leadership (to cite only the most famous ones) also emerged and took their positions among traditional leadership types**.

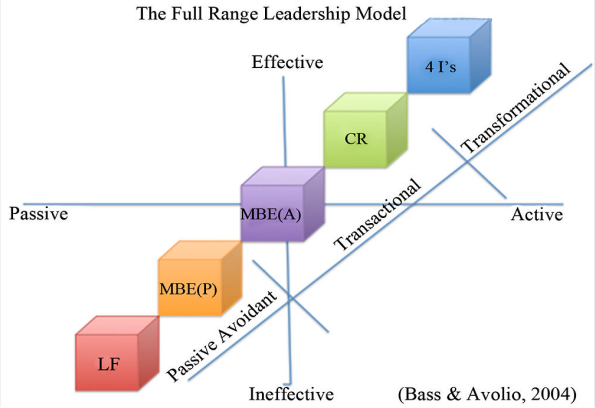


FIGURE 13: THE FULL RANGE LEADERSHIP MODEL, (BASS & AVOLIO, 2004)

The principal categories of leadership models were classified according to Bass and Avolio using what they called the full range model of leadership (Bass & Avolio, 1997). This classification is organized around two principal axes: the degree of activity of the leadership style, and the degree of the leadership style. The first one considers leaders' degree of involvement in the process, while the second one considers the level of effectiveness on followers (performance, motivation, etc.). Bass and Avolio (2004) classified transformational model as the most active and effective leadership style, followed by the transactional model, and then the laissez-faire model as the most passive and ineffective one.

Although leadership theorists recognized that many of leadership styles (specifically transactional and transformational leadership styles) could have a certain interesting relationship with creativity, **there is clear evidence that leadership styles were not specifically designed and modeled for creativity**. The full range model of leadership clearly demonstrates that leadership styles were developed by scholars to be the most active possible (involved and engaged towards organizational goals), and the most effective possible (well performing, and effective).

Of course, leaders helping their teams to be well performing and effective could also mean getting them to be more creative and generate innovative ideas. Moreover, this fact is implicitly considered in leadership styles such as transformational or transactional leadership. However, there is no clear evidence for that. In other words, **literature frequently assumes that transactional**

leaders and transformational leaders are creativity stimulator but in reality very little is known about how these leadership types really impact creativity among their followers.

4. Leadership Competencies: Creativity, an Indispensable Leadership Skill

Leadership competencies are personal skills and behaviors contributing to better follower performance. Competencies are considered as the underlying features that result in higher performance (Boyatzis, 2008). There is no doubt that leaders must have minimum competencies to inspire their followers. Besides classical leadership skills as planning, organization and goal setting, **literature has highlighted four main categories of non-traditional leadership competencies classified as follows: social, behavioral, emotional, and cognitive competencies** (Day, 2001).

The ability of leaders to adapt and match their skills according to a particular situation is also considered to be part of leaders' competencies. All these competencies are well linked to leaders' cognitive competencies, which refers to leaders' ability to use knowledge structure to organize, interpret and process a big amount of complex data within their cognitive spaces. Effective leaders have the social, behavioral, emotional and cognitive competencies that allow them to act appropriately when faced with a wide range of different situations (Denison, Hooijberg, & Quinn, 1995).

Today, creativity is considered as a principal competency and quality for any leader. "Being creative" or "being innovator" for a leader become today a fundamental competency of great leaders. **Very early studies on creative leadership have emphasized the importance of the creativity of leaders themselves, assuming that by being creative, leaders will be having the appropriate vision and methodologies to enhance followers creativity** (Mumford, Connelly, & Gaddis, 2003). Sternberg indicated that creativity is no more an optional feature of leadership, and that uncreative leaders are unlikely to push forward their organizations into the future (Sternberg, 2007). However, being creative as a leader is an important attribute but does not necessarily mean influencing people in a way so that they become more creative and innovative.

In line with the above, it is clear that the concept of leadership was not properly designed for creativity; and that along the conceptual evolution of leadership, scholars were more concerned with the development of leadership styles that would be performing well and effective for their teams, without necessarily paying attention to the variable creativity. Moreover, the **existing styles of leadership have put aside the variable creativity until very recently when leadership scholars realized its importance as a competence for future leaders**.

Moreover, even though leadership models (across the different eras, and particularly beginning from contingency era) did not have explicit links with creativity, it is important to point out that they were not completely incompatible with today's creative leadership styles. Indeed, **despite the fact that the creativity situation was not directly treated in previous leadership theories, we could note that leadership scholars had the will to design a leadership style that could be adapted to frequent situations and complex environments** (which is not very far from today's fast, complex, and innovation-dependent environments). Now let's explore the relationship between leadership and creativity.

II. Leadership versus Creativity

1. A Balance between Control and Freedom

Creative leadership **could be considered as a certain form of combination between creativity (which is the ability to generate ideas that are both novel and useful according to its definition) and leadership (which is the ability to influence others to accomplish this generation process)**. In other words, we could say that a creative leader would lead others toward the attainment of a creative outcome. But in reality, we will see that creative leadership is much more than that.

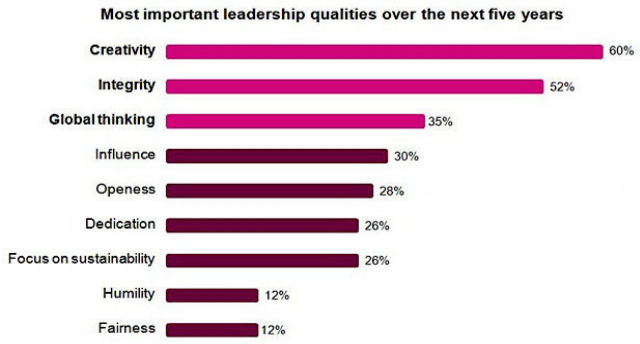


FIGURE 14: MOST IMPORTANT LEADERSHIP QUALITIES OVER THE NEXT FIVE YEARS, IBM SURVEY IN 2010

In 2007, according to a survey made by the McKinsey Quarterly on the thematic of leadership and innovation, on around 1450 organization leaders around the world, more than 70% of the senior executives of them say that "innovation will be at least one of the top three drivers of growth for their companies in the next three to five years (Barsh, Capozzi, & Davidson, 2008). Moreover three years later, IBM made a survey to more than 1500 Chief Executive Officers from 60 different countries, asking them what are the most important leadership qualities from their points of views

for the next five years. Results revealed that **60% of CEOs considered creativity as the most important quality and competency for leaders in future years** (Carr & Tomasco, 2010), according to the figure below.

Creativity has frequently been defined as the ability to generate ideas that are both novel and useful, while Innovation expands the definition of creativity, and involve taking those creative ideas and carrying them through to implementation (Amabile, 1983). Creativity flourishes from individuals' capacity for making unusual and new associations of concepts (Gardner, 1988). Cognitive scientists described it more deeply as a product of many types of mental processes that helps to set the atmosphere for creative insights and discovery (Mueller, Goncalo, & Kamdar, 2011).

Creative people usually achieve a high ideational fluency, which is the aptitude to come up with many new ideas, a high degree of novelty, and flexibility known as the ability to stimulate ideas from various categories (Guilford, 1959). In this regard, Sternberg highlighted three intellectual abilities of creative people: synthetic ability to see problems in new ways and to escape the limits of conventional thinking, analytic ability to detect which one's ideas are worth pursuing and which are not, and contextual ability to know how to persuade others in order to sell other people on the value of one's ideas (Sternberg, 1999).

Leadership and creativity have usually been perceived as antagonist concepts, compromised between two specific variables: control and freedom. In fact, most studies considered that too much leadership control could kill creativity. At the same time, other studies demonstrated that too much freedom could also lead to chaos and disorder.

On one hand, management scholars argue that **in order for creativity to appear, a certain level of autonomy and freedom is needed** (Amabile, Conti, Coon, Lazenby, & Herron, 1996; McLean, 2005). In addition, some of these management scholars argue that leaders could unintentionally kill creativity when designing organizations that work towards business imperatives (Amabile, 1998a). As a matter of fact, researchers in management tended to believe that the most important aspect of work's environments leading to creativity and innovation is autonomy, described as the degree to which individuals have the freedom to decide how to carry out their work tasks. In this regard, Amabile has identified that, in order for creativity to flourish, leaders should allow followers to decide how to climb a mountain, rather than letting them choose which one to climb (Amabile, 1998a).

On another hand, leadership's literature demonstrated that **creativity could as well emerge with a certain level of leadership control and guidance**. In this regard, leadership should be

competent enough to stimulate creativity among followers. In fact, studies have shown the significant role leadership could play to manage the appropriate conditions for creativity (Shalley & Gilson, 2004).

Creative leaders usually apply untraditional forms of behaviors and management to influence followers towards the achievement of creative outcomes (Hunter, Thoroughgood, Myer, & Ligon, 2011). They are recognized to deviate from the status quo (Tierney, Farmer, & Graen, 1999). **Creative leaders generally respond to challenges differently than traditional leaders. They typically avoid incremental improvements of products or services and rather favor the implementation of radical and disruptive innovation**.

The next section presents more details about the literature of creative leadership, analyzes **what the literature would call "creative leaders"**, and presents its perspectives on the existing forms of creative leaders.

2. A Double Standard Model of Creative Leadership: "The Innovators" & "The Facilitators"

The literature review on creativity and leadership highlights two different and distinguished figures of creative leaders. The first ones are creative leaders on behalf of their teams. **We named this first class of creative leaders "the innovators".** The innovators are considered in the literature review as creative leaders, since they are able to come up with genius and creative ideas themselves, they can drive their teams according to their visions, and even in some cases unblock their teams in case of difficulty.

The second ones are the leaders of creative teams. **We named this second class of creative "the facilitators"**. The facilitators facilitate the innovation process since they manage the set of factors that foster creativity. In fact, they create the appropriate conditions and climate to support creativity; they motivate their teams by manipulating extrinsic motivation through incentives and rewards for instance; they recruit creative members among their teams; etc.

These two models represent what we would call later on the double standard model of creative leadership. Each figure of creative leadership in the literature review could be easily categorized as belonging to one of these two figures. In the next section, we will describe more in details each of these two creative leadership models, in order to try to uncover its underlying cognitive dimensions, and see how they indirectly play roles of defixation. It is important to note that

in most studies related to creative leadership, different designations such as the "lone genius", "the innovative", "the inventor", or "the visionary" could be attributed to the innovator leader. Similarly, other labels such as "the facilitator", "the inspirational", or "the motivational" could be attributed to the motivator leader.

III. The Hidden Cognitive Dimension behind Creative Leadership Models

1. The Innovator Creative Leadership: Characteristics of Defixated but Not Defixator Leaders

As we mentioned in the previous section, we named the first model of creative leadership: "the innovator". **Classic examples of innovative leaders include Steve Jobs (late Apple's CEO), Thomas Edison (the great inventor of the light bulb), or Mark Zuckerberg (founder of Facebook).** It is worth mentioning that some studies consider innovator leaders as a myth (Berkun, 2010). For instance, these studies pretend that before Thomas Edison invented the light bulb, there were thousands of trials and attempts from other unknown scientists. Despite this fact, at the end, the invention is attributed to the inventor alone neglecting the team that has worked behind. In other words, there is clear evidence that in certain cases, innovator leaders recognize (not to say steal) great ideas, and envisions the path that ideas becoming an innovation.

The innovator could be portrayed as the principal element in the leader/members dyadic relation that leads to a particularly successful innovation. In other words, without the innovator leader, the innovation product or service would have never existed. In this model, **the innovator leaders' name is habitually associated with the innovation**. For example, the iPad first released by Apple Inc. in April 2010 was directly associated with the name of Steve Jobs, even if everybody knows that a huge creative team – generally neglected – was behind the development and implementation of the Apple tablet.

The innovators are easily identified in the creative leadership literature as being creative on behalf of their teams. **Therefore, the first characteristic of innovator leaders is that they are considered competent and possessing "creativity-thinking skills" themselves instead of their teams**. Amabile described the variable creative-thinking skills as a "disciplined work style and skills in generating ideas" (Amabile, 2012). Indeed, innovator leaders are brilliant creative thinkers (Mumford, Hunter, Eubanks, Bedell, & Murphy, 2007). Sometimes, they may be too creative for their

subordinates. They are big geniuses, which have big (and sometimes "crazy") ideas that would become the basis of innovations.

House et al. argued that **leaders with creative ability are more effective at promoting positive change and inspiring their followers than leaders who lack creativity** (House & Howell, 1992). However, Mueller et al. contradictory theorized that leaders expressing creative solutions may be viewed as having lower levels of leadership potential unless the charismatic leadership prototype is activated in the minds of social perceivers. The authors explain that stereotypes of "creative people" innovating and deviating from the status quo neglecting interpersonal leadership activities to organize and coordinate groups could be perceived differently in the mind of their followers than "effective leaders" aiming to promote order by emphasizing shared goals, may be contradictory (Mueller et al., 2011).

Some leadership studies consider that creative leaders must possess cognitive problem-solving skills (Mumford et al., 2003). These studies shape **a figure of creative leadership that is highly involved in the creative process, not to say innovating in the place of their teams**. Moreover, the expertise of these leaders is usually relevant to their innovative projects. Other studies argue that the domain-specific expertise required for these leaders is a fundamental asset, that will help them lead their teams to achieve successful innovations (Mumford, Scott, Gaddis, & Strange, 2002).

In line with the above competencies of the innovators, Sternberg et al. synthesized a model of effective leadership called WICS (wisdom, creativity, and intelligence), describing in this model that **creative leaders need to be creative themselves to generate ideas**. They need academic analytical intelligence to evaluate whether the ideas are good. They need practical intelligence to implement the ideas and persuade others of their worth. Finally, they need the wisdom to balance the interests of all stakeholders and to ensure that the actions of the leader seek a common good (Sternberg, 2007). Of course, this model shape figures of leaders that are too competent and creative.

A second important characteristic of this figure of innovator leaders is their ability to create a vision that will lead to successful innovations. In fact, **innovators have the ability to create the visions for creativity, as well as innovative strategies to attain the goals they set for their teams**. Some studies assimilate creative leaders to visionary leaders (Sashkin, 1988; Sternberg, 2006). The term vision is described as a goal, formulated by leaders, to be achieved by their teams in the future (Conger, 1999). A vision could not be achieved without clear strategies. Therefore, some leadership scholars consider that a vision should comprise not only both goals' specification but strategies and

paths to attain these goals (Yukl, 1994). Strange & Mumford argued that vision, perceived from more abstract way, as a set of beliefs leaders have on how their followers should act and interact to achieve an idealized future state, provide a powerful motivation mechanism for followers (Strange & Mumford, 2002).

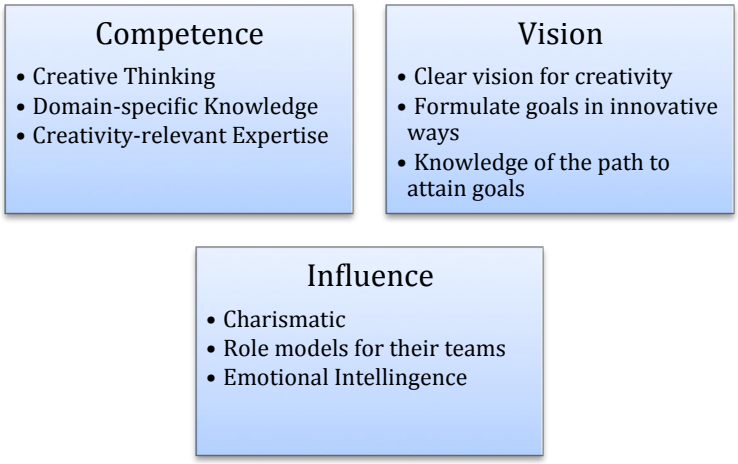


FIGURE 15: "THE INNOVATOR" CHARACTERISTICS

The third characteristic of innovator leaders according to the literature on creative leadership is their influence, and ability to drive their teams according to their visions. In fact, **creative leaders are frequently perceived either as charismatic leaders, transformational leaders, or emotionally intelligent leaders**. Charisma is a necessary component for transformational leaders, however a charismatic leader is not necessarily transformational. Indeed, innovators leaders act as role models for their teams using their charismatic appeal and have the emotional intelligence to influence (not to say manipulate) their followers in order to achieve their proper visions and goals (Jaussi & Dionne, 2003). There is no doubt that these leadership influential factors can positively influence the creativity of their followers since highly creative people have usually been exposed to role models in their pasts (Shalley & Gilson, 2004).

2. The Facilitator Creative Leadership: Characteristics of Indirect Defixator Leaders

The second model of creative leadership according to the literature review is "the facilitator" creative leader. Management perspective for creative leadership usually focuses on the image of the facilitator leader. In fact, management literature considers that **creative leaders should manage the classical contextual factors that are known to influence the occurrence of creative outcomes** (Shalley & Gilson, 2004), such as the componential factors of creativity (Amabile, 2012) to give an

example (task-motivation, domain-specific expertise, and creative skills). Amabile suggests that leaders can have an important role to play to positively affect all of these three components of creativity, even if she considers that motivation is easier to influence than the two other components (Amabile, 1998a).

According to some leadership scholars, these approaches argue that **leaders are not directly participating in the creative ideation process** (since some management studies argue that their participation could in certain cases inhibit creativity), instead their creative ideation skills become less important (Mumford et al., 2007). However, they just have the function to stimulate and facilitate the work of their teams.

In fact, **the facilitator leaders are different from the innovator leaders, in the way they are not necessarily creative themselves, they don't necessarily have clear visions of creativity, nor the means to drive their teams in clear and precise paths towards innovation**. In other words, a facilitator leader differs completely from an innovator leader, in a way that the first is not necessarily the innovation hero but the effective manager that led to a particular innovation with the help of his/her teams.

However, **facilitator leaders have the managerial abilities to control and manage the contextual factors that would facilitate creativity**. Indeed, Dyer et al. found that in most innovative companies, CEOs are not always responsible for coming up with innovative ideas but for facilitating the innovation process (Dyer, Gregersen, & Christensen, 2009).

The facilitator creative leaders approach consists of formulating the structures that will foster creativity. For instance, Sosik et al. emphasized the **role of leaders in motivating followers' creative efforts** (Sosik, Kahai, & Avolio, 1998). However, even if motivation (and especially intrinsic motivation) is considered as one the most classic levers to pull in order to foster creativity, other authors such as Carmeli et al. argue that a leadership that only motivates members to be creative is not enough but rather suggest that a facilitator leadership, in which "group members are effectively combining their knowledge and skill to produce an outcome that would not have been possible without such interaction" is more valuable and effective (Baruah & Paulus, 2009; Carmeli & Paulus, 2015).

Similarly, Anderson et al. have emphasized the need for leaders to support creative efforts (Anderson & West, 1998). Stoll et al. noted that **creative leaders set the tone, climate, and conditions where creativity can thrive**, by removing structural and cultural barriers that actively

prevent people from working together and learning from each other to be creative through interaction and dialogue (Stoll & Temperley, 2009).

Inspired by Tuckman's stage model, Rickards et al. derived a new conceptual framework of creative leadership consisting of seven team factors. Each of these factors emphasizes the functions of facilitator leaders. In fact, **facilitative efforts are made by the leader at each of the innovation stages**, beginning with creating a positive climate for the team, then exploring shared knowledge, then sharing a common vision, until learning from experience (Rickards & Moger, 2000).

Reiter-Palmon and Illies also emphasized these facilitating functions of creative leaders from a cognitive perspective. The authors argued that **leaders may facilitate and promote creative problem solving in their subordinates:** by helping and encouraging the various cognitive processes involved in creative problem solving, by providing access to and encouraging the sharing of knowledge and information to promote creativity, and by allowing followers more time for the entire creative problem solving effort (Reiter-Palmon & Illies, 2004). However, these studies treated the cognitive aspects of problem-solving without paying attention to the fixation effects.

Literature review on creative leadership has underlined the facilitative role played by leaders for creativity (Mumford et al., 2002). **Prior studies have majorly reduced and concentrated leaders' role as facilitators, mentors, or mediators to organizational creativity** (Woodman, Sawyer, & Griffin, 1993). Indeed, studies have examined varied factors that can either foster or hinder employees' creativity at the individual, group, and organizational levels, and have then introduced the role of creative leaders in this regard. Literature has shown that leaders can enhance followers' creativity by directly or indirectly adopting appropriate contextual factors like group climate, group composition, resources, knowledge management, or even human resources issues (Hemlin, Allwood, & Martin, 2008; Shalley & Gilson, 2004; Zhou & George, 2003).

Most of these studies consider that these various contextual factors could be managed and manipulated using leadership tools, among others: leadership goal-settings (Carson & Carson, 1993; Locke & Latham, 1990), leadership instructions (Paulus, Kohn, & Arditti, 2011; Runco, Illies, & Eisenman, 2005a; Runco, Illies, & Reiter-Ralmon, 2005b; Runco & Okuda, 1991), or leadership feedbacks (De stobbeleir, Ashford, & Buyens, 2008; Zhou, 1998, 2003; Zhou & Li, 2013).

Moreover, among the full range of leadership theories, **scholars consider both transactional and transformational leadership eras as having a significant indirect influence on the creativity of followers**. Indeed, studies made on the role of transactional leaders for creativity, showed for example the positive impact of extrinsic task motivation like rewards on employees' creativity.

Similarly, studies made on the role of transformational leaders for creativity, have underlined among others the role of emotional intelligence (Zhou & George, 2003) and intrinsic task motivation for creativity.

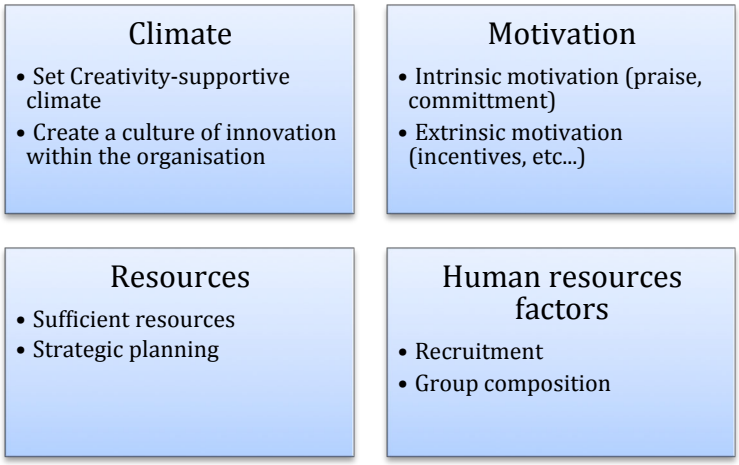


FIGURE 16: "THE FACILITATOR" CHARACTERISTICS

3. The Hidden Cognitive Aspects of The Innovator & The Facilitator

If one analyzed the innovators from a cognitive perspective, one would simply note that **innovator leaders are defixated themselves but not necessarily playing the role of defixator for their teams**. If they would affect defixation processes among their teams, this would be done by the influence of their personality and charisma. In fact, their team members would like to be as creative as they are.

As for the facilitator leader, one could say that each of the contextual or organizational variable facilitator leaders would manage is having a hidden (not well emphasized) effect on overcoming fixation, and consequently would stimulate creativity among followers. In the figure below, we resumed the most classical organizational practices facilitator leaders would manage for creativity.

In fact, **the literature presents clear empirical evidence that each of the characteristics of both the innovator and the facilitator leaders could have a direct impact on creativity** (see figure below). Some of these characteristics are for instance parts of the componential theory of creativity (Amabile, 2012): such as competence (expertise, and domain-relevant skills) or motivation (intrinsic motivation more than extrinsic motivation) or climate (environment). Other studies emphasize other characteristics that foster creativity such as the role of sufficient resources as well as human

resources factors (Hemlin et al., 2008; Shalley & Gilson, 2004; Zhou & George, 2003). Finally, some studies confirm as well that being visionary or influential can both have an indirect impact on creativity (Mumford et al., 2002).

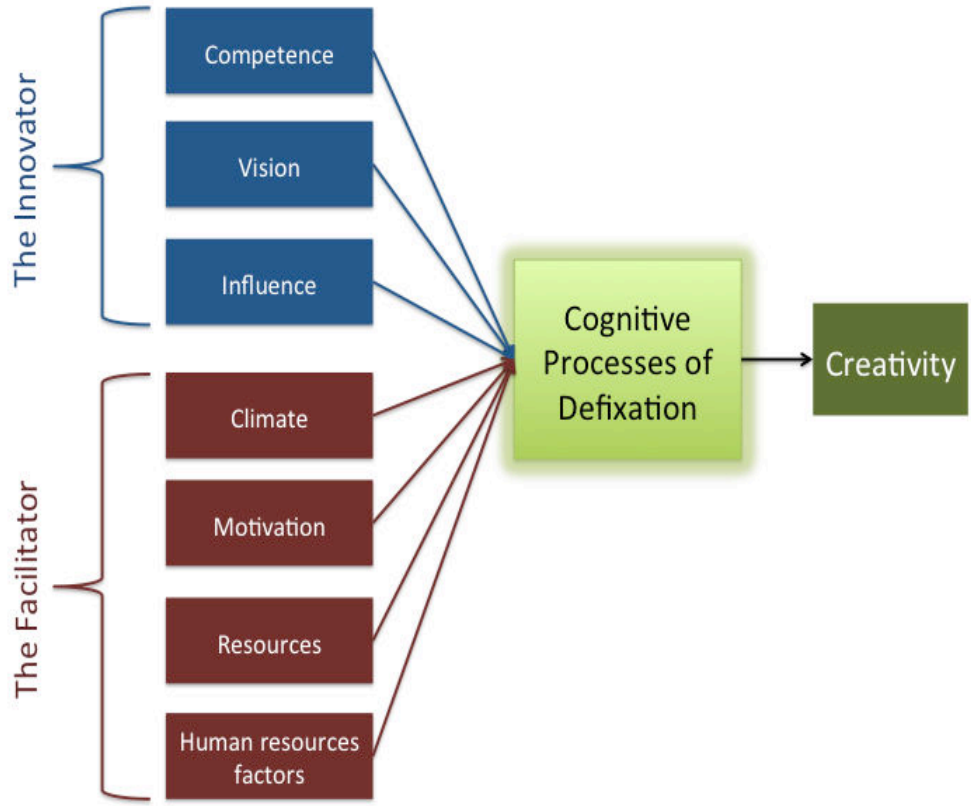


FIGURE 17: THE HIDDEN COGNITIVE PROCESSES OF DEFIXATION BEHIND THE INNOVATOR & THE FACILITATOR

The existing models of creative leadership could indirectly affect defixation processes, through what we have called earlier the hidden cognitive dimensions behind creative leadership models. However, if there is clear empirical evidence that these characteristics could directly or indirectly impact creativity, on the contrary, there is very little evidence on whether or not each of these characteristics could impact the cognitive processes of defixation. **The cognitive processes for defixation could then be reduced to a black box that precedes the creative processes**. Indeed, few studies have been devoted to the study of defixation through a manipulation of these variables of creative leadership. These hidden defixation processes are not well emphasized in the literature. Few studies have succeeded to understand how leaders or managers of innovation could manage and control very precisely these underlying cognitive processes. For these reasons, we will attempt to better understand how we could set up new figures of defixator leaders in the next chapter.

IV. Summary of Chapter III

Below is a summary box presenting the key points of chapter III:

- Leadership was not specifically designed for creativity
- Leadership is a "learnable" process of social influence in which the leader enlists the supports of his/her teams in the accomplishment of a common task
- The conceptual evolution of leadership shows that leadership scholars were more concerned with designing "efficient" – not necessarily "creative" – styles of leadership according to the needs of the current period
- Recently, leadership scholars realized the importance of the factor "creativity"
- Leadership and creativity are antagonists comprised between control and freedom
- Creative leadership literature presents a double standard model of creative leaders: the innovators and the facilitators
- For both innovators and facilitators – due to multiple variables interfering with the cognitive processes of defixation – it is difficult to uncover their underlying cognitive mechanisms of defixation
- The innovators could be considered defixated themselves but not particularly defixators for their teams
- The facilitators could be considered as indirect defixators since they manage variables that are known to affect creativity
- So the question remains: how to set up new figures of defixator leaders?

Chapter IV: How to Highlight New Forms of Defixator Leaders?

In chapter IV, we take advantage from the existing literature on defixation processes to uncover the implicit figure of leadership present in it, and this as a starting point for our main research question on how to set up new forms of defixator leaders. In this chapter, we then list our sub-research questions, our research objectives, as well as our specific research methodology.

I. State of the Art: What to Learn from Defixation Processes?

1. Better Understanding of Cognitive Mechanisms of Creativity: A Design/Cognitive Psychology Perspective

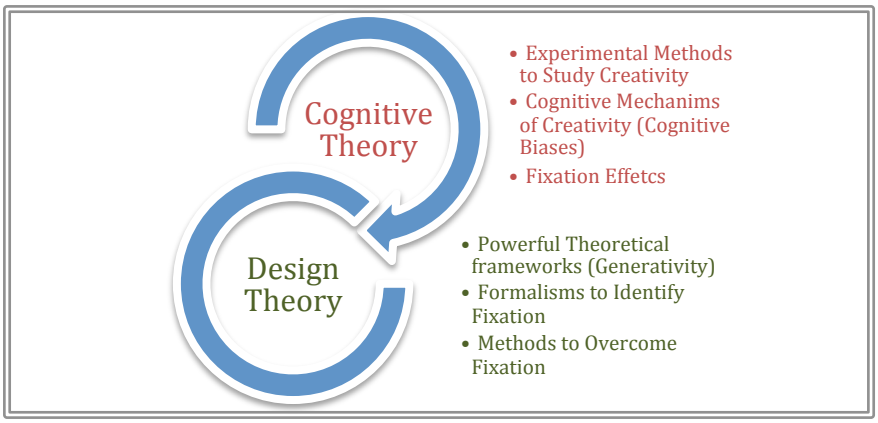


FIGURE 18: DOUBLE PERSPECTIVE IN UNDERSTANDING COGNITIVE MECHANISMS OF CREATIVITY

Fixation usually appears in divergent tasks in which individuals are required to generate a diverse set of alternative ideas and solutions to a problem. However, it could also manifest itself in convergent tasks having correct and incorrect answers. Fixation usually limits the range of ideas explored by individuals, and hinders their ability to generate alternatives, which consequently constrains their capacity to be creative.

Fixation is perceived as a "counterproductive" cognitive bias against individual creativity since it limits individuals' capacity to generate novel ideas. However, fixation could also manifest itself during collective ideation tasks. In fact, several studies have shown as well the effect of fixation on collective creativity, in which exposure to ideas of others could fixate individuals (Kohn & Smith, 2011), or on the contrary defixate them (Paulus & Nijstad, 2003).

Today, powerful theoretical frameworks in the field of design sciences and cognitive sciences helps to have a better understanding of the cognitive mechanisms of creativity in general, and on how to detect and control these cognitive mechanisms (such as fixation) more specifically. In fact, over the past years, **the field of design science has been very useful to the modeling and precise identification of these cognitive biases to creativity.** Indeed, Concept-Knowledge (C-K) theory (Hatchuel & Weil, 2003) is well renowned as a tool to not only force designers' reasoning to succeed in overcoming fixation effects (Hatchuel, Le Masson, & Weil, 2011) but is also recognized to aid the generation of ideas that are inside or outside of existing paradigms (Agogué, Le Masson, & Robinson, 2012).

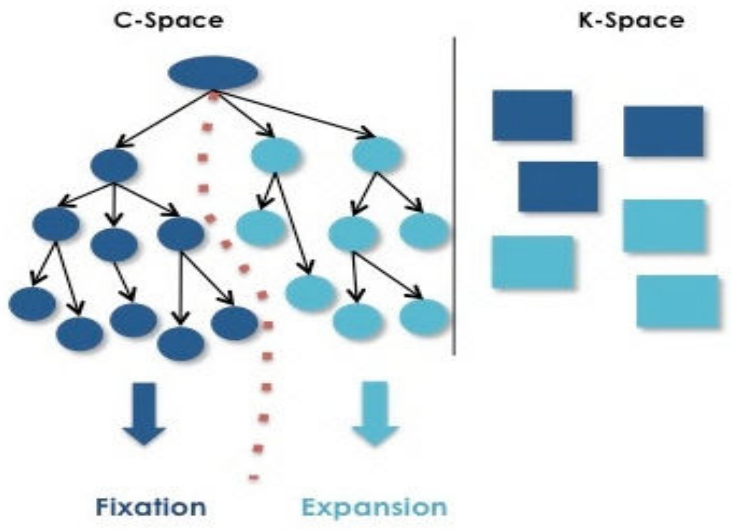


FIGURE 19: THE BARRIER BETWEEN FIXATION & EXPANSION USING C-K THEORY

This theory distinguishes between a fixation path that is based on the spontaneous activation of existing knowledge (inside fixation) and an expansive path that is based on the activation of less accessible knowledge (outside fixation) and consequently offers a method to characterize different paths of solutions in addition to the knowledge bases associated with these solutions (Agogué et al., 2014a; Hatchuel et al., 2011).

Concept-Knowledge theory helped to characterize fixation effects in creative design situations, and would also help to design new strategies to overcome fixation and lead individuals in the expansion paths. This innovative design theory can be an excellent starting point to accurately design the minimal competencies a defixator leader would need to detect fixation, as well as the necessary means of actions (stimuli) the defixator leader would make to lead his/her followers from fixation to expansion. Now, what can we learn from the state to the art on defixation procedures?

2. Varied Methodologies to Study Defixation: The Key Role of Experimental Procedures

In order to set up new figures of defixator leaders, many useful things can be learned from the existing – mostly experimental-based – studies made on the processes of creativity and defixation. Early studies in psychology have underscored the role of individuals' unconscious mind to overcome fixation. **In a series of five experiments, Smith et al. showed that the process of incubation (which consists of putting a problem aside for some period of time by taking a break, or performing unrelated tasks) could be efficiently used in problem-solving contexts to get out mental routines**, which consequently defixate individuals and enable them to generate original and insightful ideas (Wallas, 1926). Smith et al. developed the forgetting fixation theory of incubation, arguing that a time interval allow individuals to put aside the problem, forget fixation, blocks and generate better ideas and solutions (Smith & Blankenship, 1991; Smith & Linsey, 2011). In fact, fresh look to the problem may allow correct and creative solutions to emerge. Posner indicated that incubation could be a good stimulator of creativity, due to its effects on reducing mental fatigue (Posner, 1973).

Some studies in design science have demonstrated experimentally that **individuals could overcome fixation by problems reframing or abstract reformulation of problems** (Linsey, Tseng, Fu, Cagan, Wood, & Schunn, 2010; Zahner et al., 2010). In fact, abstract problem reformulation is a well-known method used in design science not only to bypass fixation but also to expand the exploration outside fixation, i.e. increase the design space.

Analogy-making is a widely used method of creativity stimulation, and was central in developing creativity methods such as Synectics (Korth, 1973), which is considered as a creative problem-solving technique along with brainstorming and lateral thinking. **Some interesting defixation techniques using analogies were developed such as the WordTree Design-by-Analogy Method** (Moreno et al., 2015; Smith & Linsey, 2011; Tseng et al., 2008). This method consists of leading individuals systematically to analogies (intra-domain or inter-domain) that can be useful for defixation.

In line with this crucial role of analogy for creativity stimulation, Bonnardel has proposed a model that mixes between the cognitive processes of analogies and the cognitive processes of constraints to better understand the mechanisms that contribute to the emergence of creative ideas in design. The author argues that **designers use analogy to enlarge the space of research of new ideas, and at the same time construct their own constrained cognitive environment to delineate this research space using different types of constraints and dynamically orient their research of new ideas** (Bonnardel, 2000).

In another study, **Bonnardel and Marmèche examined whether it is possible to stimulate analogical thinking and enhance creative idea generation using external sources of inspiration**. The experimental study consisted of presenting different kinds of sources (intra or inter-domain) to novice and expert designers, and examine if these sources would lead them to evoke new creative ideas or fixate them. Results showed that only experts could enlarge their exploration space and evoke new creative ideas with the presentation of inter-domain sources (Bonnardel & Marmèche, 2005).

Moreover, **several tools and methods, which helps mitigating fixation were recently developed such as Concept-Knowledge theory** (Hatchuel & Weil, 2002), **KCP** Method (Hatchuel et al., 2009), **TRIZ** (Al'tšuller, 1999), **SCAMPER** (Youmans & Arciszewski, 2014), or even **Morphological Analysis** (Otto & Wood, 1998).

From an interdisciplinary perspective mixing design science with cognitive science, Agogué et al. have demonstrated **the stimulating role of expansive examples, i.e. ideas and solutions that are outside fixation effects, in elevating the creative generation capacities of individuals** (Agogué et al., 2014a). The authors demonstrated that, when the participants were given a creative example (outside the fixation path) prior the task, they proposed more original solutions.

It is worth mentioning that **these same studies also emphasized the counterproductive role of restrictive examples, i.e., ideas and solutions that were inside the fixation path, to the creative generation process**. These studies were performed with participants with different backgrounds (i.e., students, psychologists, engineers, designers, and experts) (Agogue, Le Masson, Dalmasso, Houdé, & Cassotti, 2015) and different ages (Agogué, Poirel, Pineau, Houdé, & Cassotti, 2014b; Cassotti et al., 2016b) and have noticeably confirmed the negative role of restrictive examples (i.e., examples within the fixation path) on the fluency and originality of the proposed solutions to the same creative task.

From a developmental psychology perspective, some experimental studies have analyzed the problem of fixation at the reasoning level and realized that thinking outside the box could require first resisting what is inside the box. Indeed, these scholars have investigated the problem of cognitive biases at the reasoning processes level and have underscored **the critical role that could be played by inhibitory control of the fast and intuitive system of reasoning in overcoming heuristics in certain cases** (Borst, Poirel, Pineau, Cassotti, & Houdé, 2013; Houdé, 1997; Houdé et al., 2000). Based on the dual-process theory of reasoning comprising both an intuitive system (system 1) and an analytic system (system 2) (Evans & Frankish, 2009; Kahneman, 2011), Houdé proposed a third system termed "cognitive inhibition" (system 3) (Houdé, 1997). The latter system plays the role of inhibiting the fast and intuitive system (system 1) to release the slow and analytic system (system 2).

According to Agogué et al., inhibition could be seen as a form of "cognitive control that allows resisting automatism, intuitive reasoning, spontaneous activation of knowledge, and heuristics" (Agogué et al., 2014a).

Several years later, along these specific lines, recent studies have linked these above-mentioned findings with the context of cognitive biases to creativity. Considering that the difficulty in generating creative ideas might result from individuals' failures to inhibit spontaneous responses that come to mind and lead them to fixate on certain existing knowledge, these authors have proposed an analogical model of reasoning in creativity situations that they termed the "dual-process model of creativity" (Cassotti, Agogué, Camarda, Houdé, & Borst, 2016a). Similarly, these authors argue that **the ability of individuals to resist the spontaneous activation of design heuristics by inhibiting inappropriate ideas is a crucial factor in the generation of creative ideas**.

Among all these above-mentioned defixation procedures, **it is worth mentioning that a particular figure of leadership is playing a key role to execute these defixation procedures**. Using these methods, we attempted to model a leader that is implicitly present before or during the ideation process and that plays a direct or indirect role to help individuals (with very specific managerial actions and competencies). As illustrated in the table below, we selected the most famous defixation methods used in the literature review on defixation, and we tried to bring into light the associated figure of leadership that is hidden behind these methods, according to two leadership variables:

- **Leadership means of actions**: which are the stimuli they could use to help their teams overcome fixation in creativity situations
- **Leadership competencies**: the cognitive capacities (or other skills) they need to help their teams overcome fixation

TABLE 1: AN IMPLICIT FIGURE OF LEADERSHIP BEHIND DEFIXATION METHODS

Defixation method	Means of actions	Competencies
Incubation (Smith & Blankenship, 1991; Smith & Linsey, 2011)	Leaders who **provide their teams with time** interval during a task to allow them to forget fixation and generate novel ideas and solutions	Leaders who are able to recognize that their teams in a situation of fixation
Problems reframing or abstract reformulation of problems (Linsey et al., 2010; Zahner et al., 2010)	Leaders who brief their teams and provide them with task instructions before or during a creative task	Leaders who have the capacity to reframe the problem in a more abstract way so that it would stimulate their teams' creativity

Analogies (Moreno et al., 2015; Smith & Linsey, 2011; Tseng et al., 2008)	Leaders who provide their teams with instructions before or during a creative task	Leaders who have the expertise to reason by inductive inference about the functional or structural similarities between entities.
Expansive examples (Agogué et al., 2014a; Agogué, Le Masson, Dalmasso, Houdé, & Cassotti, 2015b; Cassotti et al., 2016b)	Leaders who provide their teams with initial instructions, or guidelines before a task	Leaders who have the ability and skills to distinguish between the fixation and the expansion path, as well as the expertise to name ideas outside the fixation path
Inhibitory control of the fast and intuitive system of reasoning (Borst et al., 2013; Houdé, 1997; Houdé et al., 2000)	Leaders who execute particular activities that would help their teams resist the automatism and heuristics	Leaders who have the ability to detect fixation and inhibit inappropriate ideas

Therefore, for each defixation procedure, one could realize the presence of an implicit and not well emphasized form of leadership, having very specific competencies and means of action. However, it is also very clear that the competencies needed for defixation are relatively high for most of the existing defixation procedures. As mentioned earlier in the research objectives, one of the principal aim of the research thesis was to design new figures of defixator leaders that would not necessarily be innovator leaders, nor facilitator leaders (according to the double standard model of creative leadership) but would rather **lead their teams for defixation with the minimal competencies possible, and the maximum involvement possible in the ideation process**.

II. How to Set Up Figures of "Defixator" Leaders?

1. "Defixator" Leaders: Means of Actions, Minimal Competencies and Contingent Strategies

The main research question is then: **how to set up figures of "defixator" leaders?** To answer this general question of how to set up figures of defixator leaders, we should add three sub-questions:

- **The first sub-question would consist of examining what are the means of actions of these figures of defixator leaders**. In other words, what are defixator leaders' management tools and actions to manage fixation/defixation processes? Means of actions of the defixator leaders are the stimuli they could use to help their teams overcome fixation in creativity situations. In our case, as we are trying to design the minimal profile of defixator leaders,

these tools could be limited to instructional processes such as initial instructions, or feedbacks.

- **The second sub-question is related to the competencies of the defixator leaders, or the set of skills they should possess**. The question is what should be defixator leaders' minimal competencies? In our case, since we try to model cognitive processes of defixator leaders, these competencies are the cognitive capacities they need to help their teams overcome fixation. Again, as we are modeling the minimal profile of defixator leaders, we are looking for the minimal competencies required for defixator leaders to manage the process of defixation efficiently.
- **The third sub-question is related to the contingent strategies of the defixator leaders**. Indeed, the means of actions and the minimal competencies of the defixator leaders are not sufficient to tackle the complexity of the situations they could face. According to the situational leadership theories, multiple factors beyond leader-members relationships, such as the situation, the nature of followers, their objective and their need, must be taken into considering when studying leadership**.** Situational theories focused more on the behaviors that the leader should adopt given situational factors, whereas contingency theories took a broader view supporting the concept that a leadership style effective in a certain situation may not be equally effective in another. Based on the above, and knowing that defixator leaders should match their behaviors according to the situations they face. Therefore, how should defixator leaders' behave in front of teams with varying expertise levels? How should defixator leaders adapt their cognitive styles according to the cognitive styles of the teams they face?

2. Implementing the Minimal Possible Profile of "Defixator" Leader

Our first research thesis objective is designing the minimal profile of leader that could play the role of "defixator" for their teams. Indeed, one of the main challenges of our research work was to implement a figure of defixator leaders that are not necessarily innovator (do not generate the creative ideas themselves), nor the facilitator (do not just facilitate the ideation process but is intensively present in it). There are three principal reasons for this choice:

- **The first reason is that no leader can possibly have all the answers and solutions for creativity**. The figure of innovator leader is no doubt efficient but very hard to find because of his expertise and personality.

- **The second reason is that minimal profile of defixator leader could easily be reinforced with further variables** (such as charisma to inspire followers, or incentives to motivate followers, or creative thinking skills to stimulate and challenge followers, etc.).
- **The third reason is that by designing the minimal profile of defixator leader, we could extract the necessary managerial conditions required for defixation**. This minimal profile of defixator leader could help organizational leaders integrate basic managerial tools for defixation within their organizations.

3. Neutralizing Multiple Classical Variables of Creative Leadership Models

Our second research thesis objective is to neutralize most of the classical variables inherited from creative leadership literature in order to isolate and enlighten the effects of defixation processes. In fact, these classical leadership variables comprise the following means of actions of leaders (nature of stimuli): leaders who give incentives to their teams, leaders who create creativity-supportive environments, leaders who recruit creative individuals to stimulate creativity among team members, leaders who provide their team with creative ideas or with relevant resources, etc. There are three principal reasons for this choice:

- **The first reason is that most of these classical variables could interfere with leadership cognitive processes**, and would harden the precise control and analysis of the leadership role for defixation.
- **The second reason is that by neutralizing leadership classical variables, we could shed light on the "cognitive influence"** of leaders rather than the classical "social influence". This would enable a redefinition of the concept of leadership for creativity and defixation.
- **The third reason is that neutralizing these variables could help have a better understanding of how to utilize them** efficiently for defixation purposes.

4. Designing a Leadership-driven Ideation Mechanism

Our third research thesis objective is to design a leadership-driven ideation mechanism, by bringing into light the leadership characteristics present in the defixation processes literature (instructional processes, legitimacy, defixation strategies, cognitive abilities, etc.), and endow it with means of actions, minimal competencies and contingent strategies. There are three principal reasons for this choice:

- The first reason behind this third research objective is that by designing a leadership-driven ideation mechanism, we could have a better understanding of the **management of ideation processes for creativity**.
- The second reason is that this modelling effort would help better **characterize the role of defixator leaders in terms of the required knowledge for defixation**, as well as the necessary means of actions to defixate individuals.
- Finally, the third reason is that this model would also help us to better **measure the creative ideation performance of individuals**, and most importantly it would help predict what leadership behaviours would be required to enhance them.

III. Research Methodology: Forming A New Figure of Defixator Leader Through Theory-driven Experiments

1. General Research Method: An Articulation Between Organizations And Laboratories

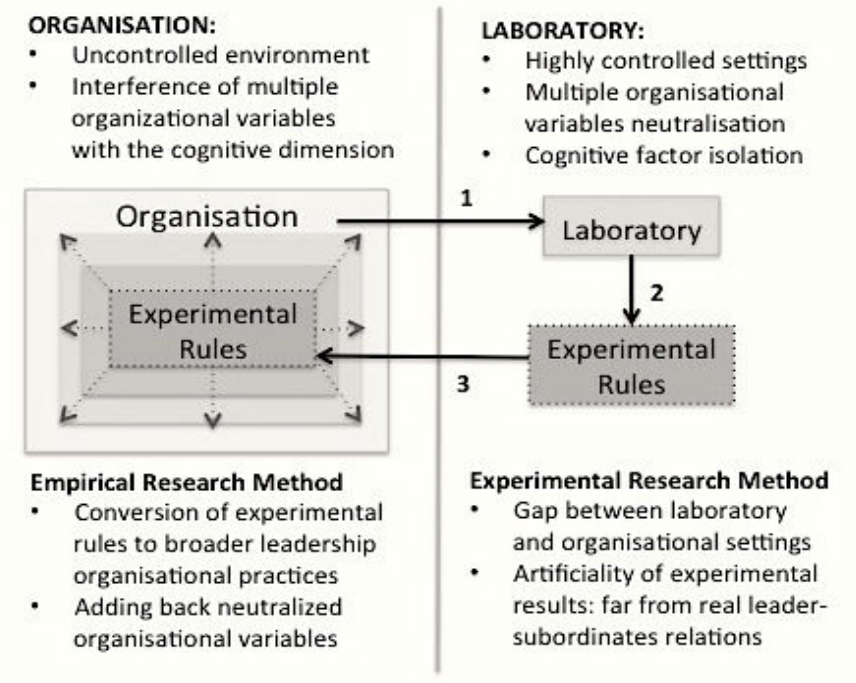


FIGURE 20: GENERAL RESEARCH METHOD & PROCEDURE

In order to answer research questions, and fulfill the research objectives set regarding the new figure of defixator leader, we had to adopt a precise research method. Our general research

method is an **articulation between organizational and laboratories environments, and consists of three steps** (as shown in the figure above):

- **Step 1: from Organization to Laboratory**

  As we have mentioned earlier, it is very difficult to precisely control and examine the defixation processes in organizational settings, since it is an uncontrolled environment where multiple variables related to leadership practices inside organization (such as recruitment, motivation, goal-setting, climate creation, evaluation, decision-making, resource allocation, team building or negotiation) can interfere with the cognitive processes. Therefore, we shifted the focus from organizational settings to laboratory settings, in order to neutralize most of these variables, and precisely isolate and control leadership role for defixation. Moreover, due to the fact that team creative performance is often the end result of an unknown combination of several observed and latent variables, it would have been hard without highly controlled laboratory experiments to determine which variables really affect the defixation process. Therefore, one needs to untangle the different organizational variables affecting creativity, in order to study the precise rules that enable defixation. Such decomposition almost requires the use of a cognitive model of leadership-driven ideation.

- **Step 2: Generating Experimental Rules**

  A. Modeling Leadership for Defixation:

  We first model leadership in ideation situations (laboratory) where leaders have the aim to defixate their teams. In this step, we lightly modified the typical definition of leadership from "a process of social influence" into "a process of cognitive process" where leaders could guide followers' reasoning and manage ideation paths from fixation to expansion.

  - **B. Experimental Validation**:

    Then, based on these series of theory-driven experiments, we were able to generate a set of experimental rules regarding the precise role of leaders to defixate their teams.

- **Step 3: Converting Experimental Rules in Organizational Contexts**

  Finally, given that these experimental outcomes could be more or less far from real leader-members settings, the third step consisted of converting and translating these generated experimental rules in real organizational settings. In this step, we attempt to re-integrate most of the neutralized variables of steps 1 and 2. Then, using empirical data in biographies of great innovative leaders, we try to have a better understanding of how these rules could be converted inside organizations using classical leadership practices.

2. Is The Research Method Appropriate To Answer Research Questions?

The research method mixes between theory-driven experiments and empirical studies. **Theory-driven experiments consist of building a theoretical model, simulating it, and then test it using laboratory experiments** (see figure below). This method is usually applied to design experimental procedures in cognitive psychology. Theory-driven experiments' methodology relies on random assignment and laboratory control to ensure the most valid and reliable results.

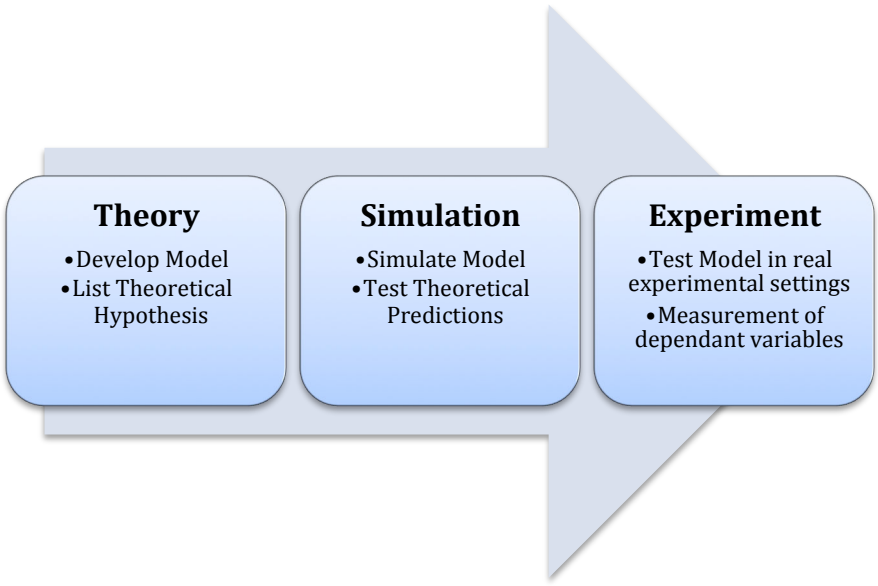


FIGURE 21: THEORY-DRIVEN EXPERIMENTAL RESEARCH METHOD

This particular research method was selected among others because **answering research questions required having highly controlled settings**, in order to neutralize most of the typical variables of creative leadership literature that could interfere with the defixation process (such as leaders motivating followers or creating creativity-supportive environment, leaders giving creative ideas to followers, leaders providing creativity-relevant resources to followers, leaders recruiting creative members, etc.). Moreover, it enables having accurate results given the fact that studying creative ideation requires some powerful theoretical framework to measure the creative performance of individuals.

However, since theory-driven experiments would generate leadership rules for defixation that would be quite far from real leader/member settings in organizational and industrial contexts, **experimental outcomes would then be contextualized to organizations using classical leadership organizational practices**. This last step would be done using the rich empirical and historical data existing regarding the managerial behaviors of great innovative leaders. In the next chapter, we apply the principal part of our proposed research method, which consists of **modeling leadership-driven ideation**.

IV. Summary of Chapter IV

Below is a summary box presenting the key points of chapter IV:

- Cognitive sciences helps to understand the cognitive mechanisms of creativity
- According to cognitive studies, fixation is a major cognitive biases constraining individual's ability to generate creative ideas
- Design theory enriches the formalisms to overcome fixation (defixation)
- C-K theory for example helps to distinguish between fixation paths and non-fixation paths (expansion) in a creative design task
- Most defixation studies present an implicit figure of leader with particular means of actions and competencies
- The research question is: how to set up new figures of defixator leaders? What should be their means of actions, minimal competencies and contingent strategies?
- To answer these questions, we need to adopt a research methodology that mixes between theory-driven experiments (to shape new figures of defixator leaders in highly controlled settings), and empirical research based on biographies of great innovative leaders (to tailor these figures in organizational contexts).
- The next step consists of developing a leadership-driven ideation model that would enable us to shape new figures of defixator leaders

Chapter V: A Leadership-driven Ideation Model

In chapter V, we propose the leadership-driven ideation model. We begin by modeling ideation based on design theories, then "sequential ideation" based on probability theories. Then, we introduce the role of defixator leaders based on this ideation model. Finally, we design an instrument to measure creative ideation performance, and introduce the creativity task for our series of experiments.

I. Theoretical Model of Ideation based on Interdisciplinary Approach Mixing Design and Probability Theories

1. C-K Theory: A Framework to Model Ideation

1.1. What is Concept-Knowledge Theory?

As mentioned in the research objectives, in order to design new figures of defixator leaders that could help their teams overcome fixation effects and generate creative ideas, a theoretical model for leadership-driven ideation mechanisms should be developed. This model is the initial step of the theory-driven experimental research procedure. Indeed, **creative ideation is difficult to study if not guided by some types of theoretical frameworks**. Cognitive modeling is perhaps the best way to isolate and identify the contribution of the defixation processes alone. Cognitive models serve as a useful tool for understanding and predicting defixation behaviors, and for thinking of useful leadership strategies for defixation.

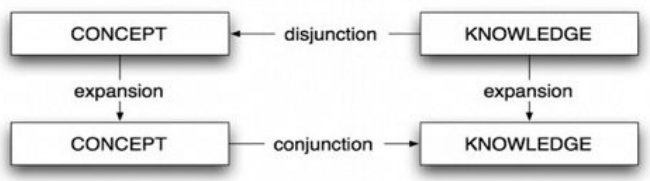


FIGURE 22: CONCEPT-KNOWLEDGE THEORY

C-K (Concept-Knowledge) theory (Hatchuel & Weil, 2002) – presented in the previous chapter – is a theory of cognitive reasoning well recognized to have strong effects on overcoming cognitive biases' effects occurring in creative design contexts.

C-K theory defines two distinct spaces: a space of concept ("C") and a space of knowledge ("K"). The process of design is described as a double expansion of both C and K spaces, and this via four operators as illustrated in the figure above:

- C → K: this operator named "**conjunctions**" pursues added (or subtracted) properties in K space to reach propositions having a logical status (true or false).
- K → C: this operator name "**disjunctions**" contrary to conjunctions, adds (or subtracts) some properties coming from K space to new concepts in C space having no logical status.
- C → C: this operator **expands the C space** by adding a new partition to it. This new partition can be "restrictive" if it does not change object's definition or attributes, or "expansive" if it transforms object's definition and identity by adding (or removing) unexpected attributes.
- K → K: this operator **expands the K space** by adding new knowledge basis to it, and indicates the knowledge structures created within concept designs.

In order to build the leadership-driven ideation model, **this theory can be very beneficial, especially in determining the minimal knowledge required by the defixator leader (mostly but not uniquely in the knowledge space), as well the means of actions for defixation (mostly but not uniquely in the concept space)**.

1.2. Modeling the Generation of Ideas in Fixation/Expansion using C-K Theory

Ideation is a principal cognitive activity in which individuals come up with ideas (generate ideas) to a particular problem. As mentioned in the research problem (chapter II), the concept of an idea itself is quite ambiguous. According to Oxford dictionary, it is briefly and simply defined as a thought, or a mental representation. Other dictionaries define it more extensively as "any conception existing in the mind as a result of mental understanding, awareness, or activity".

Modeling the process of ideation is important to facilitate the understanding of the cognitive processes behind creativity in general. Moreover, **modeling ideation would be helpful to better understand how defixator leaders could manage the cognitive processes of their teams**, and more precisely help teams overcome cognitive traps occurring during these processes (such as fixation).

To model ideation, we selected the **C-K theory among other innovative theories, because it enables both the precise identification of fixation within creative design processes,** as well as the managerial operations and mechanisms that could enable defixator leaders to overcome it. As

indicated earlier, C-K theory is well renowned as a tool to distinguish between a fixation path that is based on the spontaneous activation of existing knowledge (inside fixation) and an expansive path that is based on the activation of less accessible knowledge (outside fixation).

C-K offers a method to characterize different paths of solutions in addition to the knowledge bases associated with these solutions. Using C-K theory, **we first modeled the generation of an idea as a two-stage cognitive process involving two operations: C→K and K→C**:

- Stage 1: Conjunction (C→K)
  Beginning from an initial concept C0 in C-Space, the ideator activates in his K-Space a specific knowledge basis.
- Stage 2: Disjunction (K→C)
  The ideator then generates an idea (the lowest branch of the concept tree), associated with the activated knowledge in stage 1.

As mentioned earlier, fixation could have slightly different definitions according to the research discipline. But if the definition of fixation is used from a creative ideation perspective, it is the fact that some existing knowledge and obvious solution are spontaneously activated in individuals' mind (inside the fixation path), constraining individuals to generate creative ideas (outside fixation, i.e. inside the expansion path). Consequently, one could say that **any idea in fixation is generated from spontaneously activated knowledge (knowledge basis inside the fixation path)**. This knowledge basis F (F for fixation) is easier to retrieve from memory, and is effortless. According to the C-K theory, Hatchuel et al. argued that individuals tend to generate ideas that are more easily accessible in memory, by activating common knowledge basis (Hatchuel et al., 2011). This phenomenon illustrates fixation from a creative design perspective.

The figure below illustrates the process of generation of an idea in fixation. **Stage 1 represents the conjunction C0→K(F)** (with K(F) the spontaneous knowledge activated in the knowledge space), and **stage 2 represents the disjunction K(F)→C(F)** (in which C(F) refers to the lowest branch of the C-tree and is the generated idea in fixation).

On the contrary, activating "less spontaneously" accessible knowledge should reduce fixation and consequently generate expansion ideas. Therefore, **any idea in expansion is generated from non-spontaneously activated knowledge basis (knowledge basis in expansion)**. This knowledge basis E (E for expansion) is harder to retrieve from memory, and demands much more efforts from individuals. Similarly, the figure above illustrates the process of generation of an idea in expansion. Stage 1 represents the conjunction C0→K(E) (with K(E) the non-spontaneous knowledge activated in

the knowledge space), and stage 2 represents the disjunction K(E)→C(E) (in which C(E) refers to the lowest branch of the C-tree and is the generated idea in expansion).

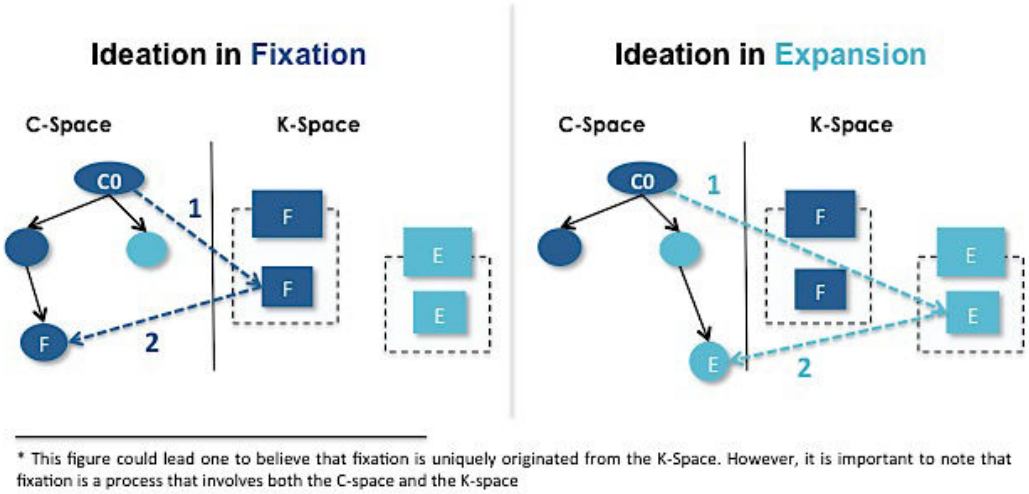


FIGURE 23: IDEA GENERATION IN FIXATION AND EXPANSION ACCORDING TO C-K THEORY

1.3. Ideation versus Sequential Ideation: A Stochastic Process

However, **simply modeling ideation as a two-stage cognitive process isn't accurate enough, since it doesn't take into consideration the dependency between the current state and the later state**. In fact, ideation could be considered a stochastic process if we consider that the generation of an idea could be influenced in certain ways by previously generated ideas. In line with the above idea of dependency, Bonnardel argues that the process of idea generation could also result from analogy-making, in a way that newly generated ideas could be inspired – at least partly – by previous situations (Bonnardel, 2000).

In the present thesis, we argue that **these situations are not only previous experiences that can be used as sources of inspiration for coming up with novel ideas but also present situations that can serve to orient individuals' reasoning towards certain paths when ideating**. To better illustrate this phenomenon, Wang gave the problem-solving example of: "how to improve university parking" (Wang, 2008). The author explains that when individuals generate ideas to this creative ideation task, the idea of "encouraging students to walk" is more likely to occur with the idea of "riding bicycles" than the idea of "increasing the parking fee". This implies that previously generated ideas could inspire new ideas.

For these reasons, **modeling the process of sequential ideation (sequence or chain of ideas) would be much more precise since it would clarify the dependency and link between successive**

ideas. Traditional ideation differs from sequential ideation, since the first considers the full process of idea generation as a whole, i.e. for example, the number of ideas generated inside fixation at the end of a brainstorming session; while the second considers as well the paths and route undertaken by the ideator to generate specific ideas, i.e. for example, the relationship between two successive ideas, and the reasoning process that led to it.

Moreover, by modeling sequential ideation, we could **enable defixator leaders to intervene during the creative ideation process itself, to stimulate followers and deviate their route from one solution to another, i.e. orient their ideation paths towards certain directions** (either in the fixation path, or in the expansion path) depending on followers' performance. This would be in line with one of our research objectives aiming to propose alternatives figures of defixator leaders different than the facilitator leaders (not intervening in the ideation processes of their teams).

Hence, **design theories alone are efficient but not enough to model accurately the mechanisms of idea generation** (chains of successive ideas generated one after one). Indeed, probability theories would be highly efficient in modeling the sequential aspect of idea generation. But, what does the literature says about "sequential ideation"?

2. A Probabilistic Approach to Sequential Ideation: Ideation as a Stochastic Process

2.1. State of the Art of Sequential Ideation

The literature does not employ the term sequential ideation, however many related studies linking ideation and chain of ideas have been made from cognitive psychology perspectives. Indeed, excellent indications of the stimulating effects between a sequence of ideas are studies related to the concept of "priming" in cognitive psychology (Meyer & Schvaneveldt, 1971). Priming refers to the phenomenon in which individuals exposed to certain words in a particular task are more likely to use those words in later tasks. **Studies on collective creativity demonstrated that exposure to ideas could prime group members, and consequently stimulate the generation of new related ideas among interacting groups** (Paulus & Nijstad, 2003).

Previous studies have attempted to model "sequential ideation", by considering the process of idea generation as a stochastic process involving certain types of dependencies between generated ideas. **Most of these ideation models have used the rich advances in probabilistic theories (principally Markov chains) to model sequential ideation**.

One of the first studies that modeled sequential ideation is the work of Brown et al. (Brown, Tumeo, Larey, & Paulus, 1998). In their study, the authors modeled the cognitive interactions between individuals in brainstorming. **They considered ideation as a Markov chain, represented by a transitional matrix of predetermined categories of ideas**. Each idea generated by individuals belongs to a specific predetermined category of ideas. At each state, individuals can either generate an idea from the current state's category (the same category of ideas of the current state), or a new category different from the current state's category.

Nijstad et al. assumed that ideas could be regarded as a **process of searching for ideas in network structures inside the long-term memory called associative memory** (Nijstad & Stroebe, 2006). They proposed a cognitive model of ideation called SIAM (Search for Ideas in Associative Memory), in which a process of activation in associative memory (first stage) is followed by a process of idea generation (second stage). According to the authors, "when a (mental) image is activated, it will be more strongly associated with the elements of the search cue, which makes it more likely that the same (mental) image is sampled again". They demonstrate using their model that the stage of knowledge activation is cue-dependent and probabilistic.

Wang modeled ideation using HMM (Hidden Markov Model) to bridge the gap between Brown et al. model (dependency between categories of ideas using Markov Chain), and Nijstad et al. model (dependency between mental images activation within memory retrieval processes). The author considered mental images as hidden states of the HMM, while the sequence of ideas as observable states of the HMM.

However, despite the huge progression made to the literature of ideation supported by these rich and diverse modeling efforts, **these models didn't integrate clear metrics to measure ideators' idea generation performance generally, and fixation-related performance more particularly**. Indeed, none of these studies has directly tested fixation. In fact, if one considers for example the model of Brown et al. (Brown et al., 1998), the Markov chain could give an interesting indication of the number of different categories covered by the ideation process but no clear indications on whether fixation occurs or not during the process. In the case of Wang (Wang, 2008) and Nijstad et al. (Nijstad & Stroebe, 2006), the SIAM or HMM could simply give us indirect indications that activations of dissimilar mental images may help avoid fixation and increase ideation performance but not clear confirmation about this fact.

For the above-mentioned reasons, we attempted in this research thesis to enrich the **probabilistic approaches of sequential ideation using design theory** (and more specifically C-K theory). The incorporation of design theories alongside probability theories allow the clear

identification and control of fixation during ideation processes, and at the same time takes into account the dependency aspects of idea generation.

2.2. Modeling Ideator's Sequence of Ideas as a Trajectory in C-K Spaces

As indicated in previous sections, when an ideator generates one idea, it could have a different ideation path trajectory in C-K spaces, whether the generated idea is inside or outside fixation. This trajectory is a double process of conjunction (C0→K) and disjunction (K→C). However, **when an ideator generates two or more ideas, the ideas generated could be dependent on previously generated ideas, and therefore the ideation path trajectory in C-K spaces at a certain state could also be dependent on previous ideation path trajectories in C-K spaces already undertaken by the ideator**.

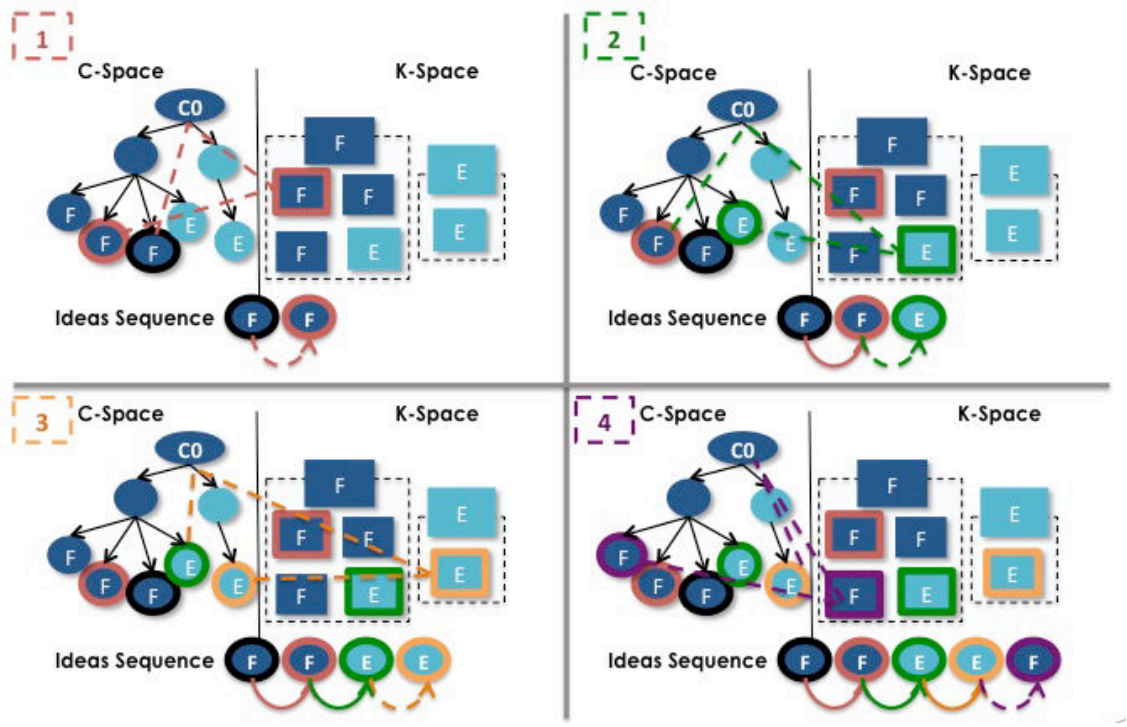


FIGURE 24: A STEP-BY-STEP SEQUENTIAL IDEATION USING C-K THEORY

As illustrated in the figure above, in step 1 the ideator (who already generated an idea in fixation in step 0) moves to the initial concept C0, and generates an idea that is again in fixation, using a spontaneous activation of a knowledge basis F. In step 2, the ideator moves again to the initial concept C0 to generate after that an idea in expansion, using a non-spontaneous activation of a knowledge basis E. Similarly, the ideator then generates an idea in expansion again (step 3), then another one in fixation (step 4). **At each step, the ideator generates an idea that is either in fixation or outside fixation (expansion) depending on the previous idea generated**.

For this reason any chain of ideas composed of at least two ideas begins with a process of C→C0 that comes before the double process of conjunction (C0→K) and disjunction (K→C). As illustrated in the example above, **at each step, the ideation path trajectory would consist of moving up from the idea already generated to the initial concept C0, before applying the double process of conjunction (C0→K) and disjunction (K→C)**.

At the end of an ideation process, as illustrated in the figure below, we could note that **the chain of ideas generated by an ideator could be described as one "extensive" ideation path trajectory** beginning from step 0 (the generation of the first idea from a double process of conjunction and disjunction) and ending with step 4 (the generation of the last idea from a double process of conjunction and disjunction, preceded by a process of C→C0).

As can be noted from the sequential ideation steps below, at each state the ideator is either fixated (inside the fixation path) or defixated (inside the expansion path). **This two states representation can be now modeled using probability theories**, and more precisely Markov models (or Markov processes, or Markov chains).

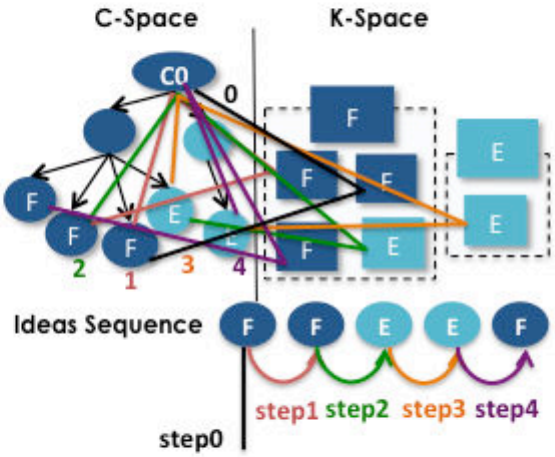


FIGURE 25: FULL SEQUENTIAL IDEATION TRAJECTORY

2.3. Fixation versus Expansion: A Two-State Markov Chain

Markov chains are stochastic processes (named after its initiator Andrey Markov) that satisfy the Markov property (Markov, 1971). Frequently described as memory-less systems, **a process satisfies the Markov property if predictions of the future states depend uniquely on its present state**. In other words, in a Markov process, what happens next depends only on the current state of the system.

Consider the example of the figure below. An ideator generates a sequence of five ideas during an ideation task. Each generated idea is either in fixation (F) or in expansion (E). The sequence of ideas the ideator generated is: FFEEF. **The Markov chain presents two states: fixation (F) and expansion (E), with four transitional probabilities**:

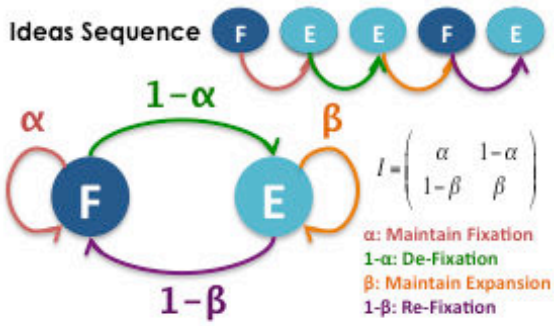


FIGURE 26: A MARKOV MODEL OF SEQUENTIAL IDEATION

- **The probability of maintaining the state of fixation (α)**: it refers to the probability that ideators generate an idea in fixation after having generated an idea in fixation. This probability refers to the incapacity of ideators to defixate. In the figure below, it is illustrated by the transition (in red) from the first idea to the second one.
- **The probability of de-fixation (1-α)**: it refers to the probability that ideators generate an idea in expansion after having generated an idea that was inside fixation. In other words, it is the probability that ideators defixate themselves. In the figure below, it is illustrated by the transition (in green) from the second idea to the third one. The more the defixation parameter is high, the more the ideator has the capacity to overcome fixation. However, we will see later that overcoming fixation is desirable but not enough to attain high creative performance.
- **The probability of maintaining the state expansion (β)**: it refers to the probability that ideators generate an idea that was inside expansion after having generated an idea in expansion. It is the probability that ideators maintain the flow of creative ideas. In the figure below, it is illustrated by the transition (in orange) from the third idea to the fourth one. This parameter represents a certain level of persistence of the ideator in his/her creative performance. The more the probability of maintaining the state of expansion is high, the more the ideator is able to generate many creative ideas (ideas outside fixation) successively.
- **The probability of re-fixation (1-β)**: it refers to the probability that ideators generate an idea in fixation after having generated an idea in expansion. In other words, it is the probability

that ideators become re-fixated again. In the figure below, it is illustrated by the transition (in purple) from the fourth idea to the last one.

Using this sequence of ideas, **one could then estimate the two parameters (α and β) of the transition matrix I (I for ideator)**, which gives a good indication of the creative performance of an ideator.

As illustrated in the figure below, **a creative ideator should have a low probability of maintaining fixation (α) and a high probability of maintaining expansion (β)**. Indeed, creative ideators would be able to score a high probability of defixation (1-α), which means they would have the capacity to defixate themselves. These creative ideators would as well have the capacity to maintain the flow of creative ideation, which means come up with many ideas in expansion.

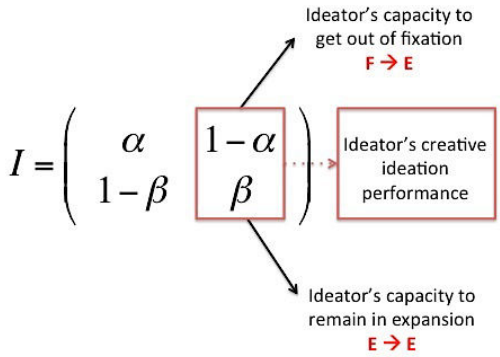


FIGURE 27: CREATIVE PERFORMANCE EVALUATION USING MARKOV MODEL

However, this **transition matrix (I) parameters' estimation is significant only if the ideator exhibits a high ideational fluency** (which means come up with many ideas). It is worth mentioning that if the ideator generates few ideas, the Markov model could be inaccurate to determine his/her creative performance.

3. Identifying Ideators' Creative Performance

3.1. Iso-Expansion Curves: Fast and Slow Ideation

Let's now take an example of how to identify the ideator's creative performance. Assume F_t is the **fixation rate of a particular ideator at time t, which means the number of ideas the ideator generated inside fixation**, divided by the total number of ideas generated by the ideator. For example, if one considers that at time t=10 minutes, the ideator generated the following sequence of six ideas for a specific creative ideation task:

F E F F E F

The ideator's fixation rate $F_{t=10\ min}$ = 4/6. Similarly, if one assumes E_t is the **expansion rate of the ideator at time t, which means the number of ideas the ideator generated inside expansion**, divided by the total number of ideas generated by the ideator, the expansion rate would be equal to $E_{t=10\ min}$= 2/6. The sum of F_t and E_t is always equal to 1.

Based on the Markov model presented above, one could say that the vector composed of the fixation rate (F) and the expansion rate (E) at sequence t+1 (of the later state), corresponds to the multiplication of the transition matrix (I) by the vector composed of the fixation rate (F) and the expansion rate (E) at sequence t (of the current state). In other words, **the fixation and expansion rate of a current state depends on the fixation and expansion rate of the previous state, as well as the transition matrix parameters (α, β)**.

$$\begin{pmatrix} F_{t+1} & E_{t+1} \end{pmatrix} = I \times \begin{pmatrix} F_t & E_t \end{pmatrix}$$

$$\begin{pmatrix} F_{t+1} & E_{t+1} \end{pmatrix} = \begin{pmatrix} \alpha & 1-\alpha \\ 1-\beta & \beta \end{pmatrix} \times \begin{pmatrix} F_t & E_t \end{pmatrix}$$

Based on the above, we then obtain the following equations:

$$F_{t+1} = \alpha \times F_t + (1-\beta) \times E_t$$
$$E_{t+1} = (1-\alpha) \times F_t + \beta \times E_t$$
$$F_{t+1} + E_{t+1} = 1$$

At steady state, we could then deduce this **interesting relationship between re-fixation (1-β) and defixation (1-α)** as follows:

$$(1-\beta) = \frac{1-E}{E}(1-\alpha)$$

Afterwards, this formula between re-fixation (1-β) and defixation (1-α) can be represented by the graph below. According to the below states' transition diagram of ideators, **a good ideator creative performance means having high scores of E (high expansion rate)**, and means moving the expansion rate clockwise.

In addition, **different couples of α and β could give the same creative performance: we called it "Iso-Expansion" curves**. However, depending on ideators' fluency, we could have fast (large sequence of ideas) or slow (short sequence of ideas) ideation performance.

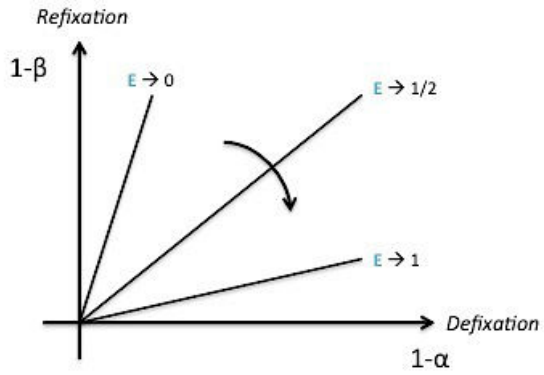


FIGURE 28: STATES' TRANSITION DIAGRAM OF IDEATORS

For example, consider two ideators: ideator A and ideator B. Ideator A generated the following sequence of ideas at time t = 10 minutes:

F E F F E E

Let's compute the probability α to maintain fixation for ideator A: α represents the number of times ideator A was in the state of fixation and remained in the same state (F → F), divided by the number of times ideator A was in state F and could move to another state (which means the number of ideas in fixation, except for the last one). In the above case, $\alpha = 1/3$.

Similarly, let's compute the probability to maintain expansion β for ideator A: β represents the number of times ideator A was in expansion and remained in the same state (E →E), divided by the number of times ideator A was in state E and could move to another state (which means the number of ideas in expansion, except for the last one). In the above case, $\beta = 1/2$.

Hence, the ideator A creative performance could be represented by the couple (α, β) = (1/3, 1/2). Now let's consider that ideator B generated the following sequence of thirteen ideas at time t = 10 minutes:

F F E E F F E E F E F E E

Similarly, for ideator B, $\alpha = 2/6 = 1/3$; and $\beta = 3/6 = 1/2$. Hence, the creative performance of ideator B could be represented by the same couple (α, β) = (1/3, 1/2). However, because the fluency of ideator B is higher than ideator A (13 ideas for ideator B versus only 6 ideas for ideator A), we could consider that **ideator B has a fast sequence of ideation** since ideas a high frequency of 1.3 ideas/minute is generated by him/her, while **ideator A has a slow sequence of ideation** since a poor frequency of 0.6 ideas/minute is generated by him/her.

3.2. Ideators Cognitive Ideation Styles

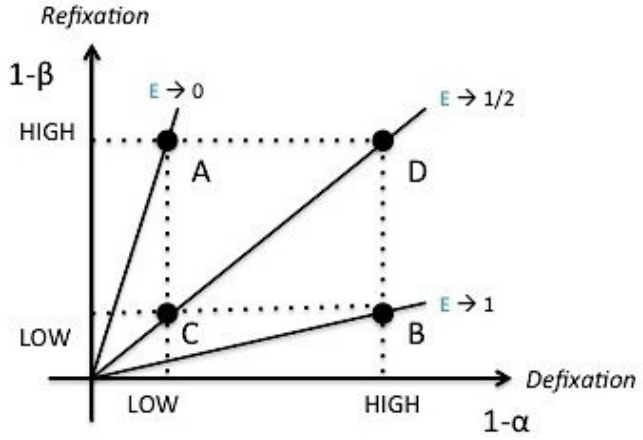


FIGURE 29: THE FOUR TYPES OF IDEATORS

Moreover, from the figure above, we could notice these main four different types of ideators' creative performance:

- **Ideator type A**: this ideator is low at defixation, and high at re-fixation. This type is the worst type of ideators. In fact, this ideator has a very low capacity of defixation in creative ideation tasks. Even, when defixated, the ideator is incapable of maintaining the state of expansion.
- **Ideator type B**: this ideator is high at defixation, and low at re-fixation. This type is the best type of ideators. In fact, this ideator is very good at getting out the fixation path. Moreover, when defixated, the ideator type B is highly capable of maintaining the state of expansion.
- **Ideator type C**: this ideator is low at defixation, and low at re-fixation. This ideator has a very low capacity of getting out from fixation. However, when defixated, ideator type C is excellent at maintaining the state of expansion.
- **Ideator type D**: this ideator is high at defixation, and high at re-fixation. This ideator differs from type C in a way that he/she has a very high capacity of getting out from fixation. However, when defixated, ideator type D is incapable of maintaining the state of expansion, and quickly becomes re-fixated again.

Each of these ideators behaves differently in creative ideation situations. Moreover, **each ideator could have different types of behavior according to the creative ideation task or to the situation**. At first glance, we could imagine that in order for defixator leaders to manage their teams' ideation processes, they should apply different strategies. This is what we are going to explore in the next section of the present chapter.

II. Integrating The Role of Defixator Leaders In The Ideation Model

1. A New Role for Defixator Leaders: "Forcing" Ideation Paths

Now that we have a model of the ideator, we need to integrate the role of the defixator leader in our model. The intuition behind our model is that **an external factor (the leader "L") could play a pivotal role in "triggering" some of the follower's (ideator "I") generated ideas at certain instants**. This could then force followers' ideation paths to take unexpected tracks they wouldn't have taken without this external factor. In fact, this forcing could lead to more creativity.

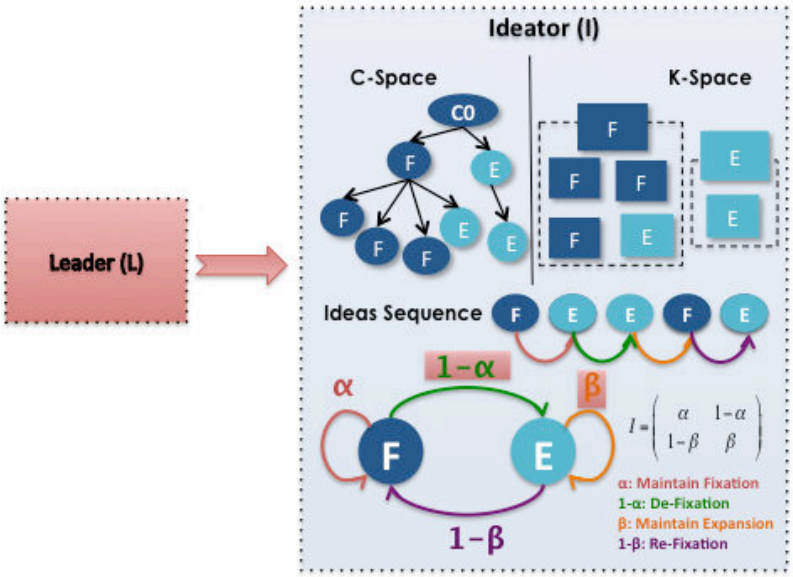


FIGURE 30: INTEGRATING LEADERS' ROLE IN THE IDEATION MODEL

This triggering effect made by leaders could stimulate followers to generate certain types of ideas, by searching for related (or unrelated) knowledge basis. It could help to enlarge (or restrain) the solution space and enable creativity to flourish. It is worth mentioning that in previous cognitive psychology studies, this triggering phenomenon was called attention. In the work of Janis (Janis, 1972), triggering referred to paying attention of individuals to a range of category of ideas in group ideation interactions (Brown et al., 1998).

It is important to note that **depending on the cognitive style of the ideator (type A, B, C or D), leaders could necessitate different contingent strategies to defixate and maintain defixation**. For instance, if ideators are very good at defixation (thinking outside the dominant design), they would need a leader to help them maintain their creative performance (persisting in the generation of creative ideas). Otherwise, if the ideators are poor at defixation, leaders should mainly

concentrate on managing the process of defixation (deviating their ideation paths outside the dominant design).

Understanding the features that surround these triggering effects are of primary interests for both creative leadership and cognitive psychology literatures. In most studies, we have shown that leaders played implicit and indirect roles for creativity (mostly relying on social factors). These leadership roles were hardly controllable, and ambiguously studied in the literature review. To this date, present creative leadership models were not designed to play precise and well-defined functions based on cognitive factors.

The research questions become more focused: **how can leaders play a crucial cognitive role to help followers stimulate creativity?** How to manage followers' ideation process efficiently? How can leaders deviate their teams' reasoning outside fixation? What should be their competencies to do so? What types of actions to do? What is the level of interactions required? Does it depend on ideators' cognitive ideation style?

2. How to Manage Defixation Processes? The Dual Challenge of Defixator Leaders

To answer these questions, it is necessary to better understand how leaders (or more specifically "defixator" leaders) should manage defixation processes. A good "defixator" leader should help followers to **decrease the probability of maintaining fixation (α)**, i.e. help to defixate his/her followers, **and to increase the probability of maintaining expansion (β)**, i.e. help his/her team to persist in generating creative ideas. This double process of increasing ideators' capacity to defixate (F→E), as well as maintaining ideators in a state of defixation (E→E) remains defixator leaders biggest challenges.

If one considers that teams' performance could be characterized by an ideation curve, which represents the frequency of ideas generated outside fixation by this team, **the role of the defixator leaders should consist of transforming their teams' ideation curve (idea frequency versus idea expansivity) in a way to increase the frequency of expansive ideas**. In other words, defixator leaders should transform the probability space of their teams. As shown in the figure below, the blue curve represents the ideation curve for a team performing without leaders, while the red curve is the modification of the blue curve by a good defixation leader. The more a defixator leader is effective, the more the gap between the blue and red curves should be big enough. To measure more specifically the effects of defixator leaders on their teams, we need to design an instrument for

creative ideation performance, an instrument that should be more adapted to our new figures of defixator leaders.

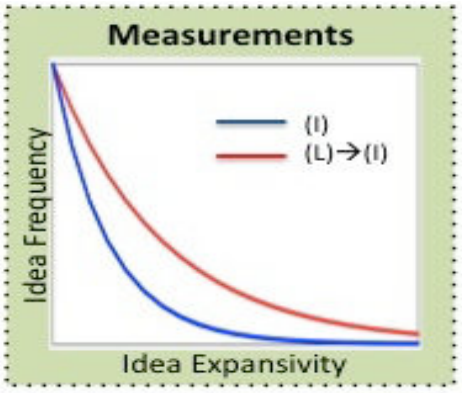


FIGURE 31: HOW LEADERS CAN MODIFY THE IDEATION DISTRIBUTION OF THEIR TEAMS

Moreover, defixator leaders' differ in the management of their team's ideation processes according to their knowledge. Theoretically, a high knowledgeable leader would be much more effective than a low knowledgeable leader. In the present research thesis, **to simplify the term "knowledge", and refer to it as the capacity of leaders to recognize if an idea generated by their teams is creative (inside fixation) or not creative (outside fixation)**.

3. A Contingency Approach to the Leadership-driven Ideation Model

To integrate this knowledge dimension in the leadership-driven ideation model, we considered two supplementary probabilities (**see Appendix II: full Markov-based leadership-driven ideation model**):

- **Probability** γ: it refers to the probability that leaders recognize that an idea is in fixation. If γ tends to one, it means that the leader could perfectly recognize if an idea is in fixation.
- **Probability** σ: it refers to the probability that leaders recognize that an idea is in expansion. If σ tends to one, it means that the leader could perfectly recognize if an idea is in expansion.

Based on the aforementioned, we assumed that **defixator leaders could intervene during the ideation processes of their teams according to their knowledge**, i.e. their capacity to recognize if the idea generated by their teams is creative (desirable) or uncreative (undesirable). These interventions should be positive when the generated idea is desirable (expansion), and negative

when the generated idea is undesirable (fixation). Positive interventions can take the form of positive feedbacks, positive instructions, etc., while negative interventions can take the form of negative feedbacks, negative instructions, etc. Therefore, we added four new states in our Markov model as shown in the figure below (for complete details see Appendix II):

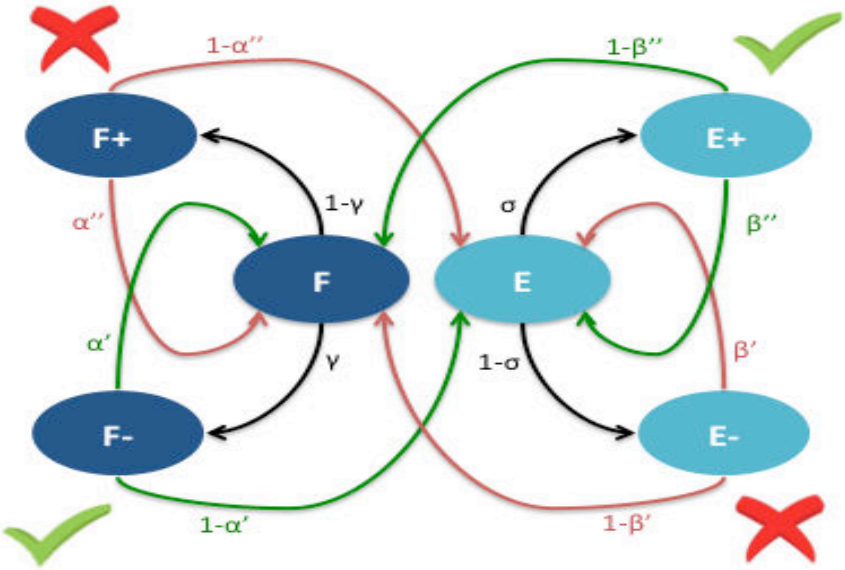


Figure 32: Markov model representing leaders' actions depending on their knowledge

- **State F-**: Leaders do a negative intervention given the idea is in fixation. In this case, the leader has the capacity to perfectly recognize that follower's idea is in fixation (γ), and consequently does a negative intervention. Theoretically, this negative intervention should help to decrease the probability of maintaining the state of fixation (α decreases to α').
- **State F+**: Leaders do a positive intervention given the idea is in fixation. In this case, the leader fails to recognize that follower's idea is in fixation ($1-\gamma$), and consequently does a positive intervention. Theoretically, this positive intervention will help to increase the probability of maintaining the state of fixation (α increases to α'').
- **State E+**: Leaders do a positive feedback given the idea is in expansion. In this case, the leader has the capacity to perfectly recognize that follower's idea is in expansion (σ), and consequently does a positive feedback. Theoretically, this positive feedback will help to increase the probability of maintaining the state of expansion (β increases to β'').
- **State E-**: Leaders do a negative feedback given the idea is in expansion. In this case, the leader fails to recognize that follower's idea is in expansion ($1-\sigma$), and consequently does a negative intervention. Theoretically, this negative intervention will help to decrease the probability of maintaining the state of expansion (β decreases to β').

Using this Markov model, **one could first deduce the new probabilities α^* and β^* after the intervention of leaders during the ideation process through feedbacks (positive or negative)**. These new parameters now depend on leaders' capacities to recognize fixation γ and to recognize expansion σ (demonstration in Appendix II: full Markov-based leadership-driven ideation model):

$$\alpha^* = \gamma\alpha' + (1-\gamma)\alpha''$$
$$\beta^* = \sigma\beta'' + (1-\sigma)\beta'$$

If leaders have a high capacity to detect fixation (high probability γ), the new α^* after the intervention of leaders tend to decrease the probability of maintaining the state of fixation (α transforms to α'). On the contrary, if leaders have a low capacity to detect fixation (low probability γ), the new α^* after the intervention of leaders tend to increase the probability of maintaining the state of fixation (α transforms to α'').

Similarly, **if leaders have a high capacity to detect expansion (high probability σ), the new β^* after the intervention of leaders tend to increase the probability of maintaining the state of expansion (β transforms to β'')**. On the contrary, if leaders have a low capacity to detect expansion (low probability σ), the new β^* after the intervention of leaders tend to decrease the probability of maintaining the state of expansion (β transforms to β').

These transformations of parameters α to α^*, and β to β^* depending on leaders' knowledge, lead to an **interesting relationship between the expansion rate E (the sum of E+ and E-) and the new probabilities of re-fixation ($1-\beta^*$) and defixation ($1-\alpha^*$)** as follows (detailed demonstration in Appendix II: full Markov-based leadership-driven ideation model):

$$(1-\beta^*) = \frac{1-E}{E}(1-\alpha^*)$$

Then, according to these equations one could then plot the relationship between the new probabilities of re-fixation (in y-axis) and defixation (in x-axis) as shown in the figure below:

- A creative leader should manage followers to force them to defixate (pushing right-side) and not to re-fixate (maintain expansion by pushing downside).
- We could note interesting situational strategies to manage leadership-driven ideation:
    - **If leaders have perfect knowledge** (high γ, and high σ), they would be able to push followers towards defixating them and maintaining expansion (see red arrow in the figure). We named this leader "expert".
    - **If leaders have imperfect knowledge** (low γ, and low σ), they won't be able to push followers towards defixating them, and they won't be able as well to maintain expansion if followers are defixated (see orange arrow in the figure). We named this leader "random".

- **If leaders have perfect knowledge of expansion** (low γ, and high σ), they won't be able to push followers towards defixating them but they would be able to maintain expansion if followers are defixated (see pink arrow in the figure). We named this leader "expert in expansion".
- **If leaders have perfect knowledge of fixation** (high γ, and low σ), they would be able to push followers towards defixating them but won't necessarily help them to maintain expansion if followers are defixated (see blue arrow in the figure). We named this leader "expert in fixation".

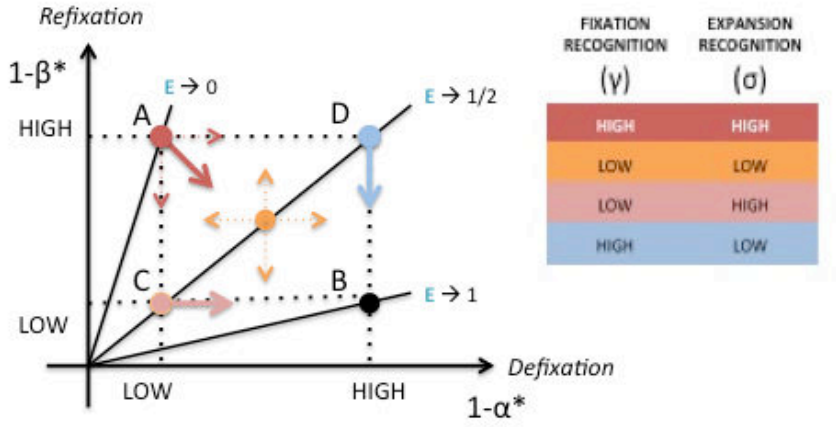


FIGURE 33: RE-FIXATION VS. DEFIXATION IDEATORS' PERFORMANCE AFTER LEADERS' INTERVENTION

III. An Instrument to Measure Creative Ideation Performance

1. Fluency/Flexibility/Originality: Torrance Components of Creative Thinking

Divergent thinking has been known to consider three main elements for evaluating a creative ideation performance, which are the ideational fluency, ideational originality, and ideational flexibility (Guilford, 1959). **Creative people usually exhibit a high ideational fluency, which is the aptitude to come up with many new ideas; a high degree of ideational originality, which is considered the degree of uniqueness of an idea; as well as ideational flexibility, which is known as the ability to stimulate variety among new ideas** (Runco & Acar, 2012).

Fluency (sometimes names productivity) is principally linked with the quantitative aspect of creative thinking, and more precisely divergent thinking. To calculate the fluency of ideas, we usually compute the **mean number of non-redundant ideas generated by participants in each group**. An individual is ideationally fluent when he/she is able to come up with many new ideas. According to a

famous chemist and biologist Linus Pauling, having many ideas enhance the probability to find creative ones (Kudrowitz & Wallace, 2013).

Flexibility is linked with both and quantitative and qualitative aspects of divergent thinking. To calculate the flexibility of ideas, we usually calculate the **mean number of different types of ideas generated by participants in each group**. An individual reflects ideational flexibility abilities, when he/she is able to come up with ideas belonging to many different categories. For example, a shoebox can be used as a hat, a diorama and a shield. Each of these ideas belongs to different categories, namely clothing, arts and toys.

Finally, originality is a primary component of creativity, and is more or less linked with the qualitative aspect of creative thinking. It is more difficult to assess originality than fluency or flexibility. To calculate the originality of ideas, we compute the **frequency of occurrence of types or categories of solutions given across all the subjects in each group**. An individual comes up with original ideas, when these ideas are statistically rare, and represent an uncommon, unexpected and unique response other individuals could not come up with.

Despite the fact that divergent thinking parameters are very efficient to measure creative ideation performance (Runco & Mraz, 1992), they are not sufficient to measure the performance of both ideators and defixator leaders. Indeed, they **do not take into account nor the fixation/expansion score used to assess fixation in a creative ideation task (Cassotti et al., 2016b), nor the sequential aspect of creative ideation according to our leadership-driven ideation model**.

2. Fixation/Expansion Score: An Additional Divergent Thinking Criteria

As explained in the previous section, although divergent thinking tests do not fully guarantee creative achievement, they are recognized to be reliable predictors for creative performance. However, to have a broader view of the creative performance, and especially identify the defixating effects of the "defixator" leaders on followers, **we used another creative performance criteria: the fixation/expansion score**, called "expansivity" in previous studies (Agogue et al., 2015).

Fixation score is the **mean number of ideas and solutions that individuals were able to generate inside the fixation zone** (restrictive solutions), while expansion score represents the **mean number of ideas and solutions that individuals could generate inside the expansion zone**, i.e. outside the fixation zone (expansive solutions). Of course, defixated individuals generate many ideas in expansion, and few ideas in fixation.

This score is no doubt pivotal to **measure the capacity of defixator leaders to decrease the rate of ideas inside the fixation path, as well as to increase the rate of ideas inside the expansion path**. To determine if an idea is inside or outside fixation design theories (such as C-K theory) could be accurate and efficient as mentioned earlier (Hatchuel et al., 2011).

3. Alpha/Beta Probabilities: Defixation and Expansion Persistence

Nevertheless, analyzing the mean number of solutions in each group in terms of fluency/flexibility/originality and in terms of the ratio fixation/expansion is efficient but not enough. These criteria do not give sufficient indications on how the ideator behaves during the task, and do not take into consideration the sequential aspect of our leadership-driven ideation model. For this reason, we need to analyze the sequential train of ideas generated by participants, by **computing the probabilities of transitions from fixation to expansion, and vice versa.** Moreover, we also need to **compute the probabilities of consecutively staying and remaining in each of the two states**.

A creative ideator should obtain a high probability of defixation (1-α), as well as a high probability of maintaining expansion (β). **Creative ideators would be able to score a high probability of defixation, which means their capacity to defixate themselves; as well have their capacity to maintain the flow of creative ideation, which means generating a high ideational fluency inside expansion**. As we have noted earlier, if the ideator generates few ideas (slow ideation performance), estimating the alpha and beta probabilities could be insufficient to determine his/her creative performance.

4. Are these Criteria Efficient to Measure The Effects of Defixator Leaders on Ideators' Creative Performances?

The instrument presented in the above sections comprises several criteria to evaluate the creative performance of ideators. However, **it is worth pointing out that evaluation creativity has always been a topic of debate among creativity scholars (Amabile, 1983; Puccio, Mance, & Murdock, 2010; Runco & Charles, 1993)**. In fact, multiple other attributes and criteria (such as usefulness, appropriateness, novelty, workability, relevance, specificity, elaboration, etc.) have been part of the list of creativity evaluators.

The traditional definition of creativity emphasizes two specific criteria: novelty (or originality) and usefulness (or appropriateness) (Amabile, 1983). The characteristic "novel" of creativity means generating something original, that has not existed before and somewhat unexpected. However, the characteristic "useful" of creativity is much more complex, since the usefulness or appropriateness of a new product or service highly depends on the sector where it is applied; and therefore depends on the evaluative criteria specified by the idea evaluator and selector in a particular context (field, time or place). Therefore, what is considered useful in one context is not necessarily useful in other contexts. It is worth mentioning that some studies consider that it is not necessarily important for an original idea to be appropriate, in order to be viewed as creative (Runco & Charles, 1993). However, according to Puccio et al., the value of creativity could be seen as a balance between originality and usefulness (Puccio et al., 2010).

Other studies went further and stated that **a product or service is considered creative if appropriate evaluators and reviewers agree that it is creative** (Amabile, 1983). In fact, Amabile argues that to judge whether an idea is creative or not creative, adequate reviewers should use their proper definition of creativity – definition that is highly dependent on their intuition and knowledge – to evaluate creative ideas (Amabile, 1979). The author states that evaluators should possess a certain level of expertise in the domain where evaluation is applied in order to properly evaluate ideas.

In line with the above idea of "intuition" in the judgment of creative ideas, Magnusson et al. have underscored **the importance of intuitive evaluation in the same context of assessing product/service ideas**. In fact, the authors explored the relationship between holistic intuitive idea screening and formal criteria-based evaluation, and established a statistical relationship between idea screening based on intuitive evaluation and idea screening based on formal criteria-based evaluation (Magnusson, Netz, & Wästlund, 2014).

In addition, Magnusson et al. demonstrated that users (a mix of technically naïve and more technically skilled users) could serve as substitutes for professional (in-house) experts in the evaluation of initial product/service ideas. In fact, these findings emphasized the idea that **companies could use users during the initial idea screening of their product/service ideas as a proxy for experts** (Magnusson, Wästlund, & Netz, 2016).

In the present thesis, **we focused on the three specific categories of criteria according to what effects of defixator leaders we needed to observe precisely**:

- The **effects of defixator leaders on the fluency, flexibility and originality** of ideators' ideas, and we considered these criteria as being the most commonly observed criteria in ideation sessions;

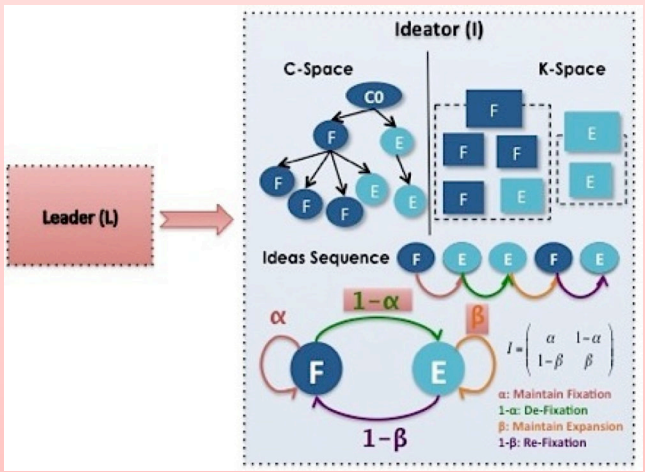
- The **effects of defixator leaders on the fixation and expansion scores** of their followers since we are dealing with leaders supposed to defixate their teams;
- The **effects of defixator leaders on the deviation of their teams' ideation paths** (sequential events), through transition probabilities (α, β) between states of fixation and expansion.

Now that we have the necessary instrument to measure creative ideation performance, we need to select a creative ideation task and perform the DOE (Design of Experiments) to shape our figures of defixator leaders through theory-driven experiments.

IV. Summary of Chapter V

Below is a summary box presenting the key points of chapter V:

- Using C-K theory, we modeled the generation of an idea as a two-stage cognitive process involving two operations: C→K and K→C
- However, simply modeling ideation as a two-stage cognitive process isn't accurate enough, since it doesn't take into consideration the dependency between the current state and the later state
- For these reasons, we modeled "sequential" ideation as a two-state Markov chain: at any time, the ideator either generates an idea in state fixation (F) or expansion (E)



- A good defixator leader "L" should intervene in the ideation process to help ideators "I" decrease the probability of maintaining fixation (α), and increase the probability of maintaining expansion (β)
- Our instrument for measuring creative performance of ideators focuses on the three specific categories of criteria: i) fluency, flexibility and originality; ii) the fixation and expansion scores; and iii) transition probabilities (α, β)

Chapter VI: Design of Experiments (DOE): Shaping the Figures of Defixator Leaders through "Leadership-driven" Ideation

In chapter VI, based on leadership-driven ideation model presented in chapter V, we present the DOE (Design of Experiments), in which we gradually shape each of the figures of defixator leaders (we build four different figures of defixator leaders), and present the general theoretical hypothesis for each of these figures.

I. Starting Point: A Creativity Task and A Referential Study Case

1. A Universal Knowledge-Independent Creativity Task: The Hen's Egg Task

In all the theory-driven experiments, a classical creativity task called the hen's egg task (also named "egg drop exercise" in previous studies) was used. This task consists of proposing the maximum number of original solutions to the following problem: **"Ensure that a hen's egg dropped from ten meters does not break"**. This task was used as a creativity task in several previous studies (Agogué et al., 2014a; Dow & Klemmer, 2011; Pasquella, 1974). There are different reasons why this particular creative ideation task was selected among others for our experiments:

- This task has **multiple interesting facets**:
    - It is considered an **ill-defined problem-solving task** because it requires using ad hoc and generative methods to come up with creative solutions to a particular ill-defined problem.
    - It is also an **idea generation task** because it requires coming up with numerous ideas to solve the task. Moreover, according to C-K theory, the initial concept C0 of the hen's egg task is more likely to be considered generative.
    - It is as well a **design task** because ensuring that a dropped egg does not break could require some types of design activities.
    - This creativity task is **open-ended**, and enables participants to test their aptitudes to provide several correct answers, as well as several ways to a particular correct answer.
- This task does **not need specific knowledge or requisites** for participants. Unlike many other creativity tasks, individuals need minimal technical expertise to be able to perform this task appropriately.

- **Fixation could easily manifest itself in this task** due to the fact that people have most probably broken eggs at least once in their life. Indeed, notions of "obvious solutions" or "existing knowledge" are effortlessly activated in individuals mind. Indeed, when attempting to solve this problem, most people tend to be fixated on the fragility of the egg. Therefore the hen's egg task enables us to identify and study both the processes of fixation and defixation.
- This specific creativity task **was performed in highly controlled settings over the past five years**. Therefore, a large database of solutions exists and enables us to accurately compare the effect of defixator leaders on the creative ideation performance of their teams.

Now that we have selected the hen's egg task for our theory-driven experiments, we need to accurately determine the frontier between fixation and expansion. It is worth mentioning that there are no standardized metrics to measure fixation (Crilly & Cardoso, 2017). However, using a C-K-based cartography of solutions, Agogué et al. have been able to develop an efficient **C-tree cartography of the solutions of this task, in order to differentiate between solutions that are inside fixation and other solutions that are outside fixation**.

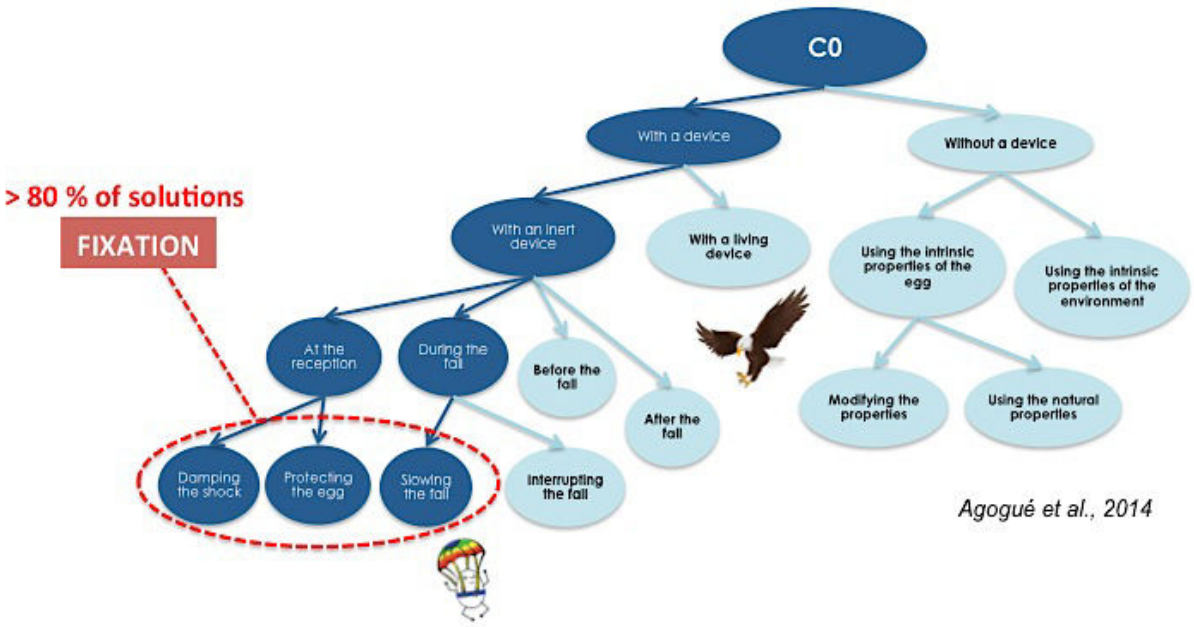


FIGURE 34: THE HEN'S EGG TASK C-TREE (AGOGUÉ, 2014)

The authors experimented this classical creative ideation task on hundreds of participants from different profiles (psychology student, engineers, designers, industrialists, experts, etc.). Using an existing database of solutions created over the last five years (Agogué et al., 2014a), **the authors revealed that 81% of the solutions belonged to three categories of "restrictive" solutions within**

the fixation path (i.e., damping the shock, slowing the fall, and protecting the egg). However, only 19% of the solutions were "expansive" solutions, i.e., solutions that were outside of the fixation path (for example, solutions implemented before and after the fall, the use of a living device, and the use of the intrinsic properties of the environment).

In Appendix I, we listed each meta-category of solutions of the hen's egg task, according to the above-mentioned C-K-based cartography. In each category, we gave some examples of solutions that are frequently given by participants from different ages and profiles according to our database. **These meta-categories are divided into fixation meta-categories (3 meta-categories), and expansion meta-categories (7 meta-categories)**.

2. "Defixator Leaders 0": Leaders with the Capacity to Formulate Expansive Examples

After selecting the creativity task, we had to select a referential study case. In fact, in order to gradually shape new figures of defixator leaders using the leadership-driven ideation model, we had to select a starting point figure of defixator leader. Indeed, as discussed in chapter IV, **particular "implicit" figures of defixator leaders could be modelled based on the existing defixation procedures.** These figures of defixator leaders are implicitly present before or during the ideation process and play a direct or indirect role to help individuals overcome fixation.

We selected as a starting point and referential study case: **the implicit figure of defixator leader extracted from the study on expansive examples** (Agogué et al., 2014a). Agogué et al. have demonstrated that when individuals are provided with expansive examples prior to the hen's egg task, i.e., ideas and solutions that are outside fixation, they become defixated and propose more original solutions (Agogué et al., 2014a).

These implicit figures of leadership that have the capacity to formulate expansive examples to their teams were named: "defixator leaders 0". "Defixator leaders 0" were selected as a starting point to design new derived figures of defixator leaders for several reasons:

- **"Defixator leaders 0" are very effective for defixation**. According to the results obtained by Agogué and colleagues, formulating expansive examples to individuals (from various profiles and ages) before a creative ideation task could have positive defixation effects on them. Indeed, in their study, the authors show that the percentage of ideas inside fixation was reduced to 10% for the group exposed to the expansive example compared to the control

group (Agogué et al., 2014a; Agogué et al., 2015b; Agogué et al., 2014b; Cassotti et al., 2016a; Cassotti et al., 2016b).

- **"Defixator leaders 0" could be considered as having particular means of actions that require little intervention from the leaders**. In fact, they simply provide an instruction to their teams at the beginning of an ideation task. Consequently, these means of actions of "defixator leaders 0" could be gradually intensified before or during the ideation process, in order to valorize the presence of leadership, and to have defixator leaders that are not simply reduced to facilitators. Indeed, intensifying the means of actions of defixator leaders perfectly goes in line with one of the research objectives stated in chapter IV, which consists of generating alternative figures of defixator leaders different from the facilitators (who do not really participate with their teams in the ideation process).
- **"Defixator leaders 0" could be considered as having relatively high competencies**. In fact, they are capable of providing their teams with ideas inside the expansion path (creative, stimulating and disruptive ideas). Consequently, these high competencies of "defixator leaders 0" could be gradually reduced to design figures of defixator leaders that are not necessarily the innovators. Indeed, reducing the competencies of defixator leaders also goes in line with one of the research objectives stated in chapter IV, which consists of designing alternatives to the figure of innovators (who do not already have great innovative ideas and drive their teams to innovate using their high competencies).

We used "defixator leaders 0" as the starting point of our experiments, and then gradually shaped other new figures of defixator leaders (figures that are of course derived from "defixator leaders 0"). **We attempted to design these new derived figures in ways they won't ideate (contrarily to innovator leaders), but they would be participating intensively in the ideation processes of the ideators (contrarily to facilitator leaders)**, and this according to the research objectives set in chapter IV. Indeed, these new figures would rather lead their teams for creativity and innovation by defixating them with the minimal competencies possible, and the maximum involvement possible.

In order to realize that, for each new figure of defixator leaders, we gradually tried to attenuate its competencies, and at the same time intensify its means of actions. This was done four times until we formed **new figures of defixator leaders that were the least "innovator" possible, as well as the least "facilitator" possible** but rather intermediary figures between these two creative leadership forms.

II. Derived Theory-driven Model I for "Defixator Leaders 1": Initial Instructions to Close Out Teams' Solution Space in Fixation

1. Attenuating the Competencies of "Defixator Leaders 1"

The first types of defixator leaders that were designed were called "defixator leaders 1". In the derived theory-driven model 1 ("derived" from the leadership-driven ideation model), we attenuated the competencies of "defixator leaders 1" compared to the competencies of "defixator leaders 0" (who were able to provide examples in the expansion path). In fact, we assumed that **"defixator leaders 1" are less competent than "defixator leaders 0", since the first is only capable to recognize the dominant design of a project, i.e. the solution space inside fixation**. This assumption is suitable with our research objectives of designing the minimal profile of leaders that could play the role of "defixator" for their teams. Indeed, as we have mentioned earlier in this thesis, one of the main challenges of our research work was to implement a figure of defixator leaders that are not necessarily innovator (do not generate the creative ideas themselves).

Indeed, "defixator leaders 0" (described in the previous section) were already considered too much competent since they were able to provide their teams with creative solutions (in the expansion path). This implies that **defixator leaders already had the knowledge of the solution space in expansion**, which requires relatively high levels of competencies (defixator leaders who already have the innovative and disruptive ideas).

Therefore, the research question for the derived theory-driven model 1 could then be: **what if defixator leaders didn't have the ability to provide their followers with expansive examples** (examples of solutions outside the fixation zone), i.e. what if leaders didn't have this capacity to recognize the solution space in expansion? In this case, how could defixator leaders still defixate their teams with an initial instruction but without having the knowledge of expansion themselves? Or in other words, how could defixator leaders creatively warn their teams about the fixation zone with only the knowledge of fixation using an initial instruction?

To realize that, one solution could consist of "closing" the solution space in fixation, in order to "force the emergence of new action means" (Le Masson, Hatchuel, & Weil, 2016). In other words, **if fixation effects inadvertently force ideators, designers, and problem-solvers to exclusively explore a restricted zone of the solution space (consequently leaving an expansive zone of solution space unexplored), what if defixator leaders initially instructed their followers to escape this restricted zone and explore the expansive zone from the beginning**? In their report on the future of research on fixation, design scholars refer to this fact as "avoidance effects", i.e. a situation where

designers are explicitly required not to explore a certain zone of the exploration space (Crilly & Cardoso, 2017). One could also refer to this fact as "negation effects", i.e. the act of negating certain ideas or concepts.

2. State of the Art: The Role of "Constraints on Examples" for Creativity

To answer these questions and explore how "defixator leaders 1" could warn their followers to prevent them from ideating inside fixation, using similar means of actions (such as the means of actions of "defixator leaders 0": an initial instruction), we had to go through the **state of the art on the role of examples and constraints on examples for creativity**.

As we have explained earlier, the process of creative ideation is not always an easy task, and could be disturbed by fixation, i.e. unconsciously and previously acquired knowledge (Agogué et al., 2014a; Jansson & Smith, 1991; Smith et al., 1993). In fact, this **accumulated knowledge spontaneously activated in individuals mind, prevent them from seeing alternative uses, and thus impending creative thinking**. Such effect, has been demonstrated to occur in creative problem-solving, as well as more openly framed problems such as ideation, where participants need to generate a lot of different ideas to a specific situation (Agogué et al., 2014b).

More specifically, not only previously acquired knowledge could lead to fixation but also **exposure to examples can either reinforce or mitigate fixation**. In fact, previous studies have shown that exposure to examples could play either a positive or negative role to modulate fixation. During ideation sessions, participants may conform to examples suggested to them (or external stimuli such as ideas suggested by other group members in interactive brainstorming for example), instead of exploring a diverse set of ideas.

Multiple studies related to the role of examples for creativity, principally in the field of design and cognition, have shown that **previously acquired knowledge in individuals' mind is most likely to act as a mental set promoting fixation** (Adamson, 1952; Sio, Kotovsky, & Cagan, 2015).

Smith and colleagues studied the fixating role of examples from a "conformity effect" angle. The authors demonstrate that designers unintentionally tend to conform to the features of the example they were shown (Smith et al., 1993). In three experiments using a creative ideation paradigm in which subjects had to imagine and sketch new exemplars of experimenter-defined categories, the authors showed that **individuals surprisingly replicate the features of the example even when they are explicitly asked to propose ideas that are different from the given example**.

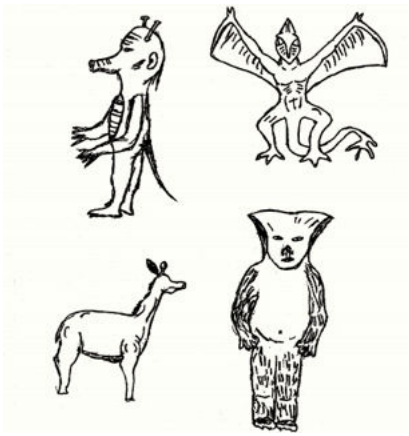


Figure 35: Animals living on other planets, (Smith et al., 1993)

It is important to point out that studies related to the role of examples for creativity have considered examples from different kinds and forms (non-verbal, verbal or a mix of the two during the same studies). For instance, Bonnardel and Marmèche (2004) have shown that **designers exposed to external sources of inspiration taking the form of graphical representations or verbal labels (whether intra-domain or inter-domain) during design sessions, could have various effects on their creative ideation performances based on the nature of the external source of inspiration as well as their level of expertise** (Bonnardel & Marmèche, 2004).

Focusing on the way instructions to be creative are delivered to participants, **other studies have provided discrepant results regarding the role of warnings and constraints on fixation modulation**. Chrysikou and Weisberg (2005) showed that the fixation effect can be reduced using instructions which warn subjects about the use of the flaws of an example (Chrysikou & Weisberg, 2005). On the contrary, Viswanathan and Linsey (2013) confirmed Smith and colleagues' findings (1993), and demonstrated that even when designers are presented with warnings about the undesirable example features along with the reasons for those warnings, fixation to those features is not mitigated (Viswanathan & Linsey, 2013).

These discrepant results could let one think at first glance that there could be a certain relationship between the level of abstraction of the examples and the level of fixation mitigation. In fact, these findings could let one think that the more the constraints and warnings on examples are abstract (without clear indications about the features of the examples), the more fixation would be mitigated. Similarly, we could also think that the more constraints on examples are specific (with clear specification of the features of the examples), the more fixation would be reinforced.

In accordance with this role of specificity and abstraction on fixation modulation in creative ideation, Baughman and Mumford demonstrated that when people are asked to combine exemplars

from separate categories to form a single inclusive category, which is considered an act of categorization, participants become more original (Baughman & Mumford, 1995). These **studies provided interesting indications about the role of abstraction for fixation mitigation and the generation of creative ideas**.

Moreover, Ward and colleagues (Ward et al., 2004) confirmed these findings on the role of abstraction for creativity. In their classical experiments where participants were asked to imagine life on other planets, the authors demonstrated that **instructions encouraging participants to formulate the given task in more abstract ways led to more creativity than instructions encouraging participants to formulate the task in very specific ways**. However, the influence of the level of abstraction on creativity has been only solely explored through the perspective of the task formulation. More focus could be placed on the relationship between the level of specificity and abstraction, and the level of fixation mitigation by applying it to the use of examples.

3. Designing "Defixator Leaders 1": Leaders Formulating Initial Instructions Warning Their Teams to Prevent Them From Ideating inside the Fixation Space

As illustrated in the figure below, **"defixator leaders 1" could also give one instruction to their teams such as "defixator leaders 0"**, which means that they provide their teams with one instruction at the very beginning of the creativity task, and then do not make any actions during their teams' ideation processes (see figure below).

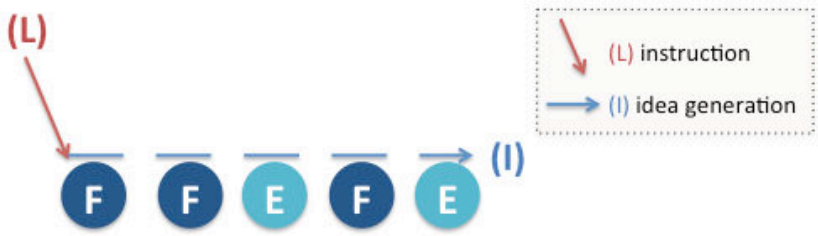


FIGURE 36: MEANS OF ACTIONS OF "DEFIXATOR LEADER 1"

Moreover, "defixator leaders 1", have fewer competencies than "defixator leader 0", since the first do not know the expansion space (they do not provide ideas in expansion, i.e. expansive examples) but only know the fixation space. In fact, considering that **"defixator leaders 1" only know the fixation space**, we first imagined that they could consequently warn their teams to prevent them from generating ideas inside fixation.

However, as explained in the previous section (state of the art), previous studies have already explored the process of warnings on examples in fixation but did not necessarily obtain positive results. **We used our leadership-driven ideation model to try to better understand why previous experimental studies imposing constraints and warnings on uncreative examples were unable to mitigate fixation**.

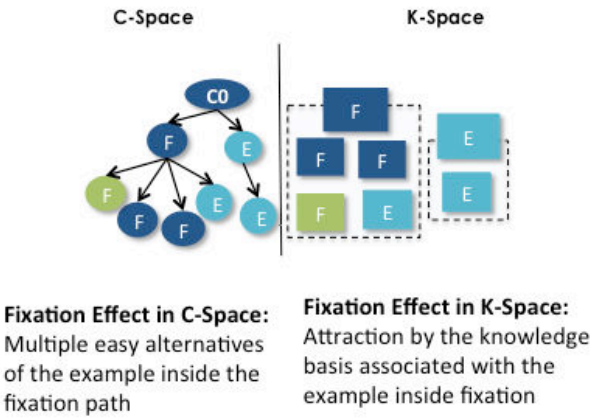


FIGURE 37: THE EFFECTS OF UNCREATIVE EXAMPLES ON FIXATION ACCORDING TO C-K

According to our model, the uncreative examples (inside fixation) that were given to participants in previous studies – such as the examples provided to participants of experiment 3 in the study of (Smith et al., 1993) – were at the l**owest level of the concept tree (see the tree leaf in green color in the figure above), i.e. which means the examples were at a high level of specificity**.

As seen in the figure above, **this high level of specificity of the uncreative examples could result in a double effect of fixation in both the C-space and the K-space**:

- **Fixation effect occurring in the C-space**: participants may effortlessly search for alternatives to the uncreative examples inside fixation in the C-space. These alternatives are more likely to be inside fixation as illustrated in the figure since they are at the lowest level of the C-tree.
- **Fixation effect occurring in the K-space**: an effect of attraction by the participants of the knowledge basis associated with the examples inside fixation in the K-space. This attraction could be due to the semantic richness associated with the examples.

Now, despite the fact that the fixation effect occurring in the K-space is not easy to control by defixator leaders (the attraction of participants towards particular knowledge basis associated with examples is hardly predictable in the K-space), **however there is clear evidence that defixator leaders could play an important defixating role by manipulating the fixation effect occurring in the C-space**. Indeed, if we consider that the same uncreative examples are formulated by defixator

leaders with a high level of abstraction (a higher level of the C-tree), this could result in fixation mitigation in the C-space, and consequently enhance individuals' creative ideation.

To assess this relationship between the level of abstraction and fixation mitigation - and in line with the above-mentioned findings - we explored **the effects of instructions warning participants to prevent them from using either uncreative examples formulated with a high level of specificity, or more abstract levels of these same examples**.

Based on the above, and assuming that "defixator leaders 1" only know the fixation space, we hypothesized that if "defixator leaders 1" impose constraints on examples at a low level in the concept tree (**blocking navigation at low level of C-tree**), it would facilitate the process of searching for alternatives inside fixation in the C-space, and therefore would reinforce the fixation effect (see figure below).

However, if "defixator leaders 1" impose constraints on examples at a higher level in the concept tree (**blocking navigation at high level of C-tree**), i.e. which represent a more abstract level of these examples such as a categorization of these examples, it would force subjects to deviate completely from fixation in the C-space, and should mitigate fixation (see figure below).

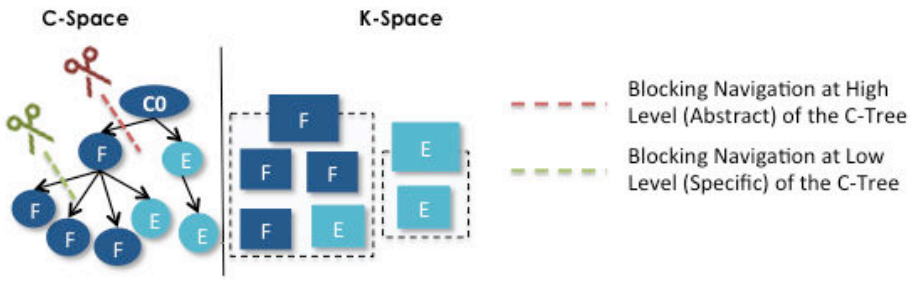


FIGURE 38: THEORETICAL PREDICTIONS OF "DEFIXATOR LEADER 1" ACCORDING TO LEADERSHIP-DRIVEN IDEATION MODEL

According to the above-mentioned predictions of fixation mitigation/reinforcement using the leadership-driven ideation model, our theoretical predictions for the derived theory-driven model 1 are as follows:

H1A: If "defixator leaders 1" instruct their teams to avoid using examples in fixation – at a high level of specificity –, it should reinforce fixation.

H1B: If "defixator leaders 1" instruct their teams to avoid using examples in fixation – by framing those examples at a more abstract level, such as a categorization of these examples –, it should mitigate fixation.

III. Derived Theory-driven Model II for "Defixator Leaders 2": Repetitive Feedbacks to Overcome Fixation Regardless of Teams' Ideas

1. Attenuating the Competencies of "Defixator Leaders 2" and Intensifying Their Means of Actions

The second types of defixator leaders that were designed were called "defixator leaders 2". In the derived theory-driven model 2, we **reduced the competencies of "defixator leaders 2" compared to "defixator leaders 1", and intensified their means of actions during the ideation process**. In order to do that, we imagined that "defixator leaders 2" would participate intensively during the ideation process using other means of actions: repetitive feedbacks.

It is worth mentioning that "defixator leaders 1" (designed in the previous section) are required to formulate warnings to prevent participants from using examples (either in specific or abstract ways) in order to defixate them. This implies that **defixator leaders should have the knowledge of the solution space in fixation**, which still requires some levels of "relatively high" competencies. At the same time, "defixator leaders 1" are not really participating in the ideation process of their teams: they just provide them with an initial instruction at the beginning of the task.

Therefore, the research questions for the derived theory-driven model 2 could then be: **what if defixator leaders didn't have the knowledge of the solution space in fixation? What if they were required to participate intensively during the ideation process of their teams (using repetitive feedbacks) to help them overcome fixation without prerequisite knowledge**?

2. State of the Art: The Role of Feedbacks for Creativity

Indeed, among the long list of tools leaders could use to foster creativity among followers (or at least avoid hindering it), there is no doubt that feedbacks maintain a central position. **Feedbacks could be used to regulate and control followers' performance in real-time**. Although the concept of feedback itself is widely used in management theories, its definitions vary considerably depending on management theorists perception (Ramaprasad, 1983). As a basis for improvement and goal attainment, leaders provide followers with certain information and reactions about followers' performance to tune it according to their visions.

Few studies have focused on the close relationship existing between feedbacks and creativity. Indeed, some researchers explored the effect of feedbacks from a relatively broad angle, focusing on the social interaction perspective. Generally, these studies analyzed the exchange of evaluative information on creative performance, arguing that it could have a strong impact on enhancing creative processes (De Stobbeleir, Ashford, & Buyens, 2011). **These studies incorporated feedbacks in the broader concept of interactions existing between employees and supervisors or between employees themselves**, underscoring the importance of being exposed to others' ideas and perspectives to boost the generation of creative ideas.

Other studies examined **feedbacks from a more self-monitoring and regulation perception, noting that it helps regulate individuals' creative performance** (Zhou & Li, 2013). However, most of the studies that have explored more deeply the question of feedbacks, from a creative ideation perspective, share common views with management scholars encouraging a certain level of autonomy for creativity. In fact, these findings have emphasized that delivering negative and controlling feedbacks to employees could damage their creative performance, while on the contrary, delivering constructive or developmental feedbacks to employees could have a positive impact on creativity (Carson & Carson, 1993; Zhou, 1998, 2003; Zhou & Li, 2013).

Nevertheless, **most of the abovementioned studies have evaluated feedbacks from a relatively large angle, and none of these studies have focused on interactive feedbacks from a creative ideation perspective**.

In line with the above, could leadership feedbacks tune and regulate followers' ideation processes? In other words, **could leadership feedbacks direct and guide ideation processes towards certain potential directions that could most likely lead to creative outcomes?** Are creative leaders capable of driving followers' path of ideation in certain directions?

Our general questions are then as follows: despite the negative perception of "controlling" feedbacks on creativity as reported by management and creativity literature (encouraging more freedom and autonomy for creativity to arise), **could repetitive feedbacks mitigate fixation in certain cases, provided that these repetitive feedbacks guide ideation towards certain directions**? What are these directions?

If we try to reformulate these research questions in other words and from a more managerial perspective: **could leaders regulate the creative processes of their teams using unchanging behaviors consisting of "simply encouraging all ideas" (such as Osborn's rules in brainstorming sessions), or on the contrary always asking them to "search for other alternatives**"?

3. Designing "Defixator Leaders 2": Leaders Providing Their Teams With Repetitive Feedbacks Regardless From Their Ideas

As illustrated in the figure below, **"defixator leaders 2" have means of actions that require more interventions that "defixator leaders 1"**, which means that they provide their teams with a repetitive feedback at each idea generated by their teams the creativity task. However, these instructions are different from previous one in a way that they do not require any type of knowledge. These instructions are just minimal feedbacks: either positive feedbacks ("continue in this path"), or negative feedbacks ("search for another path"). The third type of feedbacks (control condition) did not involve instructive information (i.e., "I confirm the receipt of your idea") and was considered neutral with regard to the two other feedbacks.

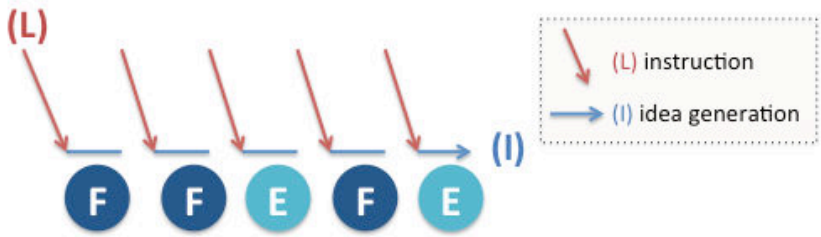


FIGURE 39: MEANS OF ACTIONS OF "DEFIXATOR LEADER 2"

Moreover, we reduced the competencies of "defixator leaders 2" to the lowest level possible, i.e. **"defixator leaders 2" do not have competencies at all**, since they just repeat the same instruction each time through feedbacks.

According to our leadership-driven ideation model, if we consider that "defixator leaders 2" should intervene in the ideation process of their teams without knowledge at all, this would mean that their instructions should be given regardless of the nature of the ideas generated by their teams, and should have a directive aspect (these repetitive feedbacks should drive ideation towards certain directions).

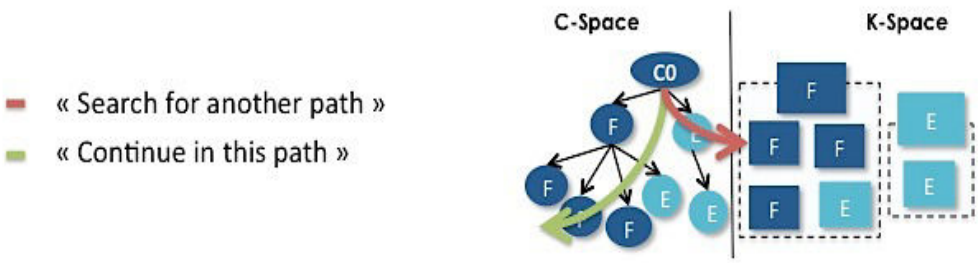


FIGURE 40: THE EFFECTS OF REPETITIVE FEEDBACKS ON FIXATION IN C-K SPACES

As illustrated in the figure above, there could be two interesting strategies of defixation, both requiring no knowledge at all:

- The **changer**: The changer "defixator leaders 2" have a breadth-oriented strategy of defixation. At each idea generated by their teams, they try to change the state of the idea by asking them to "**search for another path**". This strategy is more likely efficient for defixator leaders if the ideas generated by their teams are in fixation. In other studies, this strategy has been termed "the flexible pathway" (Crilly & Cardoso, 2017; Nijstad, De Dreu, Rietzschel, & Baas, 2010).
- The **maintainer**: The maintainer "defixator leaders 2" have a depth-oriented strategy of defixation. At each idea generated by their teams, they try to maintain the state of the idea by asking them to "**continue in this path**". This strategy is more likely efficient for defixator leaders if the ideas generated by their teams are in expansion. In other studies, this strategy has been termed "the persistence pathway" (Crilly & Cardoso, 2017; Nijstad et al., 2010)

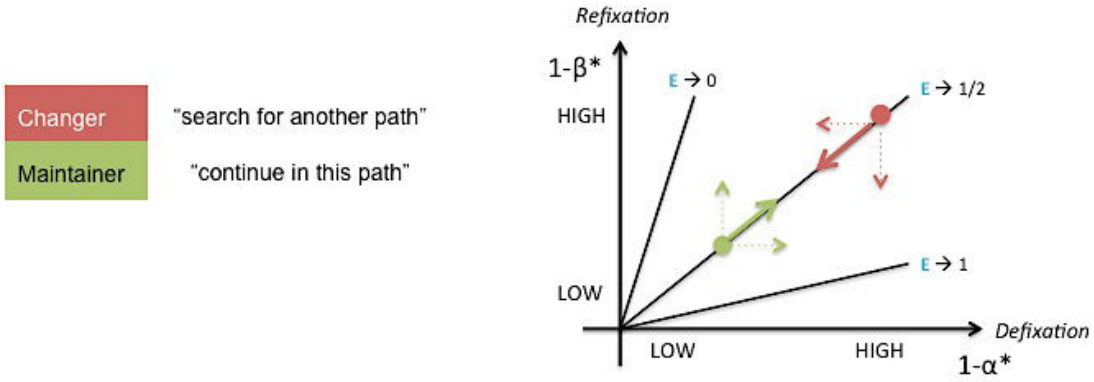


FIGURE 41: THEORETICAL PREDICTIONS OF "DEFIXATOR LEADER 2" ACCORDING TO LEADERSHIP-DRIVEN IDEATION MODEL

We illustrated in the figure above both the strategies of the changer (in red color) and maintainer (in green color). Theoretically, according to the leadership-driven ideation model, **the changers should increase both the probabilities of re-fixation (1-β) and defixation (1-α)** since they deliver negative feedbacks at each idea generated by their teams.

On the contrary, **the maintainer should decrease both the probabilities of re-fixation and defixation** since they deliver positive feedbacks at each idea generated by their teams. However, **both changer and maintainer should not have important effects on fixation** (both the changer and maintainer should move on Iso-Expansion curves, see chapter V).

Based on the above, our theoretical predictions for the derived theory-driven model 2 are as follows:

H2A: "Defixator leaders 2" changers should force their teams to change states (oscillate between fixation and expansion) more often than "defixator leaders 2" maintainers

H2B: Both "defixator leaders 2" changers and maintainers should have no major effects on fixation

IV. Derived Theory-driven Model III for "Defixator Leaders 3": Directive Feedbacks to Lead Ideation outside Fixation Depending on Teams' Ideas with Perfect Knowledge

1. Increasing the Competencies of "Defixator Leaders 3" and Maintaining Their Means of Actions

The third types of defixator leaders that were designed were called "defixator leaders 3". In the derived theory-driven model 3, we **increased the competencies of "defixator leaders 3" compared to "defixator leaders 2", and maintained the same level of interventions during the ideation process**. In order to do that, we imagined that "defixator leaders 3" would still participate intensively during the ideation process of their teams using more developed means of actions (such as directive feedbacks) but with some minimum level of knowledge (only the capacity to recognize the nature of the ideas generated by their teams, if the ideas are inside fixation or inside expansion).

Indeed, "defixator leaders 2" (designed in the previous section) are required to apply a defixation strategy that is regardless of the ideas generated by their teams. This implies that "**defixator leaders 2" should have no knowledge at all**, which is not coherent since leaders are required to have a minimum level of knowledge. Moreover, the fixed strategies employed by "defixator leaders 2" (through repetitive feedbacks) are very limited since they do not provide relevant information to their teams to drive their ideation paths in particular directions depending on what they generate.

Therefore, the research question for the derived theory-driven model 3 could then be: **what if defixator leaders just had the ability to recognize the nature of the ideas generated by their teams (if the ideas are inside fixation or inside expansion)**, how could defixator leaders intervene during the ideation process of their teams using directive feedbacks with this capacity of recognition?

2. State of the Art: The Role of Directive "Executive" Feedbacks and Inhibitory Control for Creativity

In the derived theory-driven model 3, we **increased the competencies of "defixator leaders 3" compared to "defixator leaders 2"** and slightly developed their means of actions during the ideation process (they could provide their teams with directive feedbacks instead of just repetitive feedbacks). In order to do that, we imagined that "defixator leaders 3" would participate intensively during the ideation process using directive feedbacks but would at least be able to recognize if an idea is in the fixation path or in the expansion path. **This third model would emphasize the processes of inhibition and stimulation of ideas**, since "defixator leaders 3" could recognize the state (fixation or expansion) of the ideas generated by their teams, and then inhibit the ideas they consider undesirable, and on the contrary stimulate the ideas they consider desirable.

Several studies in the developmental cognitive sciences have discussed the importance of inhibitory control and have argued that **individuals must first inhibit the spontaneous ideas that come to their mind so that they can generate creative solutions to problems** (Agogue et al., 2015; Cassotti et al., 2016a; Cassotti et al., 2016b; Houdé et al., 2000).

In fact, developmental psychology theorists have analyzed the problem of creative idea generation at the reasoning level and realized that **thinking outside the box may also require first resisting what is inside the box**. Indeed, these scholars have investigated the problem of cognitive biases at the reasoning processes level and have underscored the critical role that could be played by inhibitory control of the fast and intuitive system of reasoning in overcoming heuristics in certain cases (Borst et al., 2013; Houdé, 1997; Houdé et al., 2000).

Based on the dual-process theory of reasoning comprising both an intuitive system (system 1) and an analytic system (system 2) (Evans & Frankish, 2009; Kahneman, 2011), these authors have proposed **a third system of reasoning termed "cognitive inhibition" (system 3)** (Houdé, 1997). The latter system plays the role of inhibiting the fast and intuitive system (system 1) to release the slow and analytic system (system 2).

Along these specific lines, recent studies have linked these above-mentioned findings with the context of cognitive biases to creativity. Considering that **the difficulty in generating creative ideas might result from individuals' failures to inhibit spontaneous responses that come to mind and lead them to fixate on certain knowledge**, these authors have proposed an analogical model of reasoning in creativity situations that they termed the "dual-process model of creativity" (Cassotti et al., 2016a). Similarly, these studies argue that the abilities of individuals to resist the spontaneous

activation of design heuristics by inhibiting inappropriate ideas is a crucial factor in the generation of creative ideas (Benedek, Franz, Heene, & Neubauer, 2012; Camarda, 2017; Cheng, Hu, Jia, & Runco, 2016).

In line with the above ideas, in the present derived theory-driven model, we attempted to develop **a learning process that can be implemented to guide individuals' systems of reasoning for creativity**. More precisely, with the help of design theories, such as the C-K theory (Hatchuel & Weil, 2002), in the present study, we analyzed the roles of feedback processes in i) the inhibition of obvious solutions to a particular creativity task and ii) the gradual forcing of individuals' reasoning to explore and activate novel and creative ideas and solutions to problems.

In the domain of reasoning, Moutier and Houdé (Cassotti & Moutier, 2010; Houdé & Moutier, 1996, 1999) developed **a training paradigm that involves explicit executive feedback regarding various reasoning biases**. Using a classical pre-test/training/post-test design, the efficiency of this training procedure is indexed by comparing the post-test performance with the performance in the control training with the logic that the latter only differs due to the absence of executive feedback. Therefore, the specificity of the executive training lies in the presence of executive feedback, such as "we're falling into a trap! (...)" or "The goal here is not to fall into the trap (...)". The words "not to fall into the trap" in this training procedure are introduced to provoke a tendency to reject the biased strategy. Although the reasoning biases were found to be very high, the results revealed that only the executive training improved the subjects' metacognitive ability to overcome classical reasoning biases, such as the conjunction fallacy and the matching bias, during deductive reasoning (Cassotti & Moutier, 2010). In other words, this study emphasized the near transfer effect by confirming that the executive training could be transferred to structurally similar tasks.

This experimental design was also applied during a brain imaging study, and the results revealed a reconfiguration of neural activity that correlated with the near executive transfer effect in the domain of deductive reasoning (Houdé et al., 2001). The results revealed clear shift in neural activity from the posterior part of the brain prior to executive training (i.e., when the participants' responses were biased by the use of system 1) to the prefrontal portion after training (i.e., when they became able to inhibit the system 1 intuitive response and provide the correct answer via the use of system 2). Altogether, these findings demonstrated that **executive feedback can provoke the inhibition of strongly intuitive wrong answers** (Houdé & Tzourio-Mazoyer, 2003).

Despite the contributions made to the literature of creativity and the importance of studying the influence of feedback on ideation from this above-mentioned relatively broad perspective, **no studies have focused on the influence of directive feedbacks from a deeper cognitive perspective**

from which minimal feedback might guide individuals' reasoning outside of fixation with just the ability to recognize the nature of the ideas generated (in or out fixation).

3. Designing "Defixator Leaders 3": Leaders Formulating Directive Feedbacks Depending on the Nature of the Ideas of Teams with Perfect Knowledge of F/E Type

As illustrated in the figure below, **"defixator leaders 3" have slightly more developed means of actions than "defixator leaders 2"**. In fact, "defixator leaders 3" provide their teams with a directive feedback (depending on the interpretation of the idea by the leader) at each idea generated by their teams during the creativity task. These directive feedbacks are different from previous one (repetitive feedbacks) in a way that they do require some minimum level of knowledge. These directive feedbacks were either positive feedbacks ("continue in this path") when the idea is interpreted by the leaders as desirable, and negative feedbacks ("search for another path") when the idea is interpreted by the leaders as undesirable.

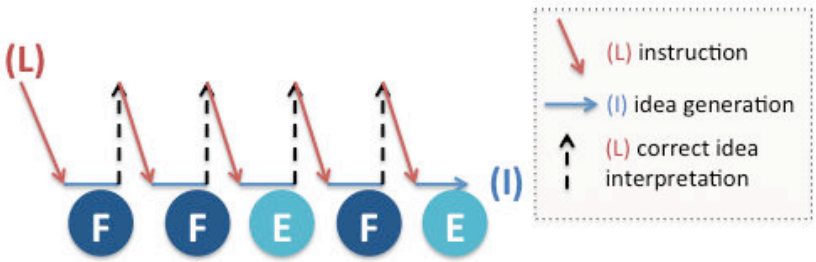


FIGURE 42: MEANS OF ACTIONS OF "DEFIXATOR LEADER 3"

In fact, **"defixator leaders 3" provide their teams with directive feedbacks that could guide their teams' idea generation paths whether inside fixation**, i.e., a conceptual space associated with the fixation effect, or in expansion, i.e., a conceptual space associated with concepts outside of fixation. In other words, we were interested in modeling a learning process that can guide individuals' ideation paths toward certain types of ideas and solutions whether they are restrictive, i.e., do not change an object's definition or attributes, or expansive, i.e., transform an object's definition and identity (Agogué et al., 2014a).

Therefore, the aim of the present derived theory-driven model was to examine **how directive "executive" feedback influences individual ideation. The executive feedback was either congruent or incongruent with the creative aim of the egg task**. In the congruent executive feedback condition, the feedback suggested that the participants "search for another path" when the proposed solution belonged to the fixation path and "continue in this path" when the solution

belonged to the expansive path. In the incongruent feedback condition, the feedback suggested that the participants "continue in this path" when the proposed solution belonged to the fixation path and "search for another path" when the solution belonged to the expansive path.

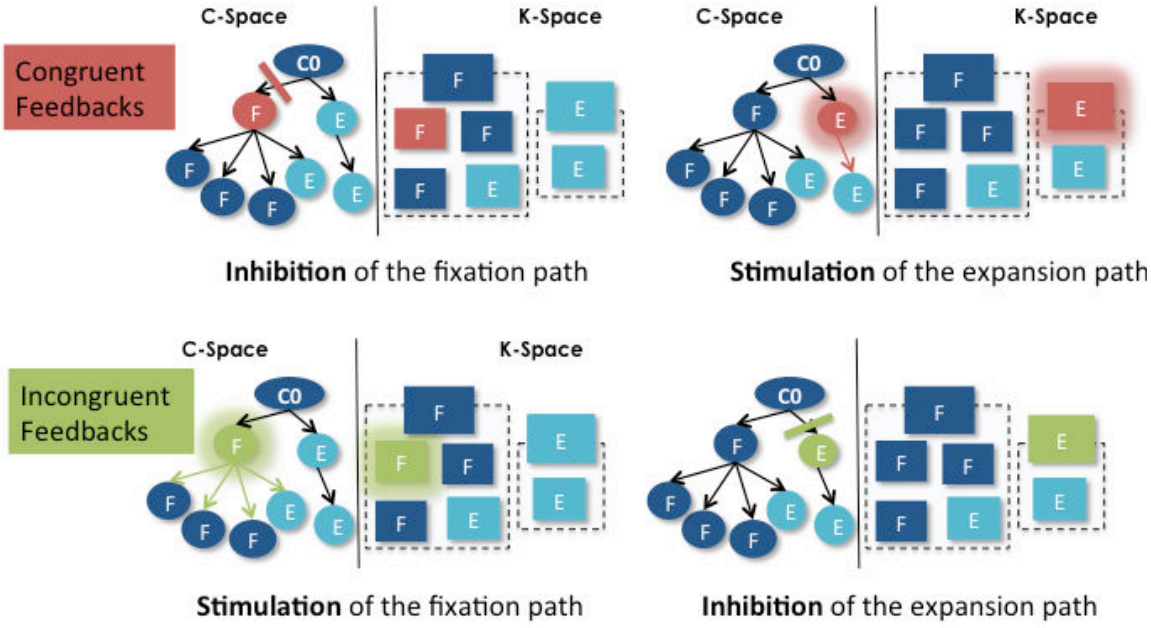


FIGURE 43: THE EFFECTS OF DIRECTIVE FEEDBACKS ON FIXATION IN C-K SPACES

We reasoned that if creative idea generation requires the inhibition of the intuitive path to the solution that leads to the fixation effect, as posited by the dual process model of creativity and the C-K theory, then the directive executive feedback should affect the participants' performances relative to a control condition that involved no instructive feedback (i.e., "I confirm the receipt of your idea").

As illustrated in the figure above in the C-K spaces, the **congruent executive feedback should improve performance by facilitating the inhibition of ideas within fixation and stimulating the exploration of ideas in expansion, whereas the incongruent executive feedback should impair performance by interfering with the inhibition of uncreative ideas that lead to fixation and stimulating the exploration of ideas within the fixation path**.

We illustrated in the figure below both the strategies of the congruent (in red color) and incongruent (in green color). According to the leadership-driven ideation model, the **congruent should increase the probability of defixation (1-α) and decrease the probability of re-fixation (1-β)**. On the contrary, the **incongruent should decrease the probability of defixation and increase the probability of re-fixation**.

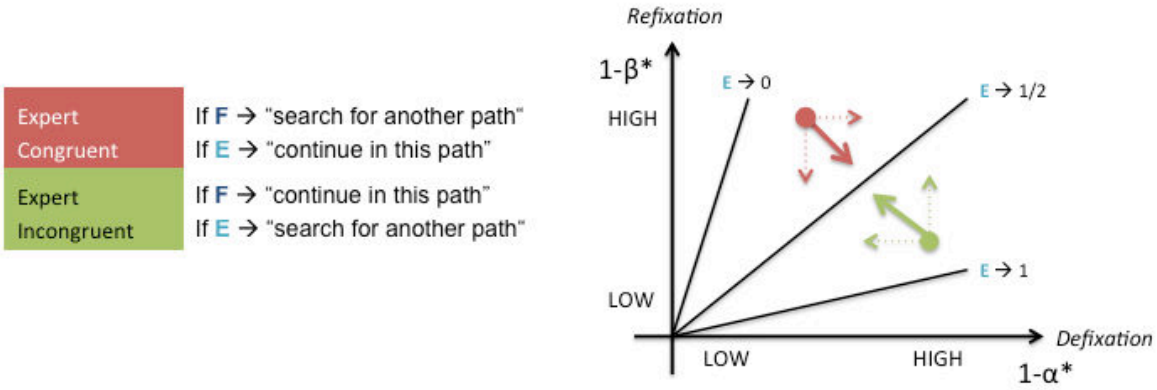


FIGURE 44: THEORETICAL PREDICTIONS OF "DEFIXATOR LEADER 3" ACCORDING TO LEADERSHIP-DRIVEN IDEATION MODEL

Our theoretical predictions for the theory-driven model 3 are as follows:

H3A: Congruent "defixator leaders 3" should mitigate fixation since they increase the expansion rate of their teams

H3B: Incongruent "defixator leaders 3" should reinforce fixation since they decrease the expansion rate of their teams

V. Derived Theory-driven Model IV for "Defixator Leaders 4": Directive Feedbacks to Lead Ideation outside Fixation Depending on Teams' Ideas with Imperfect Knowledge

1. Attenuating the Competencies of "Defixator Leaders 4"

The fourth types of defixator leaders that were designed were called "defixator leaders 4". In the derived theory-driven model 4, we attenuated the competencies of "defixator leaders 4" compared to the competencies of "defixator leaders 3" (who were able to perfectly recognize if an idea was inside fixation or outside fixation). In fact, we assumed that **"defixator leaders 4" are less competent than "defixator leaders 3", since the first is imperfectly capable to recognize if ideas are inside or outside fixation**.

It is worth pointing out that "defixator leaders 3" (designed in the previous section) need to recognize perfectly if the ideas generated by their teams are inside or outside fixation in order to defixate them. This implies that **defixator leaders still have relatively high level of knowledge**.

Therefore, the research question for the derived theory-driven model 4 could then be as follows: **what if defixator leaders didn't have the perfect ability to recognize if the ideas generated by their teams were inside or outside fixation**, how could defixator leaders intervene during the ideation process of their teams using directive feedbacks with a lower capacity of recognition?

2. State of the Art: The Role of Knowledge, Evaluation and Fixation Recognition for Creativity

In the derived theory-driven model 4, we **decreased the competencies of "defixator leaders 4" compared to "defixator leaders 3"** but did not change their means of actions during the ideation process. In order to do that, we imagined that "defixator leaders 4" would participate intensively during the ideation process using directive feedbacks (similarly to "defixator leaders 3") but would imperfectly be able to recognize if an idea is in the fixation path or in the expansion path. This fourth model would emphasize the contingency nature of our figures of defixator leaders. In fact, in certain situations, particular defixator leaders could be effective in helping their teams overcome fixation, while in other they can fail to help their teams overcome fixation. In the present derived model, we explore the effect of feedbacks, in specific cases in which leaders "lead followers in the unknown" with imperfect knowledge.

The term "leading in the unknown" means how leaders can structure the exploration of unknown paths (Hooge, Agogué, & Gillier, 2012). Of course, the unknown can be desirable (expansion) or undesirable (fixation). We have implemented an experimental protocol, in which leaders had varying levels of knowledge (leaders' ability to recognize if a particular idea generated by his team is inside or outside fixation), and **interacted with their teams to help them overcome fixation, by driving them to generate the relevant or "desirable" unknown, i.e. ideas in expansion**.

Leaders' knowledge is a crucial factor in the evaluation of an idea. As mentioned in the previous section, we considered leaders' knowledge as the capacity of interpretation of the ideas generated by their teams. In other words, it is their ability to recognize that followers' ideas are in fixation (uncreative) or in expansion (creative). Of course, in real situations, **leaders could occasionally give their followers wrong feedbacks due to their incapacity to recognize if an idea is in fixation or outside fixation**.

People usually categorize or evaluate an idea as creative if it is both useful and novel (Amabile, 1983). However, **leaders could differ on the judgment of what is creative and what it is not according to their definition of creativity**. As we have mentioned in chapter V (section III), Amabile had suggested that reviewers or evaluators use their proper definition of creativity –

definition that is highly dependent on their knowledge – to evaluate creative ideas (Amabile, 1979). This definition is of course highly based on the criteria the evaluator set for what is creative or not creative. Magnusson et al. have studied the creative evaluation process further by investigating the intuitive evaluation capacity of evaluators in the assessment of creative ideas compared to formal specific criteria (Magnusson et al., 2016).

In addition, prior studies proposed that **domain knowledge could determine the recognition of creative ideas**, arguing that ideas that could be categorized as creative if it is considered new according to one's domain knowledge (Elsbach & Kramer, 2003). According to Sternberg and Lubart, one important aspect of creativity is the ability to recognize which ideas are worth pursuing and developing, and which are not (Sternberg & Lubart, 1991).

Studies have also shown that **leaders could simply fail to recognize creative ideas, and consequently reject them** (Mueller et al., 2011). Sometimes the rejection of creative ideas could be done due to risk or uncertainty. Otherwise, a number of errors and cognitive biases could also occur leading to incorrect evaluation of the creativity of an idea (Licuanan, Dailey, & Mumford, 2007).

Sternberg et al. argue that **recognizing and accepting an idea outside fixation is not an easy task for leaders**, considering that creative ideas could be rejected because "society generally perceives opposition to the status quo as annoying, offensive, and reason enough to ignore innovative ideas" (Sternberg & Lubart, 1995; Sternberg, Kaufman, & Pretz, 2003).

Moreover, it is important to point out that the **rejection of creative ideas is not always related to the incapacity of leaders to recognize them**. In fact, in their conceptual model of what constitutes an idea, Sukhov et al. argue that the lack of elaboration of a potentially good idea can also be an important factor to reject it (Sukhov et al., 2015).

However, in the present derived theory-driven model, we argue that **recognizing creative ideas does not necessarily mean recognizing uncreative ideas**. Leaders could be very good at recognizing the dominant design of a project, and have the strategy to deviate their teams from the dominant design. Other leaders could be excellent at identifying what is creative, and outside the dominant design but hesitant vis-à-vis of uncreative ideas. The question would consist of better understanding how this capacity of recognition of leaders would affect the fixation of their teams?

3. Designing "Defixator Leaders 4": Feedback Depending on the F/E Type of Generated Idea with Imperfect Knowledge of F/E Type

As illustrated in the figure below, **"defixator leaders 4" have the same means of actions as "defixator leaders 3". However, they differ in their competencies in recognizing if an idea is in the**

fixation path or outside it. They could wrongly interpret the state of the idea, and consequently mislead their teams in certain situations (see figure below).

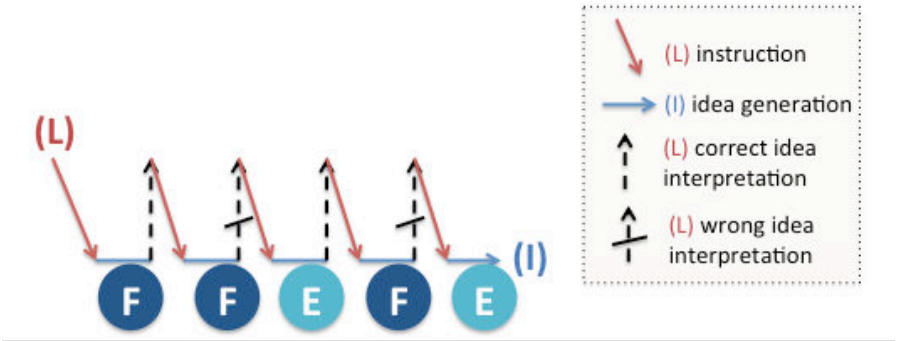


FIGURE 45: MEANS OF ACTIONS OF "DEFIXATOR LEADER 4"

In the present derived theory-driven model, the aim was to examine **how congruent "defixator leaders 4" could provide their teams with directive feedbacks, in specific cases in which leaders lead followers in the unknown with imperfect knowledge**. According to various levels of knowledge (capacity to recognize if an idea is in fixation or expansion), we derived three types of imperfect defixator leaders:

- **Random defixator leaders 4**: if the idea generated by their teams is in fixation, the random leaders would half of the time recognize it correctly and give negative feedback ("search for another path"), while the other half they would fail to recognize it and give positive feedback ("continue in this path"). Similarly, if the idea generated by their teams is in expansion, they would half of the time recognize it correctly and give positive feedback, while the other half they would fail to recognize it and give negative feedback.
- **Expansion-expert defixator leaders 4**: if the idea generated by their teams is in fixation, the expansion-expert leaders would half of the time recognize it correctly and give negative feedback, and the other half they would fail to recognize it and give positive feedback. However, if the idea generated by their teams is in expansion, they would recognize it perfectly and give positive feedback.
- **Fixation-expert defixator leaders 4**: If the idea generated by their teams is in fixation, the fixation-expert leaders would recognize it perfectly and give negative feedback. However, if the idea generated by their teams is in expansion, they would half of the time recognize it correctly and give positive feedback, while the other half they would fail to recognize it and give negative feedback.

We illustrated in the figure above both the strategies of the random (in orange color), expansion-expert (in red color) and fixation-expert (in green color). According to the leadership-driven ideation model, **a creative leader should manage followers to force them to defixate (pushing the arrow right-side) and avoid their re-fixation (maintain expansion by pushing the arrow downside)**. Moreover, one could note interesting situational strategies to manage leadership-driven ideation:

- Random: if leaders **have imperfect knowledge of both fixation and expansion** (low γ, and low σ), they won't be able to push followers towards defixating them, and they won't be able as well to maintain expansion if followers are defixated (see orange arrow in the figure).
- Expansion-expert: if leaders **have perfect knowledge of expansion** (low γ, and high σ), they won't be able to push followers towards defixating them but they would be able to maintain expansion if followers are defixated (see red arrow in the figure). These leaders would be more adequate if confronted with defixated ideators (ideators type D or B)
- Fixation-expert: if leaders **have perfect knowledge of fixation** (high γ, and low σ), they would be able to push followers towards defixating them but won't necessarily help them to maintain expansion if followers are defixated (see green arrow in the figure). These leaders would be more adequate if confronted with fixated ideators (ideators type A or C)

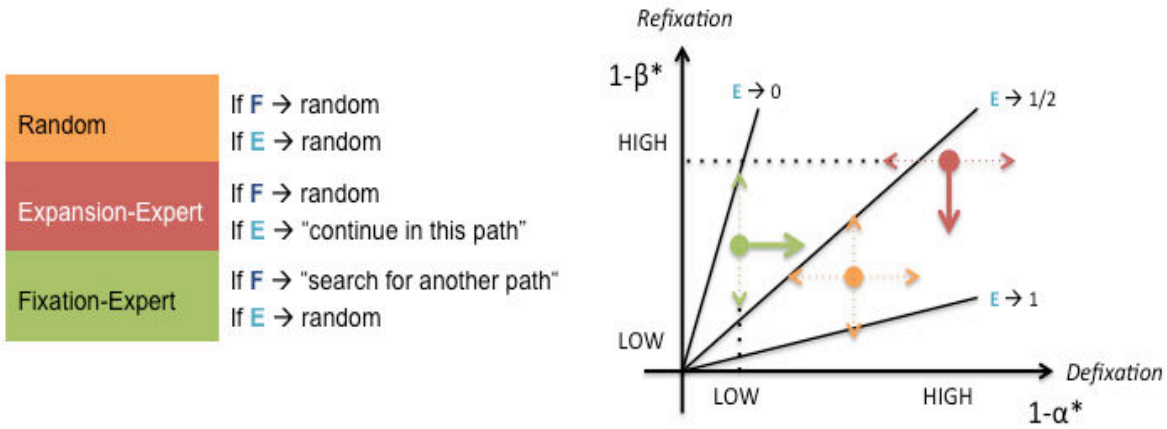


FIGURE 46: THEORETICAL PREDICTIONS OF "DEFIXATOR LEADER 4" ACCORDING TO LEADERSHIP-DRIVEN IDEATION MODEL

In line with the above, one could say that the theoretical predictions of "defixator leaders 4" differ from the three other defixator leaders (1, 2 and 3), in a way that it should take into consideration whether the participants are more or less fixated or defixated. A contingency variable is then added to our equation: the type of ideators (types A, B, C or D).

Accordingly, our theoretical predictions for the theory-driven model 4 are as follows:

H4A: Random "defixator leaders 4" should have the lowest expansion rate regardless of their teams' creative ideation performance (fixated or defixated)

H4B: Expansion-expert "defixator leaders 4" should have high expansion rate if their teams are more or less defixated (ideators type D or B)

H4C: Fixation-expert "defixator leaders 4" should have high expansion rate if their teams are more or less fixated (ideators type A or C)

In the next chapter, the objective would be now to **experiment each of these four figures of defixator leaders to confirm/refute the nine theoretical predictions** extracted from the four derived theory-driven models, as stated above in the present chapter.

VI. Summary of Chapter VI

Below is a summary box presenting the key points of chapter VI:

Figure of Leaders	Means of Actions of the Defixator Leader	Minimal Competencies of the Defixator Leader	Theoretical Predictions
Defixator Leaders 0	Provide teams with an initial instruction	Formulate an example in the expansive path	(Agogué et al., 2014a)
Defixator Leaders 1	Provide teams with an initial instruction	Formulate warnings on examples in the fixation path either with high or low level of specificity	H1A/H1B
Defixator Leaders 2	Provide teams with repetitive feedbacks	No prerequisite knowledge	H2A/H2B
Defixator Leaders 3	Provide teams with directive feedbacks	Perfectly recognize if an idea is in fixation or expansion	H3A/H3B
Defixator Leaders 4	Provide teams with directive feedbacks	Imperfectly recognize if an idea is in fixation or expansion	H4A/H4B/H4C

Chapter VII: Experimenting The New Figures of Defixator Leader

In chapter VII, we experiment each of the four figures of defixator leaders presented in the chapter VI. In this chapter, we present the statistical results in terms of fluency/flexibility/originality, fixation/expansion scores, as well as transition probabilities parameters based on our instrument to measure creative ideation performance presented in chapter V. We end this chapter by discussing our results.

I. Theory-driven Experiment I for "Defixator Leaders 1": Initial Instructions to Close Out Teams' Solution Space in Fixation

1. Theoretical Hypothesis

The theoretical predictions for the derived theory-driven model 1 as stated in the previous chapter are as follows:

***H1A**: If "defixator leaders 1" instruct their teams to avoid using examples in fixation – at a high level of specificity –, it should reinforce fixation.*

***H1B**: If "defixator leaders 1" instruct their teams to avoid using examples in fixation – by framing those examples at a more abstract level, such as a categorization of these examples –, it should mitigate fixation.*

2. Method

2.1. Participants

Seventy-five participants of an introductory course of innovation design entitled "Products Design and Innovation" were recruited for this study. The course was given during one week at Mines ParisTech. The experiment was made at the very beginning of the course, and therefore the content of the course had no influence on the performance of the participants. **Subjects were engineering students and experts working in innovation fields (91 % of the subjects were engineering students, while 9 % were experts)**. Participants (69 % men) were between 19 and 58 years old, with a mean age of 25.6 years, and a standard deviation of 6.9 years.

2.2. Procedure

In the present experiment, we considered the experimenter playing the role of team leader. **The leader (the experimenter) could only act once by providing his/her team (the participants) with an initial instruction prior to a creativity task**. The leader had very limited means of actions since he/she could not participate in the work with his/her team.

Each subject was given exactly ten minutes to perform individually the hen's egg task. Individuals had to write down on a sheet of paper all the solutions they could come up with, and were prohibited to talk to each other. Participants were randomly assigned to one of three groups: control, "abstract" or "specific" (as shown in the table below). Each participant **was given different constraints based on the group they belonged to.**

TABLE 2: "DEFIXATOR LEADERS 1" INITIAL INSTRUCTIONS PER GROUPS

Groups	**"Defixator Leaders 1" initial instructions**
Group Control (N=25) "Without constraints"	"You are a designer and your manager gives you the following problem: Ensure that a hen's egg dropped from a height of 10m does not break **The evaluation of your manager will be based on the number of original ideas that you will propose**"
Group "Abstract" (N=25) "With constraints on Abstract examples"	"You are a designer and your manager gives you the following problem: Ensure that a hen's egg dropped from a height of 10m does not break **The evaluation of your manager will be based on the number of original ideas that you will propose, knowing that your solutions must not dampen the shock, nor slow the fall, nor protect the egg**"
Group "Specific" (N=25) "With constraints on Specific examples"	"You are a designer and your manager gives you the following problem: Ensure that a hen's egg dropped from a height of 10m does not break **The evaluation of your manager will be based on the number of original ideas that you will propose, knowing that your solutions must not use mattress, nor parachute, nor bubble wrap**"

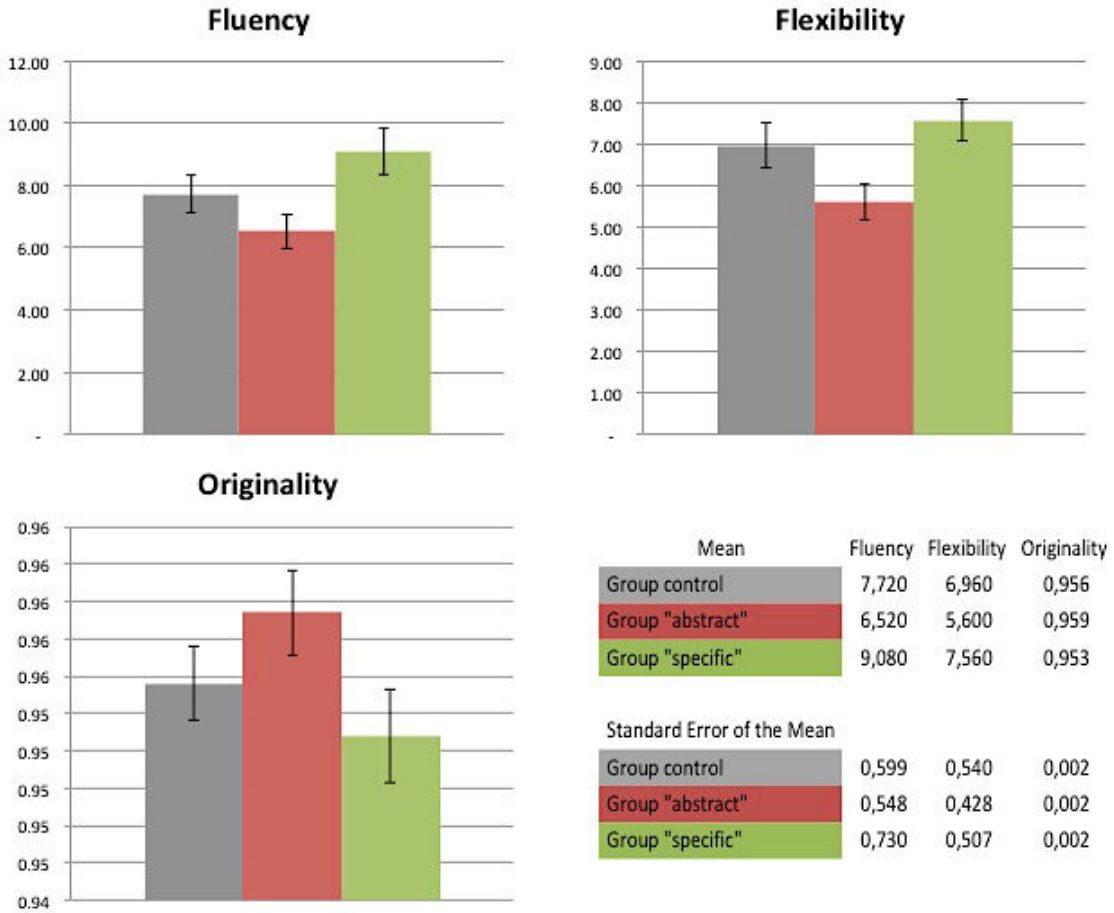
The group control was provided with a guideline stating that: "**The evaluation of your manager will be based on the number of original ideas you will propose**". This guideline was considered neutral since it is the habitual instruction given to participants performing the hen's egg task.

Participants of the group "abstract" were provided with another guideline, **imposing constraints on an abstract level of the examples inside fixation**, namely the three categories of solutions in fixation (damping the shock, slowing the fall, and protecting the egg).

Participants of the group "specific" were provided with a different guideline, **imposing constraints on a specific level of the examples inside fixation**. The three specific examples (mattress for damping the shock, parachute for slowing the fall, and bubble wrap for protecting the egg) were precisely chosen among others, due to the fact that they were the most generated examples in each of the three categories of fixation according to the database of participants that performed this task in the past five years.

3. Experimental Results

3.1. Fluency/Flexibility/Originality



Mean	Fluency	Flexibility	Originality
Group control	7,720	6,960	0,956
Group "abstract"	6,520	5,600	0,959
Group "specific"	9,080	7,560	0,953

Standard Error of the Mean			
Group control	0,599	0,540	0,002
Group "abstract"	0,548	0,428	0,002
Group "specific"	0,730	0,507	0,002

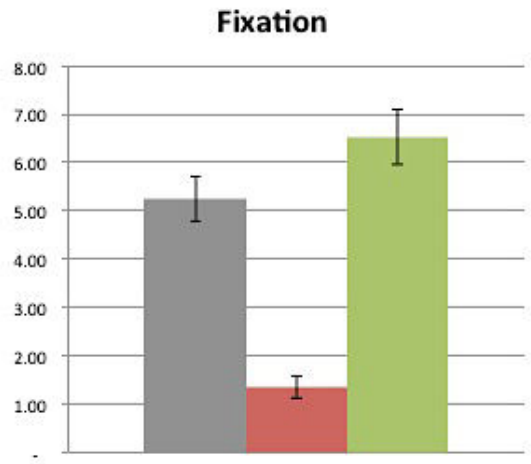
FIGURE 47: FLUENCY/FLEXIBILITY/ORIGINALITY SCORES FOR "DEFIXATOR LEADER 1"

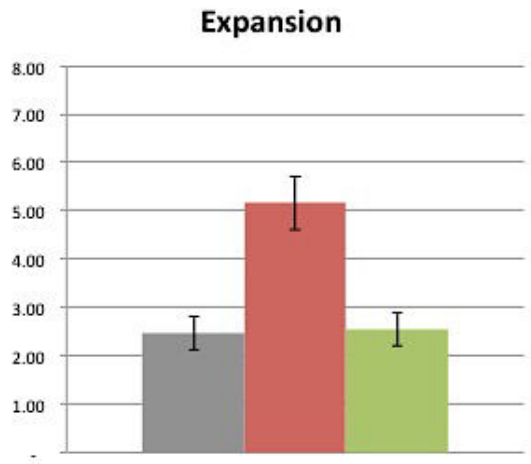
As can be seen in the figure above, in terms of fluency (mean number of ideas generated by participants in each group), we could notice that the **fluency was decreased for the group "abstract" (red color), and increased for the group "specific" (green color)**.

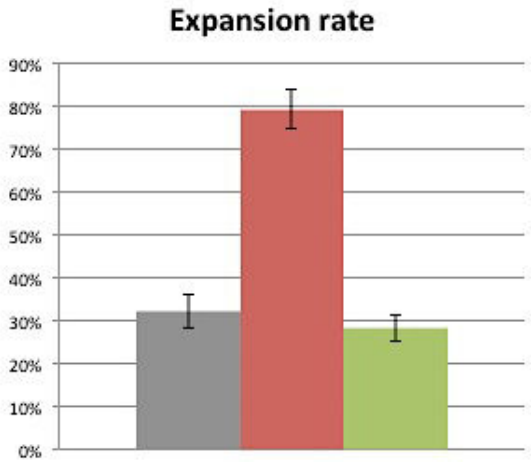
Similarly, in terms of flexibility (mean number of different types of ideas generated by participants in each group) the **group "abstract" obtained a slightly lower flexibility score than the two other groups.**

Finally, in terms of originality of solutions (frequency of occurrence of categories of solutions given across all the subjects in each group), the **group "abstract" was slightly more original than the group "specific"**.

3.2. Fixation/Expansion Score







Mean	Fixation	Expansion	Expansion rate
Group control	5,240	2,480	0,321
Group "abstract"	1,360	5,160	0,791
Group "specific"	6,520	2,560	0,282

Standard Error of the Mean			
Group control	0,470	0,356	0,038
Group "abstract"	0,230	0,552	0,046
Group "specific"	0,560	0,348	0,031

FIGURE 48: FIXATION/EXPANSION SCORES FOR "DEFIXATOR LEADER 1"

Measurement of the fixation score (mean number of ideas and solutions that individuals were able to generate inside the fixation zone) showed that the number of **solutions inside fixation was reduced to approximately a quarter for the participants of the group "abstract".** However, the number of **solutions inside fixation was slightly increased for the group "specific".**

Measurement of the expansion score (mean number of ideas and solutions that individuals were able to generate outside the fixation zone) showed that the number of **solutions inside expansion was approximately doubled for the participants of the group "abstract"**. However, there were **no significant effects of the group "specific" vis-à-vis of the group control**.

Similarly, in terms of expansion rate (rate of solutions in the expansion zone), results clearly show **a dominant effect of the group "abstract" compared to both the group control and "specific"**.

In addition, in order to examine whether the number of proposed solutions (ideational fluency) inside fixation (fixation) and outside fixation (expansion) varied according to the experimental conditions, **we conducted a repeated-measures analysis of variance (s) with the experimental conditions (specific; control and abstract) as a between-subjects factor and the category of solution (fixation vs. expansion) as a within-subjects factor**. We used the partial eta squared (η_p^2) and Cohen's d to assess the effect size.

The ANOVA revealed a main effect of the category of solution ($F(1, 72) = 7.83$, $p = .007$, $\eta_p^2 = .10$) indicating that the participants provided more solutions in the fixation path than in the expansion path. This analysis also showed a main effect of the experimental conditions ($F(2, 72) = 4.13$, $p = .02$, $\eta_p^2 = .10$). Moreover, there was a significant experimental conditions x category of solution interaction ($F(2, 72) = 48.06$, $p = .0000$, $\eta_p^2 = .57$, see figure below).

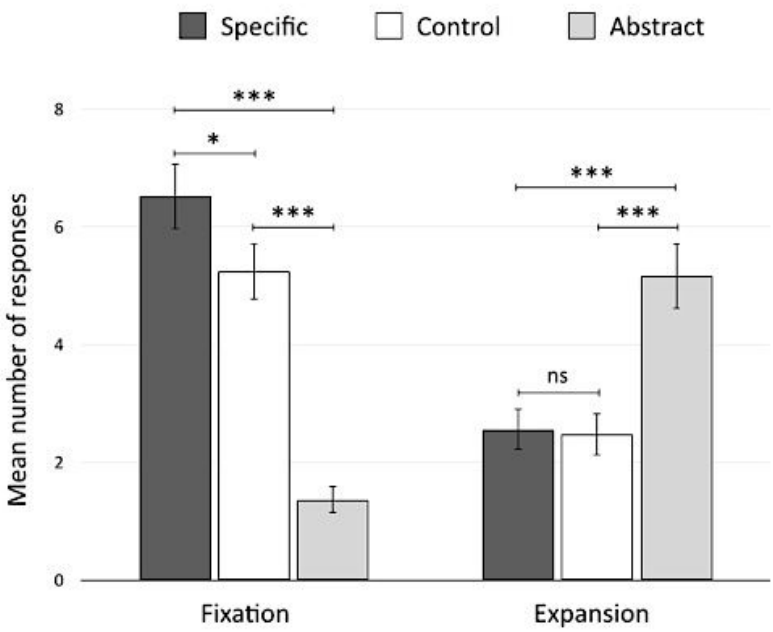
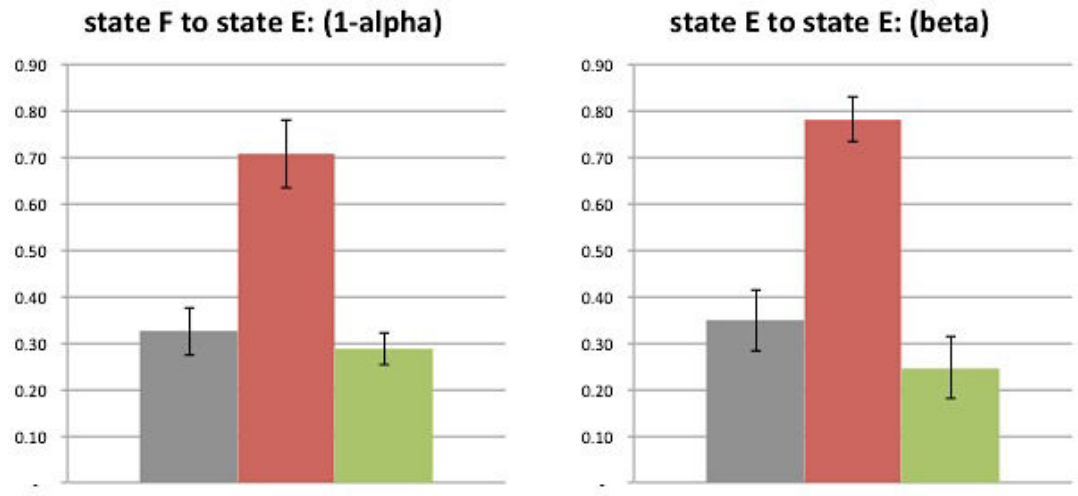


FIGURE 49: MEAN NUMBER OF SOLUTIONS ACCORDING TO THE EXPERIMENTAL CONDITION AND THE FIXATION/EXPANSION TYPE OF SOLUTION. ERROR BARS REPRESENT SEM: *<.05, ***<.0005, NS: NON SIGNIFICANT

Because main effects were modulated by the two-way interactions, we focused further analysis on the latter. **Planned comparisons, corrected with a Holm–Bonferroni procedure**, revealed no significant difference between the number of solutions in the expansion path in the control group (M = 2.48, SD = 1.78) and those in the group "specific" (M = 2.56, SD = 1.74, F(1/72) < 1, d = .04). However, participants of the group "abstract" (M = 5.16, SD = 2.76) proposed much more solutions in the expansion path compared to the control group (M = 2.48, SD = 1.78; F(1/72) = 19.48, p_{corr} = .0000, d = 1.15), and to the group "specific" (M = 2.56, SD = 1.74, F(1/72) = 18.34, p_{corr} = .0000, d = 1.13).

Interestingly, the participants of the group "abstract" (M = 1.36, SD = 1.15) proposed fewer solutions in the fixation path than did those in the control group (M = 5.24, SD = 2.35; F(1/72) = 38.43, p_{corr} = .0000, d = 2.1), as well as did the participants of the group "specific" (M = 6.52, SD = 2.8; F(1/72) = 67.97, p_{corr} < 0.0000, d = 2.41). Additionally, the group "specific" (M = 6.52, SD = 2.8) proposed more solutions in the fixation path than the control group (M = 5.24, SD = 2.35; F(1/72) = 4.18, p_{corr} = .04, d = .5).

3.3. Alpha/Beta Probabilities



Mean	1-α	β
Group control	0,325	0,347
Group "abstract"	0,706	0,780
Group "specific"	0,288	0,247

Standard Error of the Mean		
Group control	0,052	0,065
Group "abstract"	0,072	0,048
Group "specific"	0,035	0,066

FIGURE 50: MARKOV TRANSITION SCORES FOR "DEFIXATOR LEADER 1"

Statistical results of the probabilities alpha/beta of the two-state Markov chain showed that the participants of the group **"abstract" were able to approximately double both the probability of defixation 1-α, as well as the probability of maintaining expansion β**.

Moreover, we could notice that the probabilities **alpha/beta of the group "specific" did not differ that much from the probabilities alpha/beta of the group control**. However, a minor increase can be noticed for the participants of the group "specific" in terms of the probability of maintaining fixation α, as well as the probability of re-fixation 1-β.

4. Conclusion & Discussion: Efficient Instructions But Requiring High Levels of Competencies from "Defixator Leaders 1"

In the present experiment, we demonstrated that **according to the level of the specificity and abstraction of uncreative examples presented prior to a creative idea generation task, we could obtain opposite effects on fixation mitigation**.

The results confirmed hypothesis H1A: if "defixator leaders 1" instruct their teams to avoid using uncreative examples when formulated with high a level of specificity, they increase fixation, and therefore constrain teams' capacity to generate creative ideas. Similarly, **the results confirmed H1B**: if "defixator leaders 1" instruct their teams to avoid such examples while using a more abstract level for stating these uncreative examples – such as a categorization of these examples – they mitigate fixation, and consequently increase the number of creative ideas generated – and in quite a significant way.

More generally, statistical results show that **constraints on uncreative examples, formulated with a high level of specificity, slightly increase the number of solutions inside the fixation path** but however have no effect on the number of solutions outside the fixation path. However, statistical analysis showed that **constraints on uncreative examples, formulated with a high level of abstraction – such as a categorization of these examples –, approximately reduce the number of solutions inside the fixation path by more than one-third, and surprisingly double the number of solutions outside the fixation path**. Thus, the magnitude of the stimulation effect produced by explicit warning of not using certain categories is quite surprising and requires some discussion.

These findings first of all **confirm the studies regarding the negative role of examples for creativity** (Agogué et al., 2014a; Jansson & Smith, 1991; Smith et al., 1993), since the results of the group "specific" showed that the introduction of an uncreative example with a high level of

specificity could highly increase fixation effect, and therefore constrains the capacity of individuals to generate creative ideas.

Secondly, our findings add to the literature on **new practical procedures for defixator leaders to help their teams overcome fixation effects in creative ideation contexts** (Agogué et al., 2014a; Linsey et al., 2010; Moreno et al., 2015; Zahner et al., 2010), through the appropriate use of constraints and warnings. We demonstrate that two types of constraints could have opposite effects on fixation modulation, according to their level of specificity and abstraction. The more constraints on inappropriate examples are abstract, the more fixation effect is mitigated. Similarly, the more the constraints on inappropriate examples are specific, the more fixation effect is facilitated.

Thirdly, our findings raised more questions than what they contribute to, especially regarding the **crucial role of categorization in creative ideation contexts**. First of all, the present study confirms previous studies (Baughman & Mumford, 1995; Nagai & Taura, 2009; Ward et al., 2004) regarding the important role of abstraction for fixation mitigation. Furthermore, since we explicitly measure the number of solutions inside/outside the fixation path in the present experiments, using the statistical measurement of the variable "expansivity" (Agogué et al., 2015b), our findings present further evidence regarding the key role that could be played by categorization for fixation modulation and creativity.

Finally, from a purely managerial perspective, our findings are consistent with the view of the literature on expertise and categorization (Chi, Feltovich, & Glaser, 1981), arguing that experts have the skills to both recognize and restructure problems (Akin, 1990), in a way in which it allows them seeing the problem from a broader and more abstract view than novices. Additionally, it gives new sights for understanding how leaders could brief their teams through initial instructions in creativity situations, in a way they could help them to avoid falling into the cognitive trap of fixation, and stimulate their creative performance (Carson & Carson, 1993; Chaffois, Gillier, Belkhouja, & Roth, 2015; Runco et al., 2005a). We show that it is not sufficient and enough for leaders to simply impose constraints on unwanted ideas and solutions in creative projects for their teams but **leaders must have the ability to formulate these "generative" constraints at appropriate levels of abstraction, in a way that ensures fixation is majorly set aside, in order to open the way for creativity to flourish**.

In sum, the present experiment demonstrates that **uncreative examples – if formulated by defixator leaders in a high level of abstraction – can play a crucial role to help their teams overcome fixation effects occurring in creative idea generation situations**. Our results clearly suggest that the way the uncreative examples are formulated by the defixator leaders prior to a creativity task – either with specificity or abstraction – could have opposite effects on fixation. As a

result, the present study provides new sights to the literature on the positive and negative role of examples in creative ideation.

Initial instructions of "defixator leaders 1" (type "abstract") are very efficient as means of actions for defixation, however it **still requires high levels of competencies from the leader**.

II. Theory-driven Experiment II for "Defixator Leaders 2": Repetitive Feedbacks to Overcome Fixation Regardless of Teams' Ideas

1. Theoretical Hypothesis

The theoretical predictions for the derived theory-driven model 2 as stated in the previous chapter are as follows:

> ***H2A**: "Defixator leaders 2" changers should force their teams to change states (oscillate between fixation and expansion) more often than "defixator leaders 2" maintainers*
>
> ***H2B**: Both "defixator leaders 2" changers and maintainers should have no major effects on fixation*

2. Method

2.1. Participants

Forty undergraduates from Paris Descartes University participated in this study (26 men, mean age = 21.25 years, SD=3.71). Each participant was randomly assigned to one of the three following experimental conditions: **the control condition (n=20; 7 men), the changer condition (n=20; 10 men), and the maintainer condition (n=20; 9 men)**. ANOVA and chi-squared analyses indicated that the mean ages ($F(1, 38) < 1$) and gender distributions ($\chi 2 = 0.10$, $p=0.75$) did not differ significantly between the groups. All the participants provided written consent and were tested in accordance with national and international norms governing the use of human research participants. The institution that granted permission for the following experiments is the faculty of psychology of the University of Paris Descartes.

2.2. Procedure

The participants sat alone in an experimental room in front of a computer and were asked to wait for **the experimenter to contact them via a text (written) chat conversation using Skype**. The

experimenter (playing the role of leader) initiated the chat conversation and provided the following initial brief to the subject: "**design a process that allows by which a hen's egg that is dropped from a height of ten meters does not break**". Each subject was then instructed by the experimenter to write down, in the chat conversation, the maximum number of original ideas they could generate to solve this problem. The task duration was set to 10 minutes exactly per participant.

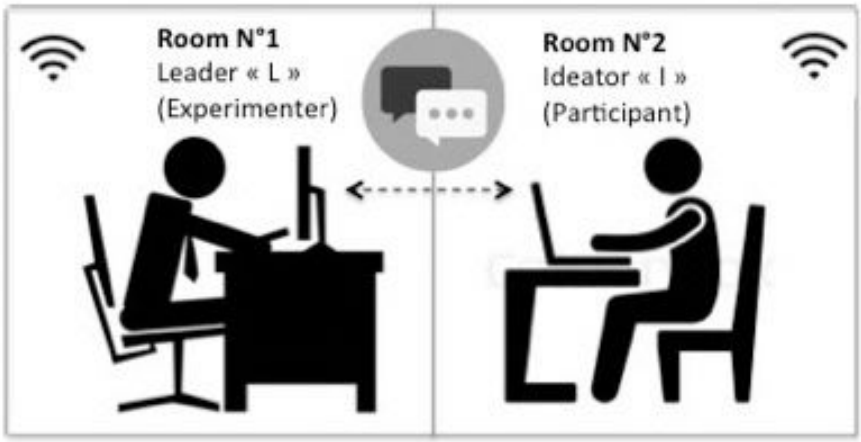


FIGURE 51: EXPERIMENTAL PROCEDURE FOR "DEFIXATOR LEADER 2"

We used and existing database of solutions that were collected over the last five years (Agogué et al., 2014a). Each participant was randomly assigned to one of the three following groups:

TABLE 3: "DEFIXATOR LEADERS 2" REPETITIVE FEEDBACKS PER GROUPS

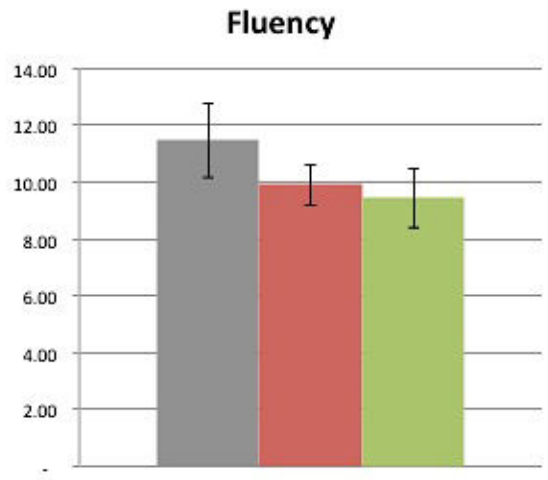
Groups	"Defixator Leaders 2" Repetitive Feedbacks	
	If idea = Fixation	If idea = Expansion
Group Control (N=20)	"I confirm the receipt of your idea and await the next idea."	"I confirm the receipt of your idea and await the next idea."
Group "Changer" (N=20)	"Continue in this path."	"Continue in this path."
Group "Maintainer" (N=20)	"Search for another path."	"Search for another path."

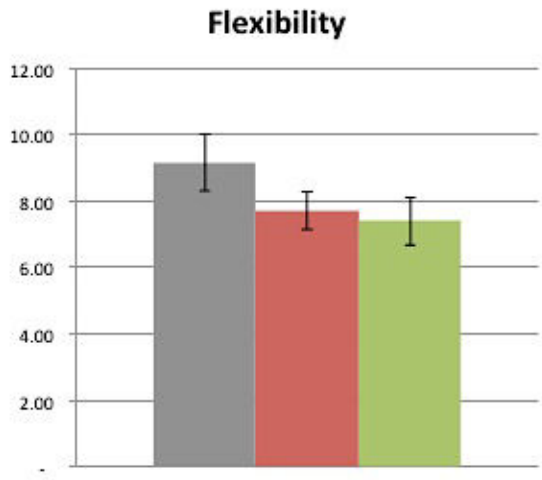
Indeed, for the participants in the group control, the feedback provided after the generation of each idea was "**I confirm the receipt of your idea and await the next idea**". We considered this feedback to be neutral vis-à-vis of the two other groups' feedbacks. For the participants of the group "changer", the feedback provided after the generation of each idea was "**search for another path**"

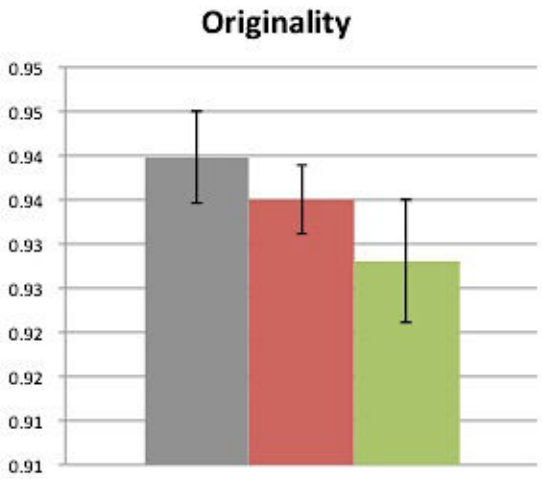
regardless of the type of idea proposed. In contrast, for the participants in the group “maintainer”, the feedback provided was “**continue in this path**” regardless the idea proposed.

3. Experimental Results

3.1. Fluency/Flexibility/Originality







Mean	Fluency	Flexibility	Originality
Group control	11,450	9,150	0,940
Group "changer"	9,900	7,700	0,935
Group "maintainer"	9,430	7,400	0,928

Standard Error of the Mean			
Group control	1,295	0,847	0,005
Group "changer"	0,732	0,558	0,004
Group "maintainer"	1,036	0,727	0,007

FIGURE 52: FLUENCY/FLEXIBILITY/ORIGINALITY SCORES FOR "DEFIXATOR LEADER 2"

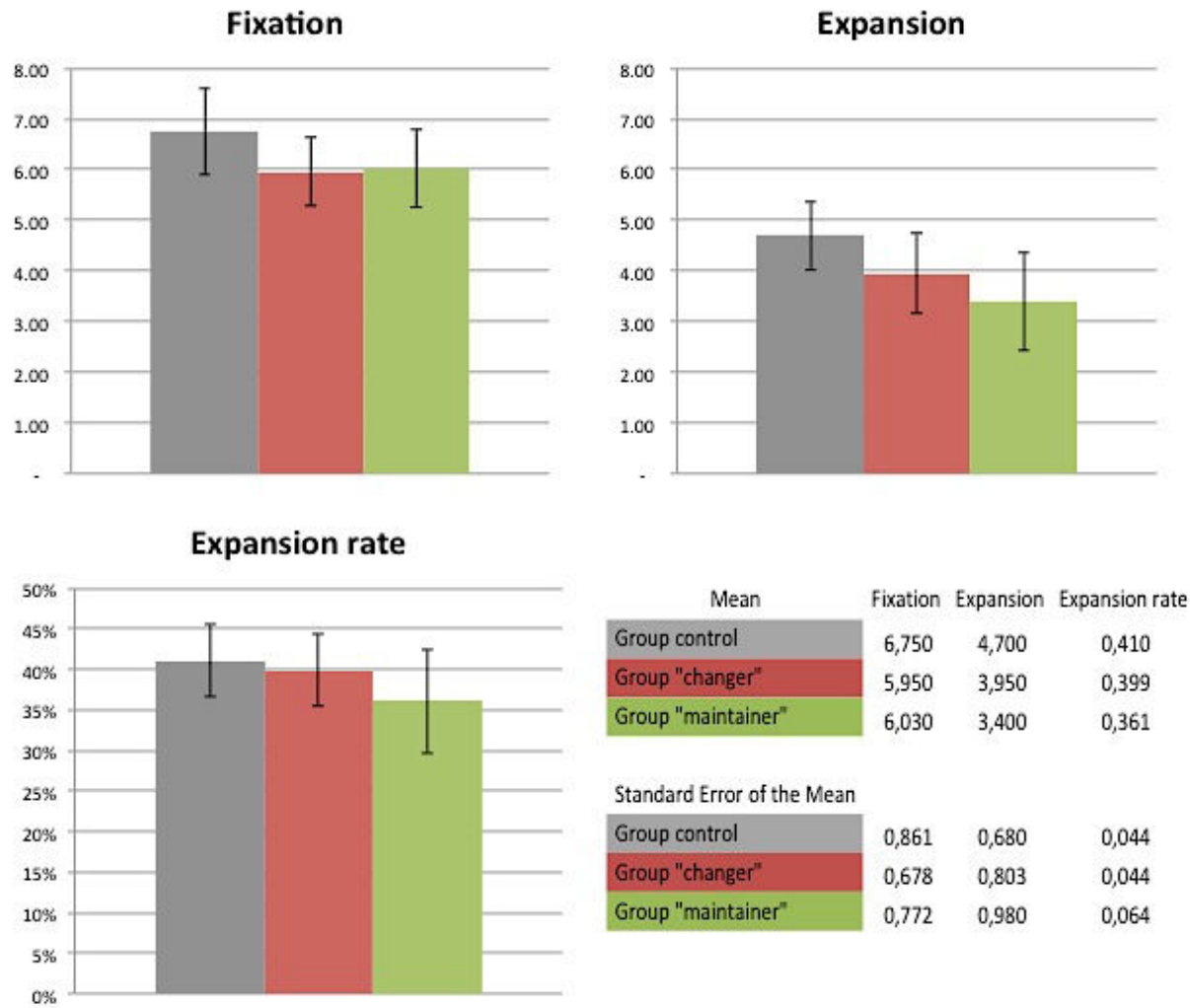
In terms of fluency, one could notice that the groups **“changer” (in red color) and “maintainer” (in green color), similarly obtained a mean number of ideas that is insignificantly lower than the group control** because of the standard error of the mean.

In terms of flexibility, if we compare to the group control, one could notice a **slight diminution in the number of ideas generated across different categories of solutions for both the**

groups "changer" and "maintainer". However, there were no significant changes in terms of flexibility between the two groups "changer" and "maintainer".

Finally, in terms of originality of solutions, t**he group "maintainer" was insignificantly the lowest original compared to the two other groups**.

3.2. Fixation/Expansion Score



Mean	Fixation	Expansion	Expansion rate
Group control	6,750	4,700	0,410
Group "changer"	5,950	3,950	0,399
Group "maintainer"	6,030	3,400	0,361

Standard Error of the Mean			
Group control	0,861	0,680	0,044
Group "changer"	0,678	0,803	0,044
Group "maintainer"	0,772	0,980	0,064

FIGURE 53: FIXATION/EXPANSION SCORES FOR "DEFIXATOR LEADER 2"

Similarly to the fluency/flexibility/originality scores, **no significant results could be extracted from the statistical analysis of the fixation/expansion score**.

Measurement of the fixation/expansion scores showed that the **mean number of ideas and solutions that individuals were able to generate inside or outside the fixation zone (i.e. inside the expansion zone) did not significantly change** across the three groups.

Similarly, the expansion rate clearly confirms this insignificance. **No significant outcomes can be extracted from the expansion rate** analysis between the three groups.

In addition, to examine whether the number of proposed solutions (i.e., fluency) within the fixation path (fixation) and outside the fixation path (expansion) varied according to the experimental conditions, **we conducted a repeated-measures analysis of variance (ANOVA) with the experimental condition (search for another path vs. continue in this path) as a between-subjects factor and the category of solution (fixation vs. expansion) as a within-subjects factor, and we used the partial eta squared (η_p^2) and Cohen's d to examine the effect size**.

This analysis revealed a main effect of the solution category ($F(1, 38) = 5.53$, $p = .02$, $\eta_p^2 = .13$, Power = .63, see figure below) that indicated that the participants provided more solutions in the fixation path (M = 5.9, SD = 3.03) than in the expansion path (M = 3.9, SD = 3.59). There was no main effect of the experimental condition ($F(1, 38) < 1$), nor significant experimental condition x category of solution interaction ($F(1,38) < 1$).

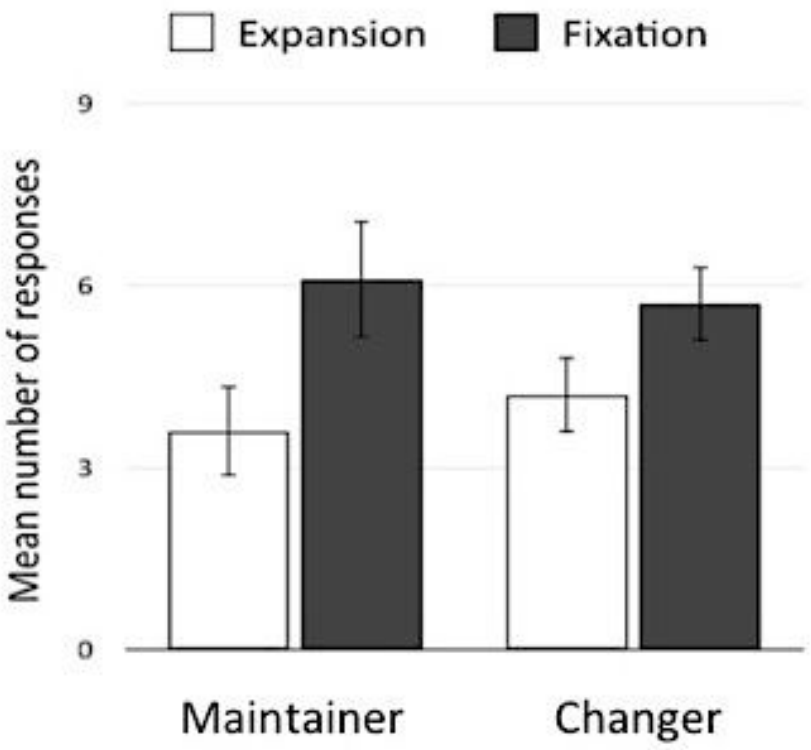
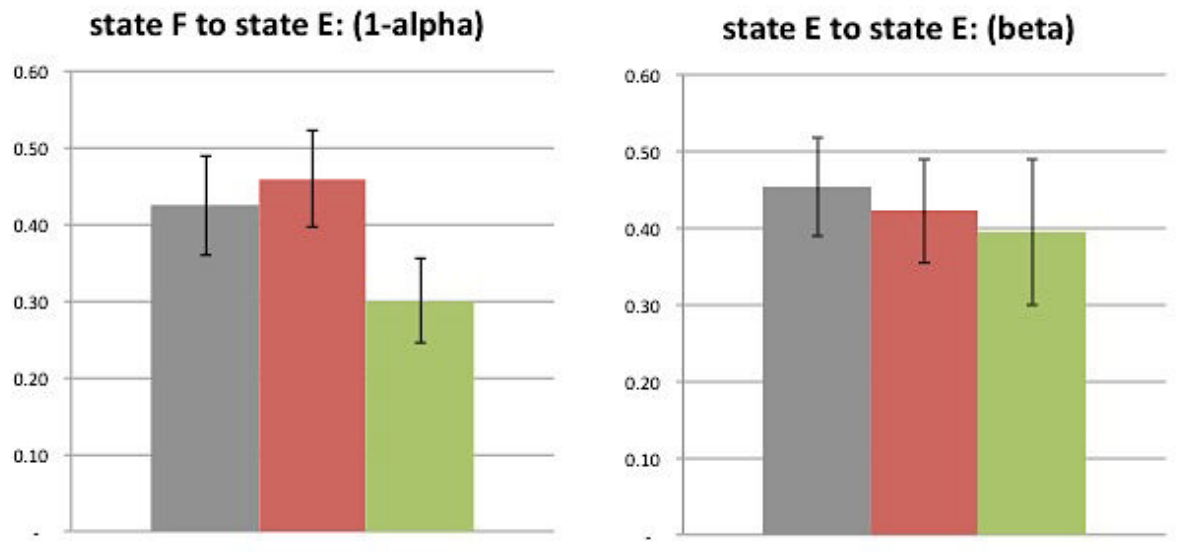


FIGURE 54: MEAN NUMBER OF SOLUTIONS ACCORDING TO THE EXPERIMENTAL CONDITION AND THE FIXATION/EXPANSION TYPE OF SOLUTION.

3.3. Alpha/Beta Probabilities



Mean	1-α	β
Group control	0,425	0,454
Group "changer"	0,459	0,421
Group "maintainer"	0,300	0,393

Standard Error of the Mean		
Group control	0,065	0,065
Group "changer"	0,063	0,067
Group "maintainer"	0,055	0,095

FIGURE 55: MARKOV MODEL TRANSITION SCORES FOR "DEFIXATOR LEADER 2"

Statistical results of the probabilities alpha/beta of the two-state Markov chain show that the participants of the group **"maintainer" were able to decrease the probability of defixation 1-α**. However, no significant changes could be detected for the probability of maintaining expansion β.

However, the group **"changer" insignificantly increased the probability of defixation 1-α**. However, no significant changes could be detected for the probability of maintaining expansion β.

4. Conclusion & Discussion: No Effects of "Defixator Leaders 2" Leading Regardless of Teams' Ideas

In this experiment, we explored the effects of "defixator leaders 2" repetitive feedbacks on their teams' creative idea generation capacity. Both participants of groups **"changer" and "maintainer" were having leaders that permanently send them the same stimuli regardless of the**

type of ideas generated: subjects of group "changer" always received the same stimulus "search for another path", and subjects of group "maintainer" received the same stimulus "continue in this path", and this was done throughout the complete task duration.

Interestingly, the **hypothesis H2A was partially confirmed** since the group "maintainer" forced followers to stay and remain in the state of fixation, and that the group "changer" insignificantly forced subordinates to defixate, i.e. change from state fixation to expansion.

However, **the hypothesis H2B was confirmed** since both "defixator leaders 2" changers and maintainers did not have effects on fixation.

In sum, results showed that "defixator leaders 2" repetitive feedbacks were able to: **(i) apply a perturbation on the fluency and flexibility (and in quite an insignificant way originality as well) scores of both participants of groups "changer" and "maintainer"; (ii) maintain the participants of the group "maintainer" in fixation, and defixate the participants of the group "changer"**.

From a management sciences perspective, these results confirm the point of view of most management scholars and academics that leaders should grant more freedom and autonomy to their followers in order for creativity to emerge, since **defixator leaders' repetitive feedbacks "without knowledge at all" (i.e. without any capacity to recognize whether the idea is inside or outside fixation) and clear vision (in which direction to lead) noticeably obstructed the generation capacity of their teams**.

III. Theory-driven Experiment III for "Defixator Leaders 3": Directive Feedbacks to Lead Ideation outside Fixation Depending on Teams' Ideas with Perfect Knowledge

1. Theoretical Hypothesis

The theoretical predictions for the derived theory-driven model 3 as stated in the previous chapter are as follows:

> ***H3A**: Congruent "defixator leaders 3" should mitigate fixation since they increase the expansion rate of their teams*
>
> ***H3B**: Incongruent "defixator leaders 3" should reinforce fixation since they decrease the expansion rate of their teams*

2. Method

2.1. Participants

Sixty undergraduates from Paris Descartes University participated in this study (32 men, mean age = 20.5 years, SD = 2.62). Each participant was randomly assigned to one of the three following experimental conditions: **congruent executive feedback** (n = 20; 13 men), **incongruent executive feedback** (n = 20; 12 men), and a **control group that received neutral feedback** (n = 20; 7 men). ANOVA and chi-squared analyses indicated that the mean ages ($F(1,57) < 1$) and gender distributions ($\chi 2 = 1.70$, $p = 0.12$) did not differ significantly between the groups. Similarly, as the previous theory-driven experiment, all the participants provided written consent and were tested in accordance with national and international norms governing the use of human research participants.

2.2. Procedure

The procedure was similar to the one used in theory-driven experiment 2 except that the feedback provided by the defixator leader depended on the idea generated by the participants. **Two experimenters were trained before the experiment to identify whether a generated idea belonged to fixation or expansion.**

TABLE 4: "DEFIXATOR LEADERS 3" DIRECTIVE FEEDBACKS PER GROUPS

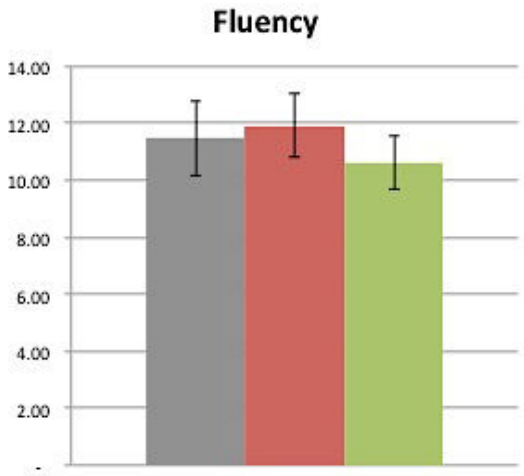
Groups	"Defixator Leaders 3" Directive Feedbacks	
	If idea = Fixation	**If idea = Expansion**
Group Control (N=20)	"I confirm the receipt of your idea and await the next idea."	"I confirm the receipt of your idea and await the next idea."
Group "Congruent" (N=20)	"Search for another path."	"Continue in this path."
Group "Incongruent" (N=20)	"Continue in this path."	"Search for another path."

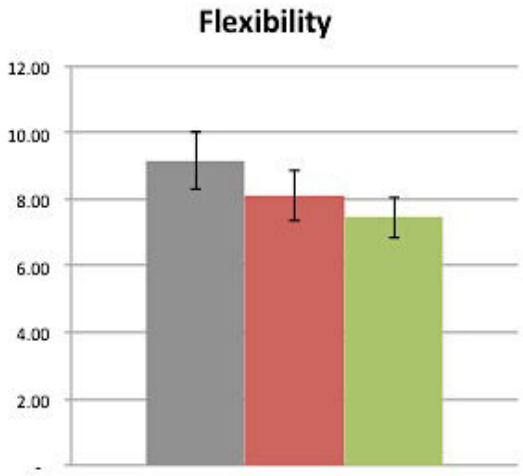
The participants in the control group received neutral feedback that simply acknowledged the reception of an idea generated by the ideator and awaited the next idea. For the participants in the congruent executive feedback group, **if the generated idea was in the fixation path, the feedback provided was "search for another path"; in contrast, if the generated idea was in the expansion path, the provided feedback was "continue in this path"**. In contrast to the congruent executive feedback group, for the participants in the incongruent executive feedback group, **if the generated**

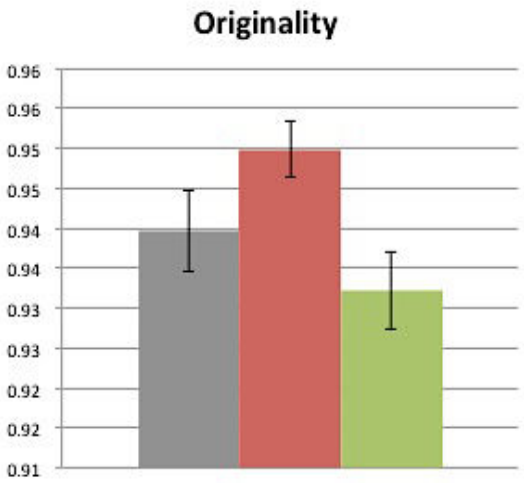
idea was in the expansion path, the provided feedback was "search for another path"; in contrast, if the generated idea was in the fixation path, the provided feedback was "continue in this path".

3. Experimental Results

3.1. Fluency/Flexibility/Originality







Mean	Fluency	Flexibility	Originality
Group control	11,450	9,150	0,940
Group "congruent"	11,900	8,100	0,950
Group "incongruent"	10,600	7,450	0,932

Standard Error of the Mean			
Group control	1,295	0,847	0,005
Group "congruent"	1,119	0,750	0,004
Group "incongruent"	0,916	0,613	0,005

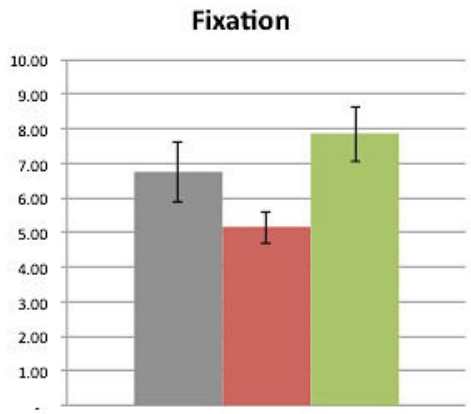
FIGURE 56: FLUENCY/FLEXIBILITY/ORIGINALITY SCORES FOR "DEFIXATOR LEADER 3"

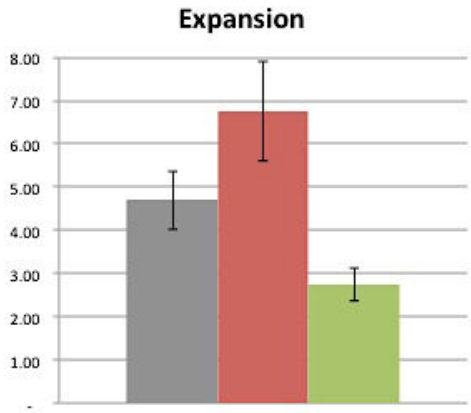
No interesting results could be extracted from the fluency score as can be noted from the figure above.

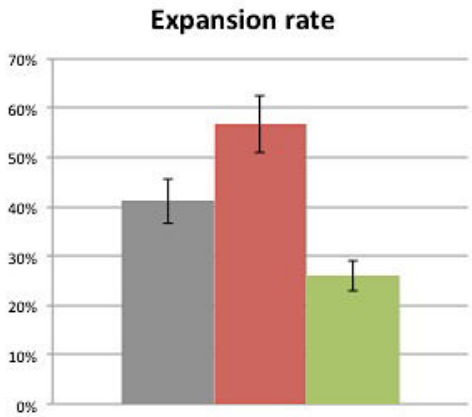
However, in terms of the flexibility score, the statistical results show that both the participants of the groups **"congruent" and "incongruent" decreased the number of ideas generated across the different categories of solutions**, with a small dominance of the group "congruent".

Finally, in terms of originality of solutions, "**congruent" leaders increased the number of original solutions, while "incongruent" leaders insignificantly decreased it**.

3.2. Fixation/Expansion Score







Mean	Fixation	Expansion	Expansion rate
Group control	6,750	4,700	0,410
Group "congruent"	5,150	6,750	0,567
Group "incongruent"	7,850	2,750	0,259

Standard Error of the Mean			
Group control	0,861	0,680	0,044
Group "congruent"	0,461	1,145	0,058
Group "incongruent"	0,796	0,382	0,030

FIGURE 57: FIXATION/EXPANSION SCORES FOR "DEFIXATOR LEADER 3"

Measurement of the fixation score showed that **mean number of ideas and solutions that individuals were able to generate inside the fixation zone was reduced for the participants of the group "congruent"**. However, the **number of solutions inside fixation was increased for the group "incongruent"**.

Measurement of the expansion score showed that the **mean number of ideas and solutions that individuals were able to generate outside the fixation zone (i.e. inside the expansion zone), was divided by two for the group "incongruent", and was noticeably increased for the group "congruent"**.

Similarly, the expansion rate clearly shows a **clear expansion for the participants of the group "congruent", as well as a clear diminution of the rate of ideas in expansion for the participants of the group "incongruent"**.

To examine whether the number of proposed solutions (i.e., fluency) within the fixation path (fixation) and outside the fixation path (expansivity) varied according to the experimental conditions, we conducted a repeated-measures analysis of variance (ANOVA) with the experimental condition (congruent; control and incongruent) as a between-subjects factor and the category of solution (fixation vs. expansion) as a within-subjects factor, and we used the partial eta squared (η_p^2) and Cohen's d to examine the effect size.

This analysis revealed a main effect of the solution category ($F(2, 57) = 9.49$, $p < .005$, $\eta_p^2 = .14$, Power = .86) that indicated that the participants provided more solutions in the fixation path than in the expansion path. There was no main effect of the experimental condition ($F(2, 57) < 1$). However, there was a significant experimental condition x category of solution interaction ($F(2,57) = 10.4$, $p < 0.001$, $\eta_p^2 = .27$, Power = .99, see figure below).

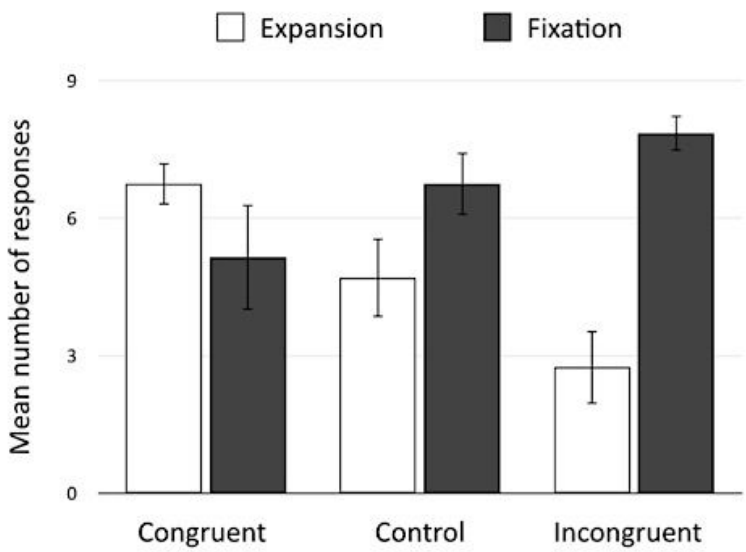


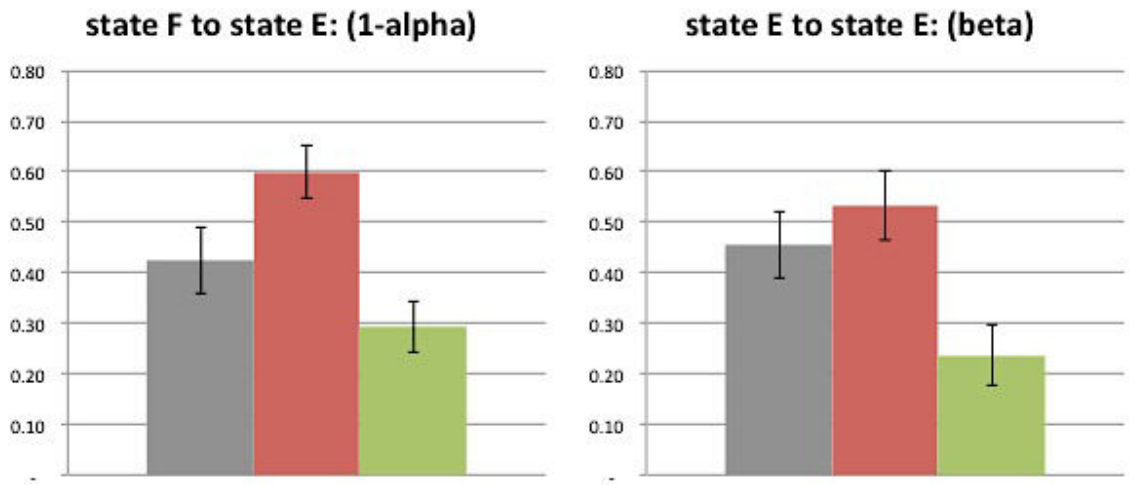
FIGURE 58: MEAN NUMBER OF SOLUTIONS ACCORDING TO THE EXPERIMENTAL CONDITION AND THE FIXATION/EXPANSION TYPE OF SOLUTION.

In addition, one-tailed planned comparisons were corrected with a Holm–Bonferroni procedure for analyses of the number of solutions within the fixation path and within the expansion path separately. Results revealed no significant difference between the number of solution within the fixation path in the control group (M = 6.75, SD = 3.85) and those in the congruent group (M =

5.15, SD = 2.06; F(1/57) = 2.42, p_{corr} = .12, d = .52). In addition, there was no significant difference between the number of solution within the fixation path in the incongruent group (M = 7.85, SD = 3.56) compared to the control group (M = 6.75, SD = 3.85; F(1/57) = 1.14, p_{corr} = .29, d = .30). Interestingly, participants proposed fewer solutions within the fixation path in the congruent group (M = 5.15, SD = 2.06) than participants in the incongruent group (M = 7.85, SD = 3.56; F(1/57) = 6.89, p_{corr} = .03, d = .92).

Critically, the participants in the control group (M = 4.7, SD = 3.04) proposed fewer solutions in the expansive path than did those in the congruent group (M = 6.75, SD = 5.12; F(1/57) = 3.88, p_{corr} = .05, d = .49). Additionally, the participants in the control group (M = 4.7, SD = 3.04) proposed more solutions in the expansive path than did those in the incongruent group (M = 2.75, SD = 1.71; F(1/57) = 3.51, p_{corr} = .032, d = .79). Finally, the participants in the congruent group (M = 4.7, SD = 3.04) proposed more solutions in the expansive path (M = 6.75, SD = 5.12) than did those in the incongruent group (M = 2.75, SD = 1.71; F(1/57) = 14.79, p_{corr} = .0005, d = .1.05).

3.3. Alpha/Beta Probabilities



Mean	1-α	β
Group control	0,425	0,454
Group "congruent"	0,599	0,533
Group "incongruent"	0,294	0,237

Standard Error of the Mean		
Group control	0,065	0,065
Group "congruent"	0,052	0,068
Group "incongruent"	0,051	0,060

Figure 59: Markov model transition scores for "defixator leader 3”

Moreover, statistical results of the probabilities alpha/beta of the two-state Markov chain revealed interesting facts. First of all, the measurement of transition probabilities show that the participants of the group **"congruent" were able to significantly increase the probability of defixation 1-α, and the probability of maintaining expansion β.**

Moreover, we could as well notice that the participants of the group **"incongruent" have significantly decreased the probability of maintaining fixation α, as well as the probability of re-fixation 1-β**.

4. Conclusion & Discussion: Efficient Strategy But Still Requires Competencies from "Defixator Leaders 3" to Recognize Fixation

The aim of the present experiment was to examine the influence of a minimal executive feedback-based learning process performed by "defixator leaders 3" on the performance of an individual ideation task in real-time to explore how such feedback could guide individuals' creative reasoning.

Hypotheses H3A and H3B were confirmed since congruent "defixator leaders 3" increased the expansion rate of their teams and consequently mitigated fixation, while incongruent "defixator leaders 3" decreased the expansion rate of their teams and consequently fostered fixation.

Three major findings emerged from this investigation as follows: 1) **congruent executive feedback increases individuals' idea generation within the expansive path**; 2) **incongruent executive feedback has the opposite effect**; and 3) critically, **incongruent executive feedback had a weaker effect on creative performance than did congruent executive feedback**.

Our results demonstrated that congruent "defixator leaders 3" could **gradually force individuals' reasoning to explore and activate novel and creative ideas and solutions to problems**. This stimulatory effect of the congruent executive feedback extends previous findings regarding the influence of training paradigms involving explicit executive feedback on various reasoning biases (Cassotti & Moutier, 2010; Houdé & Moutier, 1996, 1999). Indeed, these studies have consistently reported that executive training can greatly improve individuals' metacognitive abilities to overcome classical reasoning biases, such as the conjunction fallacy and the matching bias, during deductive reasoning. Moreover, our results are also coherent with those of previous studies that have been performed on the neuropedagogy of reasoning (Houdé, 2007) and demonstrated that minimal

executive feedback can clearly provoke the inhibition of strongly intuitive wrong answers (Houdé & Tzourio-Mazoyer, 2003).

The findings of the present experiment showing that congruent executive feedbacks increase creative ideas generation are in accordance with those of previous studies in that feedbacks in general, and more **precisely executive feedbacks, can strongly influence and regulate the creative performances of individuals** (Zhou & Li, 2013). Moreover, these findings are consistent with those of the majority of studies that have argued that the delivery of constructive feedback can positively influence creativity (Carson & Carson, 1993; De stobbeleir et al., 2008; Zhou, 1998, 2003) and extend previous findings by demonstrating that such constructive feedbacks can assume simpler forms, such as elementary and minimal guiding instructions (e.g., instructions such as "continue in this path" and "search for another path"). Such feedback requires minimal effort from the instructor given that he has the capacity to approximately recognize the frontier between fixation and expansion.

Our results also confirmed that **fixation effects could be reinforced using incongruent executive feedback**. This result is in accordance with those of previous studies that have demonstrated the strength of the fixation effect in creative idea generation and the difficulties of redirecting an individual toward expansive reasoning (2 ; 7-11).

In conclusion, our results clearly demonstrate that **incongruent feedback provided by "defixator leaders 3" reduces their teams' creative performances by decreasing the generation of ideas outside fixation and increasing the generation of ideas inside fixation**. In contrast, **congruent feedback provided by "defixator leaders 3" enhances their teams' creative performances by increasing the generation of ideas outside fixation and decreasing the generation of ideas inside fixation**.

Finally, the **process of the generation of ideas inside fixation is much more free-flowing that the process of the generation of ideas outside fixation**, which confirms that the generation of ideas inside fixation requires less effort and is more automatic and intuitive according dual-process model of creativity.

However, despite the fact that congruent feedbacks are excellent means of actions for defixation, **congruent "defixator leaders 3" still require relatively good competencies to defixate their teams**.

IV. Theory-driven Experiment IV for "Defixator Leaders 4": Directive Feedbacks to Lead Ideation outside Fixation Depending on Teams' Ideas with Imperfect Knowledge

1. Theoretical Hypothesis

The theoretical predictions for the derived theory-driven model 4 as stated in the previous chapter are as follows:

> ***H4A**: Random "defixator leaders 4" should have the lowest expansion rate regardless of their teams' creative ideation performance (fixated or defixated)*
>
> ***H4B**: Expansion-expert "defixator leaders 4" should have high expansion rate if their teams are more or less defixated (ideators type D or B)*
>
> ***H4C**: Fixation-expert "defixator leaders 4" should have high expansion rate if their teams are more or less fixated (ideators type A or C)*

2. Method

2.1. Participants

Eighty undergraduates from Paris Descartes University participated in this study (35 men, mean age = 20.7 years, SD = 2.98). Each participant was randomly assigned to one of the four following experimental conditions: **control condition** (n = 20; 7 men), **random condition** (n = 20; 12 men), **expansion expert condition** (n = 20; 7 men), and **fixation expert condition** (n=20; 9 men). Similarly to experiments 2 and 3, all the participants provided written consent and were tested in accordance with national and international norms governing the use of human research participants.

2.2. Procedure

Participants were randomly divided into four groups (20 subjects per group). Each participant was assigned a different leadership behavior type depending on the group he/she was randomly assigned to, as illustrated in the table above.

The procedure was very similar to theory-driven experiments 2 and 3. Participants of the group control were chatting with a neutral leader, which simply acknowledges reception of each idea generated by followers, awaiting the next one.

TABLE 5: "DEFIXATOR LEADERS 4" DIRECTIVE FEEDBACKS PER GROUPS

Groups	"Defixator Leaders 4" Directive Feedbacks	
	If idea = fixation	**If idea = expansion**
Group Control (N=20)	Leader gives neutral feedback ("I confirm the receipt of your idea and await for the next idea")	Leader gives neutral feedback ("I confirm the receipt of your idea and await for the next idea")
Group "Random" (N=20)	Leader could erroneously give positive feedback ("continue in this path" despite the fact that the idea is fixation) half of the time	Leader could erroneously give negative feedback ("search for another path" despite the fact that the idea is in expansion) half of the time
Group "Expert in Expansion" (N=20)	Leader could erroneously give positive feedback ("continue in this path" despite the fact that the idea is fixation) half of the time	Leader gives positive feedback ("continue in this path")
Group "Expert in Fixation" (N=20)	Leader gives negative feedback ("search for another path")	Leader could erroneously give negative feedback ("search for another path" despite the fact that the idea is in expansion) half of the time

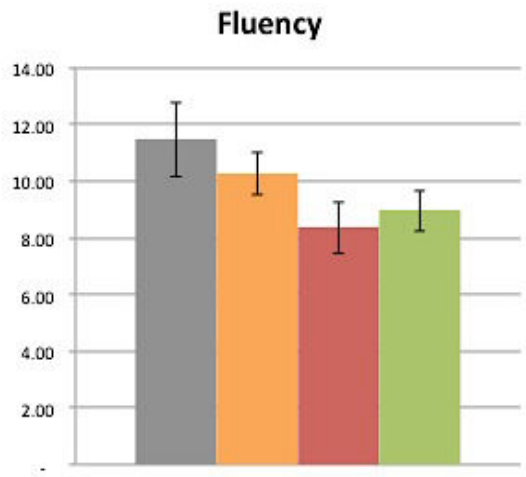
Participants of the group "random" were chatting with a **random leader in the recognition of both ideas in fixation and expansion**. If the idea generated by participants was in fixation, the leader would half of the time recognize it correctly and give negative feedback, while the other half the leader would fail to recognize it and give positive feedback. Similarly, if the idea generated by participants was in expansion, the leader would half of the time recognize it correctly and give positive feedback, while the other half the leader would fail to recognize it and give negative feedback.

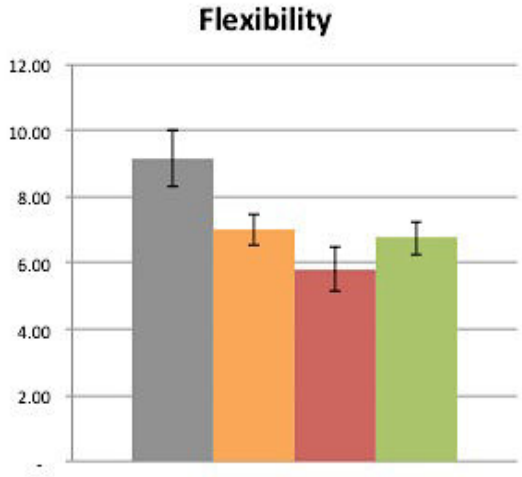
Participants of the group "expansion expert" were chatting with an **expert in the recognition of ideas in expansion**. If the idea generated by participants was in fixation, the leader would half of the time recognize it correctly and give negative feedback, and the other half the leader would fail to recognize it and give positive feedback. However, if the idea generated by participants was in expansion, the leader would recognize it perfectly and give positive feedback.

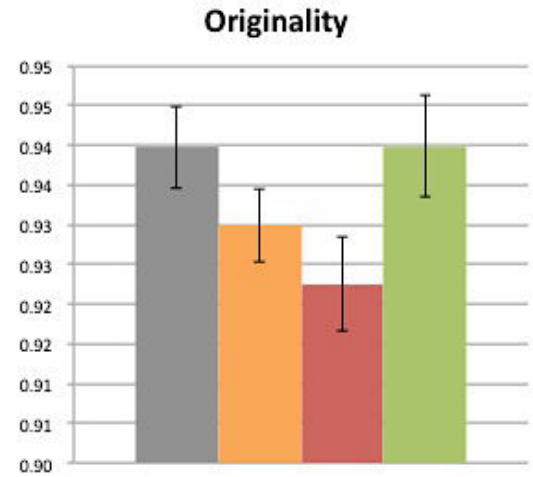
Participants of the group "fixation expert" were chatting with an **expert in the recognition of ideas in fixation**. If the idea generated by participants was in fixation, the leader would recognize it perfectly and give negative feedback. However, if the idea generated by participants was in expansion, the leader would half of the time recognize it correctly and give positive feedback, while the other half the leader would fail to recognize it and give negative feedback.

3. Experimental Results

3.1. Fluency/Flexibility/Originality







Mean	Fluency	Flexibility	Originality
Group control	11,450	9,150	0,940
Group "random "	10,250	7,000	0,930
Group "expansion-expert "	8,350	5,800	0,923
Group fixation expert"	8,950	6,750	0,940

Standard Error of the Mean			
Group control	1,295	0,847	0,005
Group "random"	0,743	0,465	0,005
Group "expansion expert"	0,901	0,671	0,006
Group fixation expert"	0,727	0,502	0,006

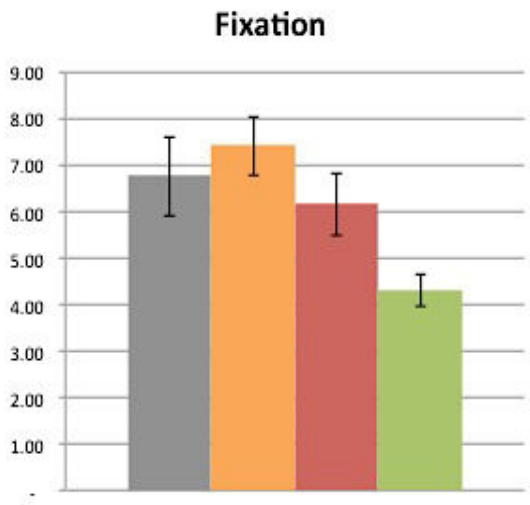
FIGURE 60: FLUENCY/FLEXIBILITY/ORIGINALITY SCORES FOR "DEFIXATOR LEADER 4"

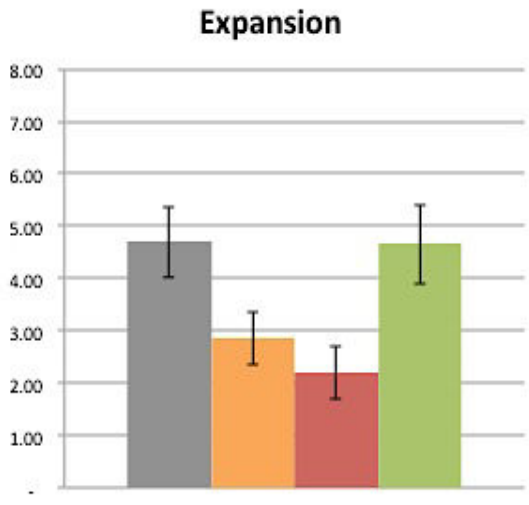
In terms of fluency, we could notice that both the groups **“expansion expert” (in red color) and “fixation expert” (in green color) obtained a slightly lower score than the groups “random”** (in orange color) and control (in gray color).

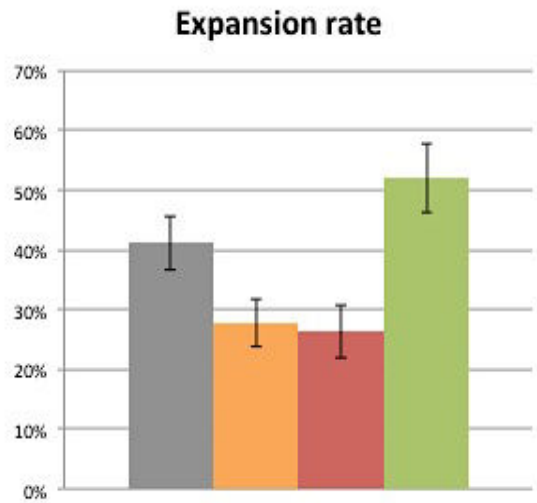
Interestingly, the **flexibility score shows that the participants of the three groups “random”, “expansion expert” and “fixation expert” noticeably decreased** the number of ideas and solutions generated across different categories, compared to the control group.

Finally, in terms of originality of solutions, **the participants of the groups “random” and “expansion expert” were less original than the group control and “fixation expert”**. Interestingly, the originality of the group “fixation expert” was not affected compared to the group control.

3.2. Fixation/Expansion Score







Mean	Fixation	Expansion	Expansion rate
Group control	6,750	4,700	0,410
Group "random"	7,400	2,850	0,278
Group "expansion expert"	6,150	2,200	0,263
Group fixation expert"	4,300	4,650	0,520

Standard Error of the Mean			
Group control	0,861	0,680	0,044
Group "random"	0,626	0,499	0,040
Group "expansion expert"	0,670	0,501	0,044
Group fixation expert"	0,341	0,755	0,058

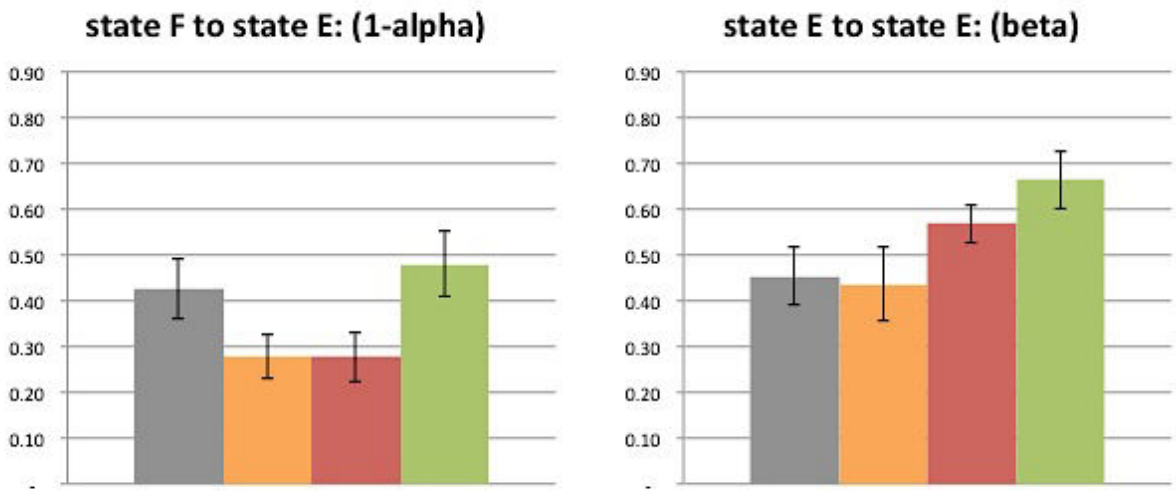
FIGURE 61: FIXATION/EXPANSION SCORES FOR "DEFIXATOR LEADER 4"

Measurement of the fixation score showed that the **mean number of ideas and solutions that individuals were able to generate inside the fixation zone was clearly reduced for the participants of the group "fixation expert"**. However, the fixation score did not change significantly between the two other groups "random" and "expansion expert".

Measurement of the expansion score showed that the **mean number of ideas and solutions that individuals were able to generate inside the expansion zone, was approximately divided by two for the participants of the group "expansion expert"**. Moreover, the expansion score was noticeably reduced as well for the participants of the group "random". However, there was just a small – and not highly significant – increase in the number of ideas in expansion for the group "fixation expert", compared to the group control.

Interestingly, the **expansion rate clearly shows that the group "fixation expert"** dominated all the groups. Similarly, we could also notice the decrease of the expansion rate for both the groups "random" and "expansion expert" compared to the group control.

3.3. Alpha/Beta Probabilities



Mean	1-α	β
Group control	0,425	0,454
Group "random"	0,278	0,436
Group "expansion expert"	0,278	0,567
Group fixation expert"	0,480	0,662

Standard Error of the Mean		
Group control	0,065	0,065
Group "random"	0,050	0,080
Group "expansion expert"	0,054	0,042
Group fixation expert"	0,070	0,061

FIGURE 62: MARKOV MODEL TRANSITION SCORES FOR "DEFIXATOR LEADER 4"

Statistical results of the probabilities **alpha/beta of the two-state Markov chain show that the participants of the group "random" and "expansion expert" have significantly decreased the probability of defixation 1-α.** However, the participants of the group "fixation expert" did not have effects on the probability 1-α.

Moreover, we could as well notice that both the participants of the group **"fixation expert" and "expansion expert" slightly increased the probability of maintaining expansion β**. However, the participants of the group "random" did not have effects on the probability β.

4. Conclusion & Discussion: Contingent Strategies Depending on the Capacities of "Defixator Leaders 4" to Recognize Teams' Creative Ideation Competencies

In the present experiment, we have explored the effect of "defixator leaders 4" feedbacks, in specific cases in which they lead their teams in the unknown with imperfect knowledge. We designated varying levels of knowledge by leaders' aptitude to recognize if a particular idea generated by his team is inside or outside fixation. We demonstrated that **leaders could efficiently play the role of de-fixators, by preparing carefully their interventions (through feedbacks) within the ideation process, not only according to their capacity to recognize the frontier between fixation and de-fixation of a project, but also according to the creative ideation capacities (ideator types) of the teams they face**.

Hypothesis H4A was only partially confirmed, since not only random "defixator leaders 4" – but as well expansion-expert – had obtained the lowest expansion rate. **Hypotheses H4B and H4C were confirmed** since the population was considered more or less fixated (in fact, the control group indicates that the probability of defixation 1-α was relatively low) and therefore the fixation-expert "defixator leaders 4" were clearly more adequate than the expansion-expert "defixator leaders 4".

In this experiment, we showed that l**eadership strategies for ideation management should adopt more situational and contingent approaches depending on followers' capacity to think out of the dominant design**.

Our findings clearly confirm that **leaders could highly improve or deteriorate followers' creative ideation capacities according to the creative ideation capacities of the teams they face (resumed in this thesis as the ideator's capacity to defixate or maintain expansion), and not only through their ability to recognize the frontier nearby the dominant design of a project**.

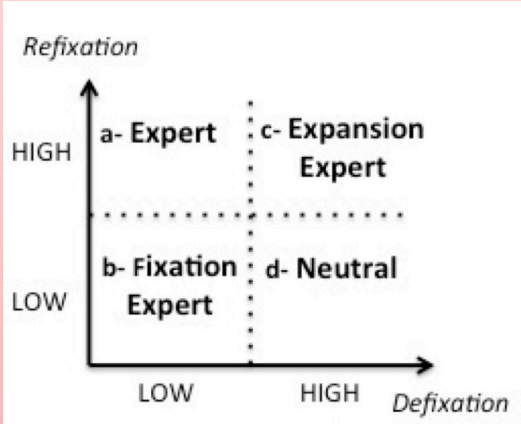
Moreover, **the present findings demonstrated that less knowledgeable leaders (having the ability to recognize either fixation or expansion) could also highly increase followers' creative ideation capacities, if they face appropriate teams**.

In fact, the present theory-driven experiment 4 **presents an interesting situational approach to ideation management**. In the present experiment, we demonstrated that if teams are more or less fixated, leaders who could recognize the dominant design of the project should preferably lead them. In this case, leaders who could recognize only creative "out of the box (fixation)" ideas would on the contrary reinforce fixation. These findings could interestingly link to situational leadership theories (Hersey, Blanchard, & Natemeyer, 1979), and give new sights to managerial implications towards situational approaches to creative leadership.

V. Summary of Chapter VII

Below is a summary box presenting the key points of chapter VII:

- Figures of "defixator leaders 1" should have the ability to formulate initial instructions in a way to warn their teams to prevent them from generating specific inappropriate solutions (examples inside fixation) in a high level of abstraction, in order to ensure fixation is majorly mitigated
- Figures of "defixator leaders 2" could not mitigate fixation using repetitive feedbacks (unchanging strategies) without prerequisite knowledge, since it noticeably obstructs the generation capacity of their teams
- Figures of "defixator leaders 3" should provide their teams with congruent directive feedbacks to gradually force their reasoning processes to get out of fixation
- Figures of "defixator leaders 4" should adapt the appropriate behavior according to the teams they face. These behaviors are resumed in the contingency graph below:



Chapter VIII: How Can Laboratory Experiments Help Uncover the Managerial Levers of Defixator Leaders in Organizations?

In chapter VIII, we present the characteristics of the new figures of defixator leaders, their features, and the standard figure of defixator leadership. We end the chapter by demonstrating how we could revisit leadership for defixation in organizational contexts using our laboratory-based experiments (which is considered the step 3 of our research methodology presented in chapter IV).

I. Features of Defixator Leaders As Emerging From Experiments

1. Defixator Leaders' Means of Actions

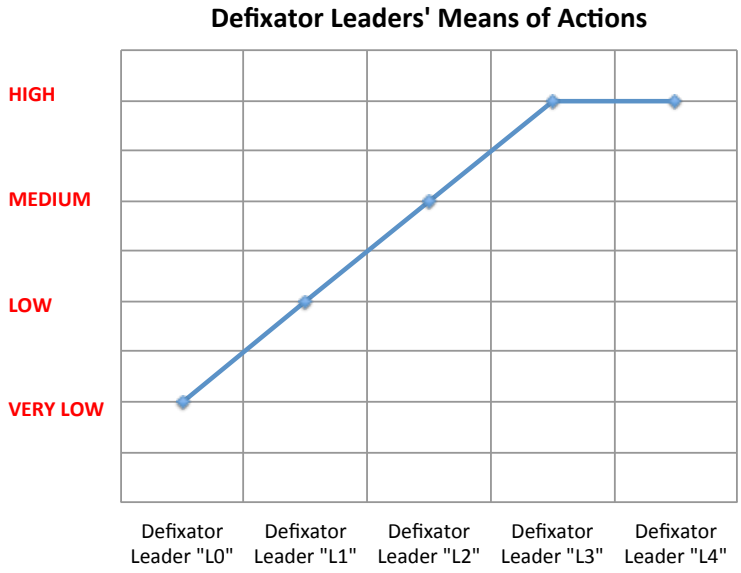


FIGURE 63: DEFIXATOR LEADERS' MEANS OF ACTIONS: LEVEL OF INTERVENTIONS IN THE IDEATION PROCESS

The first sub-research question of this research thesis consisted of better understanding what means of actions (behaviors, management tools and actions) would defixator leaders need to manage their teams' fixation/defixation processes. Across the different theory-driven experiments that were performed in the present thesis, **defixator leaders were specifically designed to operate through instructional processes (such as initial instructions, repetitive or directive feedbacks)** to help their teams overcome fixation effects in situations of creative ideation. In addition, as it could be noted from the previous chapter, one principal aim of this research thesis was to intensify the

level of interventions through the means of actions of defixator leaders, in order to design alternative figures of defixator leaders that are not necessarily in the form of the facilitators (leaders that do not really participate with their teams in the ideation process with reduced means of actions).

According to the curve above, we could say that “defixator leaders 0” (the figure of defixator leaders based on expansive examples, which was used as a starting point to shape new forms of defixator leaders) had the minimal intensity of interventions in the ideation process compared to the other four figures, since they could only formulate **one expansive example (through an initial instruction) to their teams prior to a creative ideation task**. Accordingly, we considered the intensity of the interventions of “defixator leaders 0” in the ideation process as very low compared to the four other defixator leaders.

The intensity of the interventions of the defixator leaders in the ideation process was slightly elevated for “defixator leaders 1” (from very low to low), since they could formulate a complete guideline to their teams to warn them and prevent them from generating ideas in certain paths (inside fixation). In fact, they could provide them with **examples (or categories of examples) of what is not desired, through an initial instruction given prior to a creative ideation task**.

The intensity of the interventions of the defixation leaders in the ideation process was again increased for “defixator leaders 2” (from low to medium), since they were allowed to provide their teams with **repetitive feedbacks (either “continue in this path” or “search for another path”) at each idea generated by their teams**.

The intensity was again increased for “defixator leaders 3” (from medium to high), since they were allowed to provide their teams with **two different type of feedbacks (either “continue in this path” or “search for another path”), at each idea generated by their teams**, according to their own interpretation of the nature of the generated ideas (in the fixation path, or in the expansion path).

The intensity remained the same for “defixator leaders 4” (remained high), since they were also able to provide their teams with **two different types of feedbacks at each idea generated by their teams**, according to their imperfect interpretation of the nature of the generated ideas.

2. Defixator Leaders’ Minimal Competencies

The second sub-research question was related to the minimal competencies required for the defixator leaders, or the set of socio-cognitive skills they need to possess in order to help their teams

overcome fixation. Again, since we were modeling the minimal profile of defixator leaders to design alternative figures of defixator leaders that are not necessarily in the form of the innovators (in line with one of the research objectives set in chapter III), **defixator leaders were designed to possess the minimal competencies possible** (not being necessarily creative or able to provide their teams with innovative ideas, not having clear vision for creativity, or not having high influential skills, etc.).

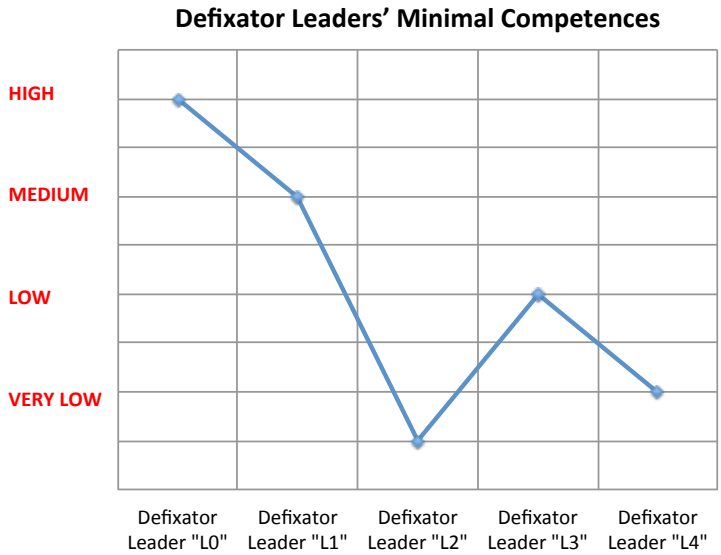


FIGURE 64: DEFIXATOR LEADERS' MINIMAL COMPETENCIES: LEVEL OF COGNITIVE CAPACITIES

As a starting point of our design of figures defixator leaders, we considered that "defixator leaders 0" were required to have relatively high competencies compared to the other four figures (see the figure above), since **they were able to provide their teams with creative and stimulating examples** (in the expansion path) to help them overcome fixation.

The competencies of "defixator leaders 1" were diminished (from high to medium), since they were not able to formulate examples in the expansion path but rather were **capable of formulating examples uniquely in the fixation path**. We considered that having the knowledge of the fixation space (which is equivalent to the dominant design of a particular project) necessitates fewer competencies than having the knowledge of the expansion space.

The competencies of "defixator leaders 2" were intensely reduced (from medium to very low), since **they were not required to have any kind of competencies**. In fact, they were just providing their teams with the same repetitive feedbacks, regardless of the ideas that were generated by their teams.

Then, the competencies of "defixator leaders 3" were again increased (from very low to low), since they were **able to "perfectly" recognize whether the ideas generated by their teams were inside the fixation path or outside it**. In fact, they were providing their teams with different directive feedbacks ("continue in this path" or "search for another path") according to the nature of the ideas generated by their teams (in the fixation path, or in the expansion path).

Finally, the competencies of "defixator leaders 4" were slightly decreased (to a particular level that was considered between very low and low), since they were **able to "imperfectly" recognize whether the ideas generated by their teams were inside the fixation path or outside it**, and consequently could provide their teams with directive feedbacks that would be sometimes congruent, and other times incongruent (and misleading).

3. Defixator Leaders' Contingent Strategies

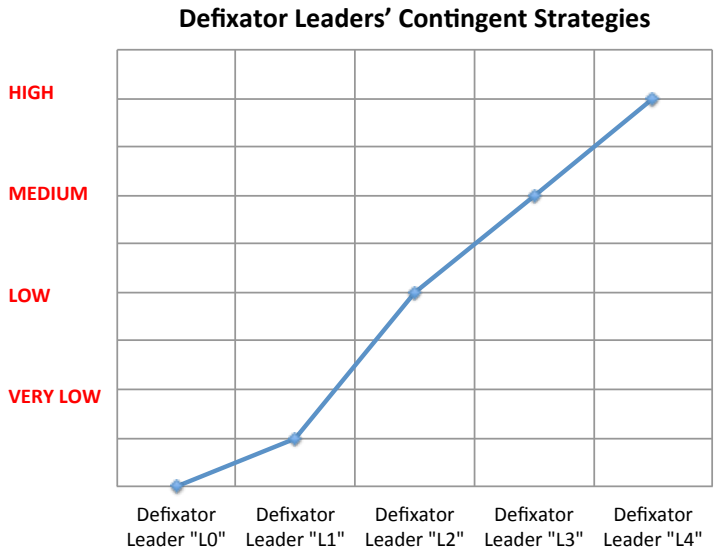


FIGURE 65: DEFIXATOR LEADERS' CONTINGENCIES: CONTINGENCY VARIABLES

The third sub-research question was related to the contingent strategies of the defixator leaders. This sub-research question consisted of exploring how defixator leaders' should behave if they face teams that have varying expertise levels. In this case, we described the varying expertise as their capacity to get out of fixation by themselves (change the state from fixation to expansion), as well as their capacity to maintain their creative performance (stay in the state of expansion). Indeed, one of the research goals of this thesis was to **disclose the contingency nature of defixator leaders**.

The figure above and the table below summarize the contingent strategies of each of the four figures of defixator leaders. We considered that “defixator leaders 0” are more likely to apply a more or less **universal strategy of defixation that does not necessarily depend on the situation** (nature of the task, the ideas generated or the team they face).

TABLE 6: CONTINGENCY VARIABLES OF "DEFIXATOR LEADERS"

Figure of Defixator Leaders	**Contingency Level**	**Contingency Variable**	**Contingent Strategy**
Defixator Leaders 0	NA	NA	General strategy (universal)
Defixator Leaders 1	Very low	Depends on the frontier fixation/expansion of the solution space	Should adapt to the fixation space of the ideator
Defixator Leaders 2	Low	Depends on the generativity of the task (initial concept C0)	If generative C0 then changer (breadth-oriented strategy), else maintainer (depth-oriented strategy)
Defixator Leaders 3	Medium	Depends on the nature of the generated idea (fixation/expansion)	If idea in fixation then change, else continue
Defixator Leaders 4	High	Depends on the level of expertise of the team (defixation and persistence cognitive skills)	If team fixated then fixation-expert, else then expansion-expert

“Defixator leaders 1” apply contingent strategies of defixation that are dependent on the **frontier fixation/expansion of their teams**. However, what “defixator leaders 1” considers inside fixation is not necessarily a fixation for the ideator, and vice-versa.

“Defixator leaders 2” execute contingent strategies of defixation that could be dependent on the **generativity of the initial concept of the task** (high or low generative C0 according to C-K theory). In fact, depending on this level of generativity of the C0, “defixator leaders 2” should adapt their strategies (depth-oriented strategy for the maintainer, or breadth-oriented strategy for the changer).

As for “defixator leaders 3”, the contingent strategies of defixation should depend on the **nature the ideas generated by their teams** (idea inside the fixation path, or idea inside the expansion path). In fact, if the ideas generated by their teams are inside fixation, these defixator leaders try to change the state from fixation to expansion by asking them to “search for another

path". On the contrary, if the ideas generated by their teams are inside expansion, these defixator leaders try to maintain the state in expansion by asking them to "continue in this path".

Finally, "defixator leaders 4" apply contingent strategies of defixation that should be dependent on the **level of expertise of their teams** (their cognitive capacities to defixate themselves, or to maintain the state of expansion). According to the leadership-driven ideation model, if the teams are more or less fixated they should preferably face a fixation-expert leader. On the contrary, if the teams are more or less defixated, they should preferably face an expansion-expert leader.

II. Standard Figure of Defixator Leaders

1. Laboratory Experimental-based Defixation Rules

Our theory-driven experiments have been able to tackle the standard "cognitive" role of leadership for defixation very precisely, with figures of leaders that do not require very high levels of knowledge and expertise. Principal results have shown that leadership strategies to defixate followers are important but not sufficient. According to these experimental findings, leading and managing the process of defixation in itself should follow these defixation rules:

1. **Analysis of the situation:** detecting the current state of followers (fixation "F" or expansion "E") depending on the project/task;
2. **Action:** deviating from the state of fixation if followers are fixated, and maintaining individuals outside the state of fixation (expansion) if followers are defixated (see figure below).

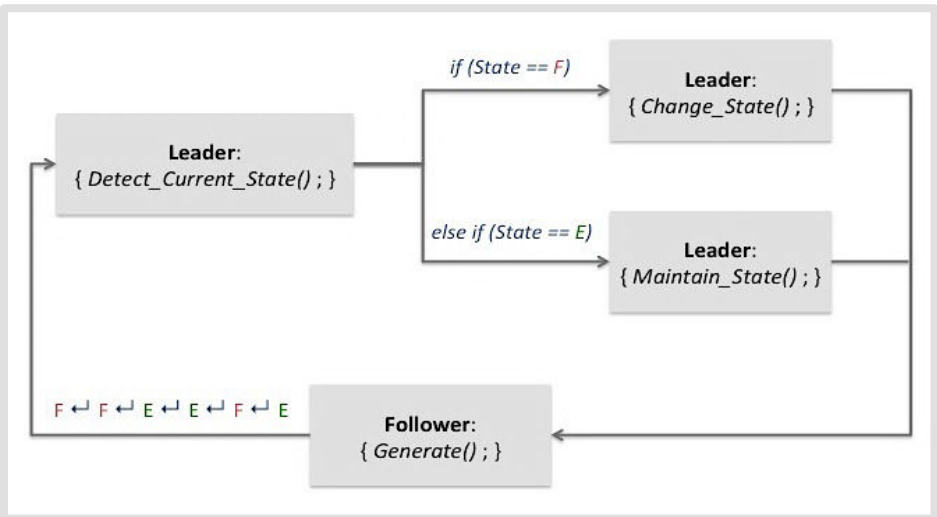


FIGURE 66: DEFIXATION RULES IN LABORATORIES

2. Specific Contingent Strategies of Defixator Leaders

Furthermore, our findings proposed specific **contingent leadership strategies for defixation for even "less competent" leaders**. Based on varying levels of knowledge (leaders' ability to recognize if a particular idea generated by their teams is inside or outside fixation), our findings suggest that leadership strategies for ideation management should adopt less generic and universal tactics (such as Osborn brainstorming rules (Osborn, 1953) for example) but rather more situational strategies depending on followers' capacity to think out of the box.

Indeed, in theory-driven experiment 4, we show that **leaders should first analyse the relationship team/task (more or less fixated or defixated), and then apply a "contingent strategy" that is appropriate with this relation team/task** (according to the figure below).

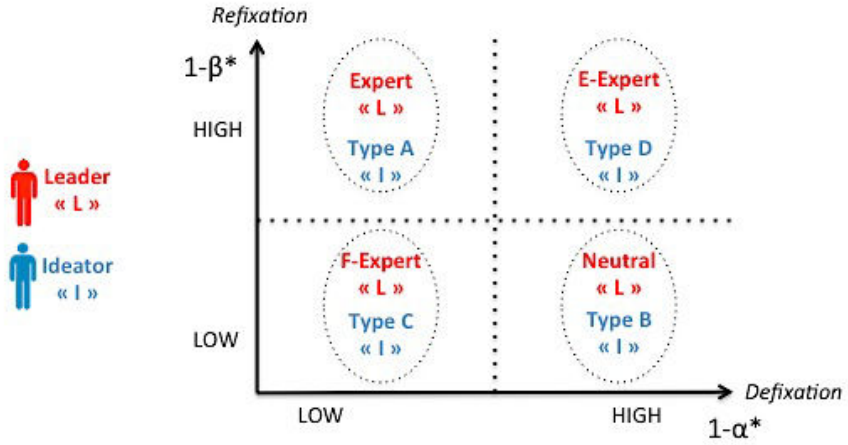


FIGURE 67: CONTINGENT DEFIXATION STRATEGIES FOR IDEATION MANAGEMENT

In fact, we demonstrate the following four cases:

- If teams are highly competent such as **ideators type B** (high defixation 1-α, and low re-fixation 1-β), they are more likely to perform better if they face **neutral leaders** (such as the leaders of the control groups used in our experiments).
- If teams are highly incompetent such as **ideators type A** (low defixation 1-α, and high re-fixation 1-β), they are more likely to perform better if they face **expert defixator leaders** (leaders that are perfect at recognizing fixation and expansion, such as congruent "defixator leaders 3").
- If teams are more or less fixated to a specific project such as **ideators type C** (low defixation 1-α, but not necessarily high re-fixation 1-β), they are more likely to perform better if they face **fixation-expert defixator leaders** (leaders that are good at recognizing the dominant design of a project, such as fixation-expert "defixator leaders 4").

- If teams are more or less defixated to a specific project such as **ideators type D** (high defixation 1-α, but not necessarily low re-fixation 1-β), they are more likely to perform better if they face **expansion-expert defixator leaders** (leaders that are good at recognizing disruptive ideas, such as expansion-expert "defixator leaders 4").

III. Rethinking Leadership Organizational Practices for Defixation

1. Why are "Managerial Implications" not Sufficient?

It is important to note that these specific defixation rules (resulted from the theory-driven experiments) are interesting and beneficial for managing ideation sessions. However, at first sight, they could seem **quite artificial and incompatible if applied in real organizations contexts**, and somewhat far from what represent real leadership practices in organizations.

However, **simply validating these laboratory-based defixation rules using empirical data** (as it is usually made in most studies under the umbrella of "managerial implications") could be inaccurate for numerous reasons:

- **Defixation and expansion**: Most studies in the literature of creativity usually focus on defixation as the turning point for creativity, giving less attention to expansion, i.e. the process of maintaining individuals outside fixation. However, our laboratory experiments clearly showed that maintaining expansion after being out of fixation could sometimes be even more difficult than defixation itself. In fact, if individuals don't have the ability to persist in generating creative ideas, they could easily return back to their initial state and re-fixate again.
- **Dissimilar creativity evaluation criteria**: laboratory experimental studies evaluate creativity based on the maximum number of creative ideas generated by subjects (participants of the experiments) during a limited ideation session (usually 10-20 minutes). However, in real life, the creativity evaluation criteria are no doubt more complex than that.
- **Leadership and followership**: our experimental studies built protocols that involve both leaders and followers during a creative process. However, most empirical studies simply focus on leaders as being the inventors or the lone innovators, and very little is known about the role of followers. For this reason, it is hard to examine contingent strategies for defixation in organizations based on the literature alone. Moreover, it is worth mentioning

that usually hidden creative leaders inside teams could also play crucial roles for creativity. Similarly, these hidden creative leaders are not well emphasized in empirical studies.

Notwithstanding the above-mentioned irregularities between the laboratory and the organization worlds, **we applied step 3 of our research method, in which most of the organizational variables neutralized by experiments (in step 2) were added again**. To do so, we first redefined what represent leaders' fixation/expansion recognition in organizations (part 1: "analysis of the situation" in the defixation rules), and then revisited leaders' roles in organizations (part 2: "actions" in the defixation rules).

2. Contextualizing Experimental Rules in Organizational Contexts?

2.1. From Fixation Detection to Dominant Design Recognition

It is worth pointing out that our experiments show that leaders' capacity to detect and recognize what is inside and/or outside fixation is a crucial factor for defixation. Contrarily to experimental studies, **empirical studies assume that if individuals have the ability to recognize creative ideas, they should also be able to recognize uncreative ideas (inside fixation)** (Zhou & Woodman, 2003). This hypothesis could seem at first sight logic but it is not necessarily true. In fact, some individuals could have excellent abilities to detect ideas that are inside fixation but would be less capable and more hesitant when they have to evaluate ideas that are outside fixation. Furthermore, few empirical studies clearly treat the question of creativity recognition but it has to be implicitly assumed as a prerequisite of creative leaders.

In addition, despite the fact that the definition of fixation could let one think that is simply an individual tendency occurring in creative ideation, it is important to note that **fixation is a broader concept that exists at social and organizational levels** (Stempfle, 2011). For example, some studies have demonstrated that individuals can become fixated due to social factors, such as the exposure to ideas of others during a brainstorming session (Kohn & Smith, 2011). Similarly, at the organizational level, employees can become fixated to their way of doing things, or on old and well-established existing paradigms (Stempfle, 2011).

However, **in many organizations, leaders do not necessarily detect fixation but can rather detect the "dominant design"** (Hatchuel et al., 2001) of their current product, service or industry. The concept of "dominant design" introduced by Utterback and Abernathy (Abernathy & Utterback,

1975) is a new technology, product, or set of key features that become a de facto standard. When the dominant design is established, it becomes more and more fixated and difficult to change.

Many empirical studies show that **leaders who recognize the dominant design (when it exists) could make the big difference**. For example, James Dyson was able to recognize the dominant design of the vacuum cleaner industry (which had not changed for several decades), and thereby led his team to design the first bag-less cleaner in the latter half of the nineties (Beverland & Farrelly, 2007; Le Masson, Weil, & Hatchuel, 2010). On the contrary, in the French public transport provider RATP, the microbus project was considered a failure at first because the RATP leaders were unable to recognize the creative value behind the microbus project (Elmquist & Le Masson, 2009). Indeed, these leaders were fixated to the dominant design of the classical public transport means at this time. In line with the above, we could also find multiple examples in the biographies of great innovative leaders such Steve Jobs, Thomas Edison, Larry Page, Elon Musk, Mark Zuckerberg etc. that they had the capacity to detect the dominant design of the project they were working on, and most importantly they used to undertake the necessary steps to break away from the dominant design.

2.2. From Leaders' Instructional Processes to Leadership Organizational Practices

Laboratory experimental results stated that leaders' capacity to provide their teams with the appropriate defixation actions (such as the appropriate type of instructions/feedbacks for example) in creative ideation is considered as well as another important factor for defixation. Similarly again, **in real organizational contexts, leaders do not only provide their teams with instructional processes (initial instructions, repetitive feedbacks and directive feedbacks) but numerous means of actions can replace its roles**.

To **shape leadership roles for defixation in organizations according to laboratory-based defixation rules**, we first selected the seven most typical roles leaders usually do in organizations: recruitment, resource and time allocation, evaluation, decision-making, goal-setting, climate creation, and motivation. It is important to recall that most of the above-mentioned leadership organizational practices were neutralized in laboratory experiments. We then demonstrated how each of these leadership organizational roles could be revisited according to laboratory rules for defixation (indicated in step 2). In fact, these experimental rules helped to shed the light on specific variables which were put aside, and usually not considered in the literature of leadership and creativity.

2.3. Observed and Latent Leadership Variables for Team Creative Performance in Organizations

The figure below illustrates the above-mentioned procedure of step 3. In order to attain high team creative performance in organizations, **leaders usually consider well-known observed variables (variables O_i) to manipulate a set of latent variables (L_i)**. As opposed to observed variables, latent variables can only be measured indirectly, through their impact on team creative performance.

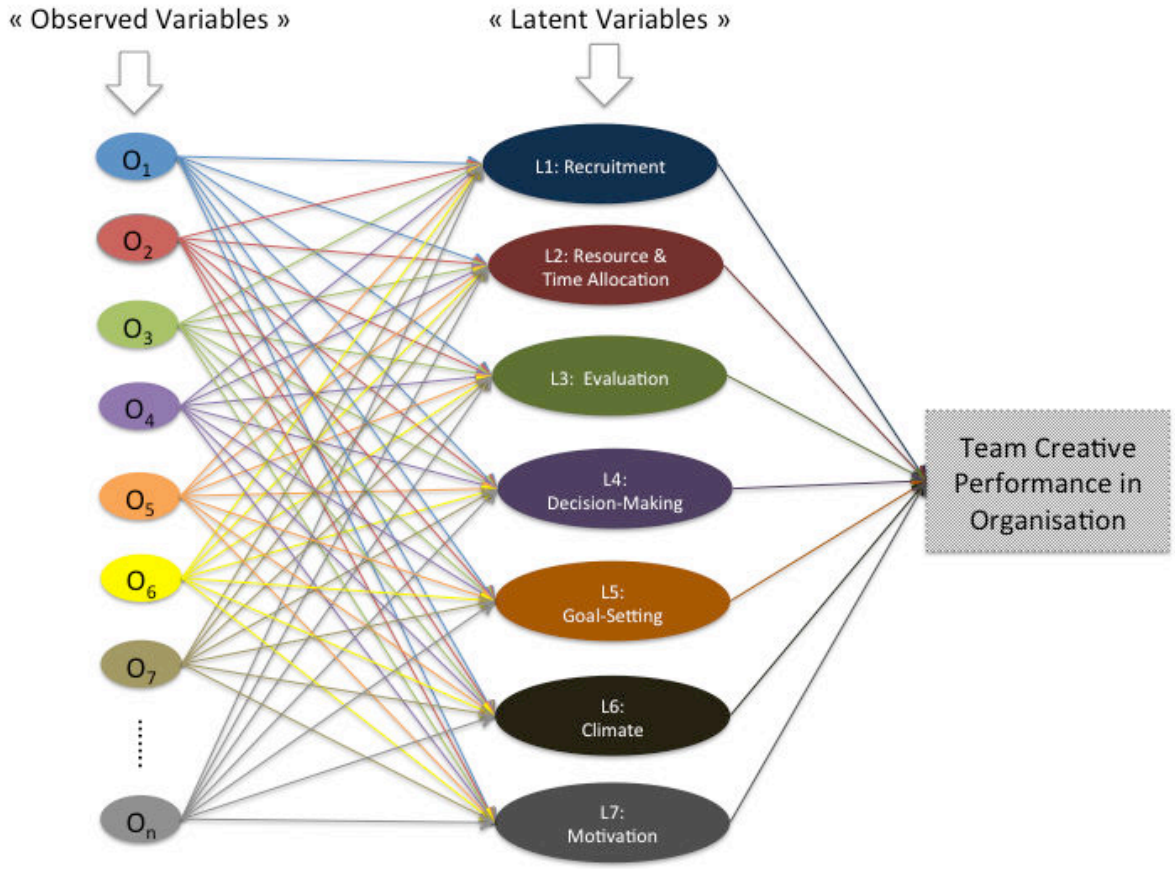


FIGURE 68: OBSERVED AND LATENT LEADERSHIP VARIABLES FOR TEAM CREATIVE PERFORMANCE

For example, in order to manipulate the latent variable "recruitment" (L_1 in the figure below) for team creative performance in organizations, leaders usually consider observed variables such as "team diversity", knowing that if leaders recruit varied profiles, they are more likely to enhance their team's creative performance. Similarly to manipulate the latent variable "motivation" (L_7 in the figure below), leaders could consider enhancing their team's creative performance though incentives (observed variable "extrinsic motivation").

However, according to the defixation rules (step 2), these classical observed variables could not be always appropriate to execute the defixation rules generated from step 2. Indeed, **other**

observed variables – usually unconsidered by the literature of leadership and creativity – may perhaps be more convenient to execute leadership defixation rules.

In what follows, we attempt to **shed the light on these "other observed variables" (usually put aside by the literature), and demonstrate (according to empirical evidence in biographies of great innovative leaders) that these other observed variables could be efficient to manipulate the classical latent variables** (i.e. leader classical practices or roles in organizations).

To do so, for each leadership organizational practices (latent variables), we first determined the typical descriptors (observed variables) that are known to support creativity (team creative performance in organizations) according to the literature review. Then, for each latent variable, we shed the light on other **observed variables that may be efficient to perform leadership experimental rules for defixation**. Finally, we illustrate why these observed variables (usually unconsidered by the literature) are useful and could not be excluded using i) rich empirical data in biographies of famous innovative leaders such as Steve Jobs (Apple), Kenneth Mees (Kodak), Larry Page and Sergey Brin (Google), David Kelley (IDEO); as well as ii) more general empirical studies in the literature of leadership for creativity and innovation.

3. Shedding the Light on New Variables that Can Execute Defixation Rules

3.1. The Defixator Recruiter

Recruitment is a principal human resource management function of leaders in organizations. It refers to the process of hiring candidates for specific jobs within an organization. If we explore leaders' role as recruiters in organizations, we would note that the literature has focused on the following **observed variables to manipulate the latent variable "recruitment" to foster team creative performances**:

- **Team diversity** (Bassett-Jones, 2005; Cox, Lobel, & McLeod, 1991): in order to achieve creative outcomes, leaders are more likely to recruit members from different areas, they must seek for new expertise among their teams. For example, some researchers have found that different ethnic in groups can produce more creative ideas (Cox et al., 1991).
- **Rich profiles**: certain profiles are recognized to contribute to the success of creative efforts, and are more predisposed to be creative than others. For instance, creative leaders are more likely to recruit "project champions" (Mumford et al., 2007): individuals with good network connections and credibility; experts (Stringer, 2000): individuals with past experiences in the

area where the innovation is of concern; or creative thinkers (Zuckerman, 1979): individuals with substantial creative thinking skills.

- **Salaries and rewarding contracts** (Kachelmeier & Williamson, 2010): salaries and rewarding contracts are recognized to be a good recruitment instrument in the hand of leaders to stimulate creativity among their teams. For example, leaders can offer their future employees a system of "rewarding contracts" to encourage their creative performances.

However, if we now try to rethink the role of leaders for recruitment according to our experimental rules, we would **find new variables in the recruitment process that may appropriate to execute our defixation rules**: i) detect the current state (F/E type), then ii) maintain the state if E or change the state if F.

Our defixation rules could let one think of new recruitment variables that were not emphasized in the literature, such as the **contractual relationship between leaders and their members, i.e. the leader/member subordination type**. In fact, few studies have shed the light on the contractual relationship type as an important factor for creativity (Lloréns Montes, Ruiz Moreno, & Miguel Molina Fernández, 2004; Singh Panesar & Markeset, 2008). The **contractual relationship type can act as an efficient observed variable for defixation in organizations**. According to our defixation experimental rules, it can serve to manipulate the status of followers (maintain their state when defixated or change their state when fixated).

For example, creative leaders such as **Kodak's Kenneth Mees (who co-developed the first panchromatic photographic plates) used "contractual relationship types" to manipulate the states of his collaborators** (Le Guern, 2017). In fact, in the Kodachrome project, Mees proposed special contracts (without any form of formal subordination and hierarchy) to two independent photochemists (Leopold Mannes and Leopold Godowsky), who undertook their first successful experiments even before their official collaboration with Kodak. Indeed, Mees wanted to preserve their creative behaviors and may have believed that their creative performances would have been perturbed if they were employed under traditional contracts (with standard leader/member subordination and hierarchy); whereas the same leader would impose traditional contracts on his R&D team, since he considered them less creative.

Similarly, **Google's Larry Page – who believed in informality – used to hire very creative people, and did not impose any formal subordination (no hierarchy) on them** (Coget, Shani, & Solari, 2014). Page may have believed as well that this would have preserved the creative behaviors of these creative people.

3.2. The Defixator Resource and Time Allocator

Resource and time allocation is a plan made by leaders for using available organizational resources and time strategies to achieve specific organizational goals. There is no doubt that leaders play a crucial role in leveraging the organization resources to accomplish organizational goals. If we now analyze leaders' role as resources and time allocators in organizations, we would note that in order to enhance teams' creative performances through **the latent variable "resource and time allocations"**, literature review has emphasized **the following observed variables**:

- **Sufficient resources** (Makri & Scandura, 2010; Mumford et al., 2007): in order to appropriately achieve creative outcomes, leaders are more likely to provide sufficient and appropriate resources for their teams. They must avoid projects to suffer from the appropriate resources needed. Indeed, to be creative, employees need access to particular material resources.
- **Appropriate timing strategies** (Gruber & Davis, 1988): Another factor that is recognized to support creativity is the capacity of leaders to allocate enough and careful timing strategies for innovative projects.

These variables are of course very efficient but do not necessarily allow leaders to handle and manage followers' states (fixation/expansion) in a way to follow the defixation rules. However, **other observed variables such as constraints or allowances (i.e. the degree of freedom) can more adequately play this function**. It is worth mentioning that allowances or constraints on resources and timing can serve as a good leadership strategy to manipulate followers' state.

In the biography of late Apple's Steve Jobs, we could note that he may have constrained time and resources in certain situations, and imposed severe constraints and hard deadlines on his teams to force things to happen (Deutschman, 2001). Perhaps, Job may have considered his teams in a situation of fixation, and unable to come up with crazy and disruptive ideas or solutions to problems. If we analyze this fact from the lens of our experiments, we could say that Steve Jobs – playing the role of defixator leader – was attempting to change the state of his followers from fixation to expansion.

For example, Google's Larry Page or Sergey Brin used to allow free time and extra resources for some of his teams for "pet projects" (20 per cent time) in order to allow them to pursue their own interests. In fact, Page knew they were creative people in the company that were capable of giving rise to great innovative projects and wanted them to maintain their current state (considered expansion in our experiments). AdSense, Gmail, Google Transit, Google News or Google Talk were successful products and services that came out of "pets projects" (Coget et al., 2014).

3.3. The Defixator Evaluator

Evaluation is a systematic process for obtaining information about the performance of an organization. Leaders' role as evaluators is another classical leadership function in organizations. Some studies have shown that evaluation can have a negative effect on creativity through motivation (Shalley & Gilson, 2004; Shalley & Oldham, 1985); and vice-versa (Harackiewicz & Elliot, 1993). According to the literature review, **the following observed variables are recognized to manipulate the latent variable "evaluation" in order to enhance the creative performance of individuals**:

- **Constructive and developmental evaluation** (Carson & Carson, 1993; Zhou, 1998; Zhou & Li, 2013): empirical studies have stressed that leaders who provide negative and controlling evaluation to their teams could damage their creative performance. On the contrary these studies argue that leaders who deliver constructive and development evaluation to their teams could enhance their creative performance.
- **Exchange of evaluative information** (De stobbeleir et al., 2008, 2011): studies argue that the exchange of evaluative information enhance individuals' creative performance.

Rethinking the role of leaders for evaluation according to experimental rules would let one think of **new and unexpected observed variables such as nudging to manipulate the latent variable "evaluation"**. In fact, according to cognitive psychology studies, "positive nudging" (labeling an uncreative team as being creative), or "negative nudging" (labeling a creative team as being uncreative) could both have interesting effects on changing/maintaining individuals' states (Agogué, Cassotti, Hooge, & Parguel, 2015a).

IDEO's David Kelley is known to encourage his team using positive remarks even if his team is in difficulty. Again if we analyze this fact from the lens of our experiments, we could say that David Kelley is trying to change the state of his teams from fixation to expansion. In other words, he is trying to defixate his teams using positive nudging.

On the contrary, **there is clear evidence in the biography of Apple's Steve Jobs that he was very demanding vis-à-vis of his team to the level of sometimes considering them as lacking creativity**. We could imagine that Steve Jobs used negative nudging to preserve the state "expansion" of his teams, and push the limits of individuals he considered creative (such as Steve Wozniak) to make innovative things happen.

3.4. The Defixator Decision-Maker

Decision-making is the process of making choices between two or more alternatives (alternatives can take the form of choices between creative ideas, financing options, or even choosing new branch location for a company). The decisional function of leaders depends on the information obtained by their teams, as well as their cognitive abilities to use this information to make the appropriate decisions. When we examine leaders' role as decision-makers in organizations, we would again find according to the literature **the following team creativity-supportive observed variables that served to manipulate the latent variable "decision-making"**:

- **Collective decision-making** (Stasser & Birchmeier, 2003): group decision-making – in opposition to individual decision-making – is usually considered an efficient creativity-supportive variable for creative decision-making processes.
- **Risk-taking in decision-making** (Dewett, 2007): Leaders encouraging their teams to take risks is as well considered another important variable for creativity in decision-making processes. People must be eager to try new and crazy ideas, and perhaps fail to learn from errors. Google's Larry Page or IDEO's David Kelley are known to apply a more or less risk-based decision-making in their leadership style (Brandt, 2011). Indeed, they both used to encourage their subordinates to take risks and make mistakes (Coget et al., 2014).

However, other observed variables such as **the role of "committed non-decision-making" were put aside in the literature review**, despite the fact that it could enable leaders to manipulate employees' states. We could describe "committed non-decision-making" as to the **act of suspending the process of decisions intentionally, in order to search for more new and useful alternatives or new decision opportunities**, alternatives that would be better than all known alternatives (Chu & Hung, 2009; Gregory, Failing, Harstone, Long, McDaniels, & Ohlson, 2012; Keeney, 1994; Nutt, 2004).

In fact, the act of **committed decision-making, as well as committed non-decision-making can serve again as a decision-making tool in the hands of leaders to maintain/change their followers' states**. Apple's Steve Jobs could be categorized as a committed non-decision-maker, in the way he would transform decision-making from convergent to divergent processes, by challenging his teams to create more creative alternatives (Coget et al., 2014). On the contrary, Kodak's Kenneth Mees would be categorized as a committed decision-maker, since he would make fast and radical decisions, such as the one undertaken by his R&D teams to re-build the Kodak research laboratories from scratch (Le Guern, 2017).

3.5. The Defixator Goal-Setter

Goal-setting is another classical leadership function in organizations, and refers to the process of specifying organizational targets, as well as the plan to achieve them. According to the literature review **the following observed variables of the goal-setting (latent variable) are recognized to enhance the creative performance of individuals**:

- **Set creativity as a goal** (CHUA & Iyengar, 2008): one of the variables known to affect creativity is setting "creativity as a goal".
- **Goal specificity and difficulty** (Litchfield, 2009): studies show that the more the goal is specific, difficult or challenging the more creativity of individuals is higher.

However, when we rethink goal-settings according to experimental rules, we would highlight variables that would enable to switch followers' state from fixation to expansion and vice-versa. This variable could consist of **either specifying the goal or specifying what the goal is not**. Indeed, leaders may sometimes specify what the objectives are not – instead of specifying what the objectives and goals are, which may have a positive impact on stimulating creativity among followers. Van de Ven et al. demonstrated that innovation is not necessarily planned and controlled around a well-specified goal (Van de Ven, Polley, & Garud, 2008).

3.6. The Defixator Climate Creator

If we now analyze leaders' role as climate creators in organizations, we would again find according to the literature review **the following variables belonging to climate creation that are recognized to enhance the creative performance of individuals**:

- **Creativity-supportive climate and culture of innovation** (Tesluk, Farr, & Klein, 1997): studies show that leaders creating a creativity-supportive climate and promoting a culture of innovation in their companies are more likely to achieve successful innovation with their teams.
- **Play and serious play** (Heracleous & Jacobs, 2008): studies found that play, and serious play could also serve as an interesting climate creation tool to stimulate employees' creativity in organizations. In fact, having fun engages creativity and have been found to increase creative thinking skills, such as IDEO's David Kelley method of "rush to prototype" (KELLEY, 2001).

Nevertheless, rethinking the role of leaders for climate creation according to our experimental rules could again highlight **other observed variables, such as maintaining an open and**

relaxed environment versus creating a closed and stressful organizational climate (applying a certain type of perturbation in the organizational climate and culture). This new variable could enable switching the state of followers from fixation to expansion for example.

Apple's Steve Jobs for instance, used to create a more or less stressful, judgment-based environment in Apple where employees feel judged and insecure. It is worth mentioning that the same leader could create a culture of pirates, along with a specific flag of pirates in the organization to change the organizational climate and culture among his creative teams (Imbimbo, 2009). On the contrary, Google's CEO maintained Googleplex relaxed and open environment to enable their employees to informally collaborate and exchange ideas (Coget et al., 2014).

3.7. The Defixator Motivator

Finally, motivation is a crucial leadership function in management, and refers to the capacity of a leader to create willingness amongst their staffs to perform in the best of their abilities. If we examine leaders' role as motivators in organizations, we would again find **the following observed variables that are recognized to support team creativity**:

- **Intrinsic motivation** (Amabile, 1998b): findings suggest that intrinsic motivation is one of the principal factors that affects employees' creativity in organizations. Usually, transformational leaders are recognized to intrinsically motivate their teams by the means of their charismatic influence.
- **Extrinsic motivation** (Mumford & Hunter, 2005): similarly, other studies found that extrinsic motivation (such as incentives, rewards, promotion, etc.) can play a crucial role in fostering teams' creative performance in organizations. Similarly, transactional leaders are known to utilize the intrinsic motivation tool to manipulate their teams' creative performances. Amabile argues that **intrinsic motivation is more efficient in stimulating creativity than extrinsic motivation**. However, the author argues that some types of extrinsic motivations (rewards, incentives, etc.) can affect intrinsic motivation if they inspire advances at work (Amabile, 1996).

However, few studies have emphasized variables such as **the role of combining motivation and demotivation for creativity**. In fact, most studies focused on motivating people to enhance their creativity. However, experimental rules for defixation emphasize demotivation as well as a tool to handle individuals' states (maintain the defixated, and change the fixated). For example, Apple's Steve Jobs' used demotivating behavior style in many situations with his teams (Coget et al., 2014).

Nevertheless, this demotivating style didn't prevent his teams from achieving very creative outcomes.

The following table resumes the seven most classical roles of leaders in organizations (latent variable), the classical observed variables for creativity, other relevant observed variables that arise from the defixation rules, as well as an illustration of this defixation rule:

TABLE 7: RETHINKING LEADERSHIP PRACTICES FOR DEFIXATION IN ORGANISATIONS

<table>
<tr><th rowspan="2">Latent Variables: Leaders Organizational Roles</th><th rowspan="2">Observed Variables: Creativity & Leadership Literature</th><th rowspan="2">Relevant Variables according to defixation rules</th><th colspan="2">(A) Leader Detect Team/Task state: "Fixation" | "Expansion"</th></tr>
<tr><th>If state = "Expansion" → then (B1): Leader "Maintain state"</th><th>If state = "Fixation" → then (B2): Leader "Change state"</th></tr>
<tr><td>Recruitment</td><td rowspan="2">- Team diversity
- Rich profiles (expertise, project champions, creative thinkers)
- Salaries and rewarding contracts</td><td rowspan="2">- Design jobs according to the candidate creativity level
- Contractual relationship type with/without subordination</td><td colspan="2">(A): As recruiters, leaders could design jobs according to the creativity level required by the candidates to perform the job, and therefore detect their appropriateness for the jobs</td></tr>
<tr><td>(B1): New types of leader/member contractual relationship that would avoid any kind of subordination such as the relationship between Kenneth Mees and photochemists (Mannes & Godowsky) in the Kodachrome project at Kodak (Le Guern, 2017). Similarly, Google's Larry Page philosophy was to hire highly creative people without imposing standard subordination on them (Coget et al., 2014).</td><td>(B2): Traditional types of contractual relationship with standard subordination, such as the contractual relationship type (with hierarchy) between Kenneth Mees and his R&D team at Kodak (which were considered less creative) (Le Guern, 2017)</td></tr>
<tr><td>Resources and Time Allocation</td><td>- Sufficient resources (appropriate resource allocations)
- Appropriate timing strategies</td><td>- Regulation of Resources and Time Allocation according to creativity projects
- Resources and Time Allowances / Constraints</td><td colspan="2">(A): As resources and time allocators, leaders could regulate high or low resources and time allocations according to the creativity level of the project to accomplish</td></tr>
<tr><td></td><td></td><td></td><td>(B1): Resources and time allowances: Provide extra resources and time for creative behavior persistence, such as 20 per cent time for "pet projects" such as Larry Page and Sergey Brin philisophy at Google (Goffee & Jones, 2007)</td><td>(B2): Impose resources and time constraints, such as Google innovation principle "Creativity loves constraint" imposed by Google's vice president of search products and user experience Marissa Mayer (Dyer et al., 2009)</td></tr>
<tr><td>Evaluation</td><td>- Constructive and developmental evaluation
- Exchange of evaluative information</td><td>- Creativity measurement tests
- Positive/ Negative Nudging</td><td colspan="2">(A): As evaluators, leaders could detect the state of their followers (fixation/expansion) using creativity measurement tests to identify the fixation level of their teams for a particular project</td></tr>
<tr><td></td><td></td><td></td><td>(B1): Positive nudging by labeling people as being very creative, such David Kelley nudging behavior vis-à-vis of his team at IDEO (Kelley & Kelley, 2013)</td><td>(B2): Negative nudging that pushes the limits of their teams, such as Steve Jobs attitude vis-à-vis of his team at Apple (Elliot & Simon, 2011)</td></tr>
</table>

Decision-making	- Collective decision-making - Risk-taking in decision-making	- Resistance to radical decisions - Committed decision-making, and committed non decision-making	(A): As decision-makers, leaders could detect if their teams are fixated or defixated in a specific project by considering their resistance to radical decisions	
			(B1): Committed non decision-making: not making decisions but pushing teams to create new alternatives or decision opportunities. Steve Jobs' highly critical decision-making style was useful in forcing his teams to create better alternatives (Coget et al., 2014)	(B2): Committed decision-making: make radical decisions that make change (re-structure a research team from scratch), such as Kenneth Mees total re-structuration of Kodak Research Laboratories (Le Guern, 2017)
Goal-Setting	- Set creativity as a goal - Specific and difficult goals	- Set ambiguous goals - Remind the goal or Specify what the goal is not	(A): As goal-setters, leaders could set ambiguous goals for their teams, and then distinguish how individuals adapt themselves creatively according to these goals	
			(B1): Remind the team with the goals of the organizations. Thomas Edison is a good example of the leader who had great abilities to clearly remind his creative teams with the goal of the organization.	(B2): Specify what the goal is not, what the objectives are not (attitude vis-à-vis of uncreative teams)
Climate Creation	- Creativity-supportive climate and culture of innovation - Play and serious play	- Comfort levels in varied environments - Open and relaxed versus closed and stressful organizational climate	(A): As climate creators, leaders could differentiate fixated/defixated members in their teams according to their comfort levels in varied environments (bureaucratic, stable, unstable, etc.)	
			(B1): Maintain a relaxed and open climate and culture: Google's CEO maintained Googleplex climate inside Google headquarters to enable his employees to informally collaborate together in friendly and relaxed social environment(Coget et al., 2014)	(B2): Create a new more or less close and stressful organizational environment such as Steve Jobs' work climate in Apple, in which employees feel judged and insecure (Imbimbo, 2009)
Motivation	- Intrinsic motivation - Extrinsic motivation (rewards, incentives, etc.)	- Willingness to perform creative tasks - Activate motivation (motivate) or deactivate motivation (demotivate)	(A): As motivators, leaders could distinguish between fixated and defixated individuals according to their willingness to perform creative tasks	
			(B1): Motivate team with facilitative behavior, encouraging, and push-forward style, which is the motivator style used by leaders such as Larry Page at Google (Vise, 2007) or IDEO's David Kelley (Kelley & Kelley, 2013)	(B2): Demotivate team with demanding behavior, push-back, and redirector style, which is as well considered a form of motivator style used by leaders such as Steve Jobs at Apple (Kothari, 2010)

IV. Summary of Chapter VIII

Below is a summary box presenting the key points of chapter VIII:

- In many organizations, leaders do not necessarily detect fixation but can rather detect what is the "dominant design" of a project
- In real organizational contexts, leaders do not only provide their teams with instructional processes but numerous means of actions can replace its roles
- Leaders usually consider well-known observed variables to manipulate a set of latent variables
- We selected seven latent variables, i.e. the seven most typical leadership roles in organizations: recruitment, resource and time allocation, evaluation, decision-making, goal-setting, climate creation, and motivation
- We demonstrated how laboratory experiments can help us to shed the light on other new observed variables – usually unconsidered by the literature of leadership and creativity – that could be more convenient to execute the defixation rules obtained in our experiments: "change" when team/task fixated, "maintain" when team/task defixated
- We illustrated the cases of these new observed variables for the defixator recruiters, resource and time allocators, evaluators, decision-makers, goal-setters, climate creators, and motivators using biographies of great innovative leaders

Chapter IX: Conclusions and Discussions

We end our thesis dissertation with chapter IX, which concludes with the major contributions of our research thesis, the limitations, the future perspectives, and the thesis-related publications.

I. Major Contributions of the Research Thesis

1. New Figures of "Defixator" and "Fixator" Leaders

Apart from generating new figures of defixator leaders, which was considered a major result of this Ph.D. research thesis in chapter VI, the four theory-driven experiments have also helped us to shed the light on **different categories of "fixator" leaders, i.e. leaders that foster fixation effects during creative idea generation situations**. In fact, our studies have demonstrated how leaders that intervene before or during creative ideation sessions through instructions or feedbacks can have damaging effects on the creative performance of their teams (even if this was not the objective of the research):

- **Inappropriate formulation of uncreative examples of solutions**:

One figure of "fixator" leaders that could be extracted from the theory-driven experiment 1 is the leader who inappropriately formulates uncreative solutions to his/her teams. As a matter of fact, in this experiment we have shown that uncreative examples – if formulated by leaders in a high level of specificity – can increase fixation effects in creative idea generation situations.

- **Unchanging strategies without knowledge**:

Theory-driven experiments 2 have shown that leaders, who intervene during the ideation processes of their teams without knowledge at all, by simply applying unchanging strategies (such as the changer or the maintainer), could be misleading in certain conditions. In fact, when teams were defixated, changer leaders (promoting flexibility) played the role of re-fixator for them. Similarly, when teams were fixated, maintainer leaders (promoting persistence) increased fixation.

- **Incongruent feedbacks**:

The incongruent leaders – experimented in the theory-driven experiment 3 – have an excellent capacity to recognize both creative ideas (outside fixation) and uncreative ideas (inside fixation). However, one could label them as "dominant design leaders" or "status quo leaders", which means that the creative ideas generated by their teams are simply undesirable for them. There are several reasons for this fact: they may prefer to stick to the dominant design of the projects they are

working on with their teams, or they could simply be afraid of diverging too much from the status quo for multiple reasons (leadership responsibilities, financial or timing constraints, instructions from their superiors, etc.), or simply they may consider creative ideas as unrealistic or unpractical for a particular moment.

- **Imperfect recognition of fixation/expansion**:

Low knowledgeable leaders – originated from theory-driven experiments 4 – such as random leaders, and fixation or expansion expert leaders, could also be considered as another interesting form of misleading leaders. As a matter of fact, they differ from incongruent leaders in a way that they have imperfect abilities to recognize (either or both) creative and uncreative ideas. One could label them as simply "novice leaders" or "inexperienced leaders", since they interact with their teams while they are not confident of their choices. They consequently provide their teams with incongruent feedbacks during the creative process that could disturb their creative performance. However, fixation-expert leaders are more likely to be inadequate if confronted with defixated teams. Similarly, expansion-expert leaders are more likely to be inadequate if confronted with fixated teams.

2. Redefinition of Leadership for Creativity

2.1. Redefinition of Leadership Centered on Cognitive Approaches of Creative Ideation

The classical definition of leadership refers to it as "a process of social influence in which the leader enlist the support of his/her followers to accomplish a common task" (Chemers, 2014). In the present thesis, **we have attempted to shape new forms of leadership for creativity and defixation, with a major focus on its "cognitive influence" on followers (rather than social influence), by isolating the cognitive mechanisms of leaders to help their teams overcome fixation effects in creative ideation contexts**. Along the design of figures of defixator leaders, the principal goal was to uncover the underlying cognitive mechanisms of leadership for creative idea generation.

Indeed, in the present thesis, we have revised the identity of creative leaders, their means of actions, their competencies, and their contingent strategies. **This revision has opened the way to new and unexpected variables that were not taken into account before when developing leadership models along the evolutionary eras of leadership**, such as the cognitive capacities of leaders (their capacities to recognize certain ideas whether in fixation or outside fixation, as well as their capacities to categorize ideas, i.e. formulate ideas at a high level of abstraction). Similarly, this revision has enabled us to pay attention to new variables for followers as well (their capacities to

defixate themselves, to reason outside the fixation, to resist certain heuristics, to persist in generating ideas outside fixation, etc.).

2.2. Intermediate Figures between the Innovator and the Facilitator

In addition, we have responded to the challenges fixed in the research objectives regarding the new figures of defixator leaders. Intermediate figures of leaders between the innovator and the facilitator were generated. Indeed, our figures of defixator leaders **were not in the form of "the innovator"**, i.e. they do not ideate themselves and provide their teams with creative ideas and solutions. They were leading their teams to structure an unknown space of solutions without being perfectly knowledgeable. Moreover, our figures of defixator leaders **were not in the form of "the facilitator"**, i.e. they were highly involved in the creative processes of their teams. They could participate in the ideation process with minimal feedbacks that were just in the form of guiding instructions ("continue in this path" or "search for another path".

3. Modeling Leadership-driven Idea Generation Mechanisms

Moreover, we have designed our **new figures of defixator leaders based on a model of leadership-driven ideation**. In fact, we first modelled ideation using design theory (C-K theory), and then sequential ideation using probability theory (Markov models). We then used this model to shape the precise means of actions of our figures of leaders. Moreover, the model helped us to identify what competencies are required by the leaders (defixator leaders) to defixate their teams (the ideators), and helped us as well to develop contingent strategies for defixation by simulating this model in various situations.

The principal contributions resulted from modelling leadership-driven ideation mechanisms were that it **served as a perfect tool to design the means of actions of defixator leaders (stimuli in the form of instructions and feedbacks), as well as their predicted cognitive effects on followers**. On one hand, the leadership-driven ideation model helped to better characterize the role of defixator leaders in terms of the required knowledge for defixation, as well as the necessary means of actions to defixate individuals. On another hand, the model served as an accurate metric to measure the creative ideation performance of individuals (fixation/expansion metrics, as well as transition probabilities between states), and most importantly to predict what leadership behaviours would be required to enhance them.

In addition, since fixation is perceived today by design scholars as a concept that should be linked to a much broader context comprising several fields (Crilly & Cardoso, 2017), the **leadership-driven ideation model served as a tool to better understand the interactions that occur between internal mental states of ideators (their ideation paths, their cognitive capacities, etc.), and the external stimuli (instructions, feedbacks, etc.) of defixator leaders**.

4. New Defixation Methodologies

4.1. Defixation using Constraints on Abstract Reformulation of Uncreative Examples: The Role of Categorization

Our experiments have provided new sights into the literature related to the role of examples for creativity, and especially related to the effects of uncreative – also named restrictive in other studies (Agogué et al., 2014a) – examples of solutions on fixation. Indeed, in the theory-driven experiment 1, we have demonstrated **how uncreative examples – if formulated by leaders in a high level of abstraction, such as a categorization of these examples – can play a crucial role to help their teams overcome fixation** effects in creative idea generation situations.

In fact, previous design studies had already shown that individuals could overcome fixation by problems reframing or abstract reformulation of problems (Linsey et al., 2010; Zahner et al., 2010). As a matter of fact, **abstract problem reformulation is known to expand the exploration of the solution space outside fixation**. However, the effects of abstract reformulation of uncreative examples were a major contribution of this research thesis, and precisely opened new perspectives for understanding the crucial role of categorization for fixation mitigation.

4.2. Defixation using Minimal Executive Feedbacks

Another defixation methodology provided from theory-driven experiment 3 was the defixation using minimal executive feedbacks. Indeed, results of this experiment have demonstrated how **minimal executive feedbacks could be used to gradually force individuals' reasoning to get out of fixation, and explore novel and creative ideas** and solutions to problems. We have demonstrated that minimal executive feedbacks could improve performance by facilitating the inhibition of ideas within fixation and stimulating the exploration of ideas in expansion. Of course, these minimal executive feedbacks were congruent, which means that feedback provided by leaders suggested that the follower "search for another path" when the proposed solution belonged to the fixation path and "continue in this path" when the solution belonged to the expansive path.

These results extended previous findings both in cognitive psychology and management literature. In fact, it gave new sights in cognitive psychology literature regarding the influence of training paradigms involving explicit executive feedback on various reasoning biases (Cassotti & Moutier, 2010; Houdé & Moutier, 1996, 1999). In addition, these findings were also in accordance with previous studies arguing that feedbacks in general, and more precisely executive feedbacks, can regulate the creative performances of individuals (Zhou & Li, 2013), as well as the studies that argued that the delivery of constructive feedback can positively influence creativity (Carson & Carson, 1993; De stobbeleir et al., 2008; Zhou, 1998, 2003).

5. Shedding the Light on New Leadership Practices for Defixation in Organizational Contexts

In the present thesis, based on the series of laboratory theory-driven experiments we have made, we were able to shed the light on new leadership practices for defixation in organizational contexts. In other words, we were able to **shape new leadership roles for defixation in organizations according to what we called "leadership defixation rules"**, i.e. leadership-based defixation methods extracted from laboratory experiments.

As a matter of fact, we selected seven of the most typical leadership roles in organizations, and demonstrated – using empirical data of great innovative leaders – **how each of the seven traditional practices of leaders in organizations could be revisited according to "leadership defixation rules"**. Indeed, these experimental rules enabled us to shed the light on specific variables (belonging to each leadership organizational role), which were put aside, and usually not considered in the literature of leadership and creativity.

6. "Leadership Control" Does Not Always Kill Creativity

As mentioned in chapter III of this thesis, leadership and creativity have usually been viewed as antagonist concepts, compromised between two contradictory variables: control and freedom. **Studies – especially in management sciences – suggested that in order for creativity to emerge and flourish, leaders should grant more freedom and autonomy to their followers** (Amabile, 1998b; Amabile et al., 1996).

From a management science perspective, our results confirmed the point of view of most management scholars arguing that leaders should grant more freedom and autonomy to their

followers in order for creativity to emerge, since theory-driven experiment 2 demonstrated that **interacting with a team without knowledge and vision noticeably obstructed the creative idea generation capacity of subordinates**.

However, despite the negative perception of "control" on creativity as reported by management and creativity literature, we also demonstrated in this thesis that on the contrary, **control could enhance employees' creative performance in certain cases, provided that leaders have appropriate vision and domain-relevant knowledge**. In fact, our findings showed that ideation processes could be controlled and directed towards potential directions for creativity (expansion zone) via minimal executive feedbacks, provided that leaders have a minimum knowledge and vision for creativity. In other words, leaders should know the dominant design, and should be able at least to identify and recognize the principal categories of uncreative ideas and solutions.

7. The Process of Defixation is not Enough: The Importance of Maintaining Expansion

In the present thesis, we have introduced four different types of ideators (A, B, C, and D). **Among these four types, two were especially interesting since they were high at re-fixation**. In fact, ideator A had a very low capacity of defixation in creative ideation tasks, and even when defixated, this ideator was incapable of maintaining the state of expansion. Ideator type D was better than ideator type A in a way that he/she had a very high capacity of getting out from fixation. However, when defixated, ideator type D was incapable of maintaining the state of expansion, and quickly became re-fixated again.

These two types of ideators emphasize the fact that defixation alone is important but not enough, and that the process of **maintaining expansion could sometimes be even more difficult than defixation** itself. As a matter of fact, if individuals don't have the ability to persist in generating creative ideas, they could effortlessly return back to their initial state: fixation.

Indeed, as we have mentioned in previous chapters, **defixation studies were frequently "fixated" on defixation as the turning point to creativity**, giving less attention to expansion, i.e. the process of maintaining individuals outside fixation. In other words, one important role of defixator leaders is to assure their teams maintain their "good" creative performance, and persist in generating ideas that are "out of the box (fixation)".

II. Limitations

1. Students as Experimental Participants

Except for theory-driven experiment 1, in which the experimental participants were a mix of engineering students and professional experts working in French innovation companies, one limitation of our present work is that **the population that was used for the experiments were mostly based on university students**, and especially students from the Faculty of Psychology of Paris Descartes University. Using students as a sample for experiments do not constitute a critical problem, given that the recruited subjects agree to be manipulated in controlled environments for some period of time, and that all participants provided written consent and were tested in accordance with national and international norms governing the use of human research participants. At the same time, there is no doubt that the practical challenges of subject recruitment for experiments have led us to rely on convenience samples of university students. However, for some reviewers and scholars – especially in management science – the use of students as participants for experiments could sometimes remain insufficient to confirm or refute certain hypotheses.

2. Short Duration of the Experiments

One limitation of our work is that the idea generation session for all our theory-driven experiments was only 10 minutes long. Since some creativity studies suggest that creative ideas may emerge later in the ideation process, this short duration could have limited the capacity of participants to generate more creative and novel ideas. At the same time, we have noticed along our experiments that usually participants finish generating ideas and solutions for the hen's egg task before the end of the specified period (10 minutes), hence the ten minutes duration for this particular task seems to be sufficient. In addition, since the aim of the experiments was to compare its results with previous ones made for the same creativity task in similar experimental conditions (Agogué et al., 2014a), the short duration of our experiments was not considered a critical problem in the present thesis.

3. Not Involving Ordinary Participants in the Evaluation of Creative Ideas

In theory-driven experiment 4, we explored the effect of feedbacks provided by defixator leaders to their followers, in specific cases in which they lead ideators in the unknown with imperfect knowledge. In this experiment, we showed that **three types of low knowledgeable defixator leaders**

(random, fixation-expert, and expansion-expert) could be more effective if they face specific types of ideators (type A, B, C or D).

Since a fixed framework based on C-K theory was used for all our theory-driven experiments (Agogué et al., 2014a), with a predefined repertoire of what ideas belonged to fixation or expansion in the hen's egg task, **we did not involve ordinary "inexpert" participants in the evaluation of creative ideas** (i.e., in providing ideators with minimal executive feedbacks). In fact, it could have been fruitful in terms of experimental findings to recruit participants (playing the role of "defixator leaders"), and ask them to evaluate other participants' ideas (playing the role of "ideators"), according to their proper vision of what ideas are creative (outside the box), or uncreative (inside the box). This would have also been in line with previous studies confirming the appropriateness of ordinary users in the assessment of ideas in the early phase of ideation (Magnusson et al., 2016).

4. No Post-Experimental Interviews

In all the theory-driven experiments, **we did not include written post-experiment interviews with participants,** in order to better understand how the participants understood the feedbacks ("continue in this path", or "search in this path"), or the way they interpreted and approached experimenter's instructions or feedbacks, or if they were aware they were blocked to specific categories of solutions (i.e. if they were aware they were fixated), or even if they hesitated to submit particular ideas or solutions to the hen's egg task. Indeed, the experimenters could only discuss these issues orally with the participants after the experiments but did not have a written record of these data. There is no doubt that post-experimental interviews (and interviews more generally) would have helped to clarify these several issues related to the attitude of participants towards fixation (Crilly, 2015). Finally, these interviews would have helped us to better adjust and ameliorate our future experimental protocols.

5. Defixation from Laboratory Settings to "Real World" Settings

In chapter VIII, we illustrated how our laboratory theory-driven experiments, helped us to shed the light on new leadership practices for defixation in organizational contexts. In other words, it helped us to re-interpret the phenomenon of fixation from a purely organizational perspective, from the lens of organizations' leaders. In this part of our thesis work, **we introduced a method for linking real-life organizational settings with laboratory research settings in the case of leadership and their roles in defixation**, and how they promote teams to overcome mental blocks in innovation. In fact,

these could be considered interesting "managerial implications" resulted from our thesis since most fixation studies employ experimental research methods unwell linked to the real world.

However, **it is important to point out that these findings were just a first step towards better understanding the roles of defixator leaders inside organizations**. In this part of our thesis work (step 3 of our research method), we identify ways leaders can help mitigate fixation in organizations, through who/how they recruit their team members, how much time/space they provide to their teams, how they evaluate performance of their teams, make decisions, set goals, create climate and culture or motivate people. All these are interesting points and new perspectives that can be learned from our laboratory experiments but of course, there is no doubt that defixation in a laboratory setting differ very much from defixation in a complex organizational context.

Nevertheless, **more studies should be made inside organizations – not only uncover the roles of defixator leaders – but to experiment these roles**, and to clarify the move of a defixation process that is designed to work in a highly controlled setting (such as a laboratory experiment setting), being then applied to the overall messy realities of a big organization. Indeed, by shifting from the laboratory to the complex and uncontrolled "real world", we are dealing with a big number of socio-cognitive and environmental variables that all could have different effects on cognitive processes such as fixation. This is the reason why our research method (step 1) suggested from the beginning neutralizing all these variables to precisely analyze the cognitive mechanisms of defixation.

III. Future Perspectives

1. Learning Process of Defixator Leaders

It is important to note that **good defixator leaders can help their teams to learn to develop their own creative ideation strategies to overcome fixation**. Theory-driven experiment 1 and 3 are perfect illustrations of this fact. On one hand, defixator leaders 1 could help their teams to enhance their creative ideation skills by imposing constraints on fixation categories. Ideators had to develop their own strategies to generate alternative ideas and solutions outside fixation. On another hand, defixator leaders 3 were able to develop a learning process that helped their teams to gradually explore novel and creative ideas and solutions to problems.

However, there is no doubt that **with appropriate learning strategies (mental activities and procedures), defixator leaders can also learn to be prolific defixators**. As a matter of fact, defixator leaders can learn from the ideas generated by their teams or from previous situations. For instance,

they can notice the occurrence of certain types of ideas, and consequently detect the emergence of mental blocks during their teams' creative ideation processes. One future perspective of our work is to integrate this crucial aspect of learning for defixators, i.e. learning to be good defixators.

2. Memory-less Markov-based Model: Leadership-driven Ideation

It is important to note that **leadership-driven ideation model is a good first step towards specifying the defixating role of leaders in the ideation processes of their teams**. Indeed, as we mentioned in chapter V, creative ideation would have been very hard to study without a leadership-driven ideation model. This model was perhaps – to the best of our knowledge – the finest way to both understand and predict defixation behaviors, and consequently generate efficient leadership strategies to overcome fixation.

However, **the "memory-less" property of the Markov-based leadership-driven ideation model is not in full accordance with real ideation phenomena**. In fact, ideation phenomena could not be considered memory-less, and future states should depend on the sequence of events that preceded it, and not only depend on the present state. Therefore, in order to model ideation more adequately and be able to better understand and predict individuals' ideation behaviors, memory should be considered. In other words, all previous ideas generated by teams – and not only the previous idea generated – must be taken into consideration by defixator leaders. This memory property of the leadership-driven ideation model would be an excellent way to model learning processes of defixator leaders. In other words, it would help defixator leaders to learn from previous ideas generated by their teams as specified in the previous section.

3. Future Experiments Inspired from Novelty-Search Algorithm: Search For Novelty without Objectives

In line with the above memory-based model of leadership-driven ideation, we could imagine future experiments in which defixator leaders could ask ideators to generate alternative ideas to all the ideas already generated by them: "**search other paths than all the paths you have already undertaken**". These experiments could be in line with recent interesting studies done in evolutionary computation, which have highlighted new horizons in real-world problems using novel techniques to drive and lead particular search processes through computational algorithms.

One recent result in evolutionary robotics showed that driving and guiding a robot by focusing on the performance criteria, which consist of rewarding the robot getting closer to the goal, could be sometimes misleading (Lehman & Stanley, 2011). These findings were demonstrated in a set of computation tests done within the context of maze solving algorithms (which is not very far from classical problem-solving approaches), and have shown that **driving a search process using a "search for novelty" oriented approach (rewarding novelty behaviors, not necessarily closer to the goal, i.e. not essentially near the output of the maze) could lead to better results than driving it using a "search for performance" oriented approach (which rewards getting closer to the goal)**. Actually, novelty-search algorithm tends to ignore the objective element, and searches for novel behaviors by avoiding paths already undertaken, and this according to an already pre-existing memory.

4. Group Creativity and the Role of Social Biases

Due to multiple social biases (production loss, free riding, evaluation apprehension, perception of risks, social rejection, etc.) individuals have been found to be less effective when ideating in groups than individually (Dugosh & Paulus, 2005; Hatchuel et al., 2009; Kohn & Smith, 2011; Mueller et al., 2011; Nijstad & Stroebe, 2006). In all experiments, **we focused principally on the individual aspects of creativity, putting aside the group and team aspects of it**. Of course, as we indicated in chapter IV, all these social biases were neutralized along with other traditional leadership variables in our thesis in order to precisely examine the cognitive aspects of fixation in creative ideation. Therefore, our experiments were designed in a way to focus only on the individual aspects of creativity.

Even if we have discussed the re-integration of neutralized variables – especially organizational variables, i.e. leadership traditional practices inside organizations) in chapter VIII (step 3 of our research method – there must be some future studies **to assess whether these above-mentioned social biases present during group interaction would have fostered or mitigated fixation in creative ideation contexts**. There is clear evidence that these social biases may have opposite effects on fixation. The exposure to other partners may defixate and stimulate creativity, which means that group interaction could in certain cases help to inhibit the ideation process during a brainstorming session. At the same time, these social biases could also reinforce fixation in other cases.

References

Abernathy, W., & Utterback, J. 1975. A dynamic model of product and process innovations. ***Omega***, 3(6).

Adamson, R. E. 1952. Functional fixedness as related to problem solving: a repetition of three experiments. ***Journal of experimental psychology***, 44(4): 288.

Agogué, M. 2016. ***Alex F. Osborn - Le brainstorming, premier outil de support à la pensée créative***: Éditions EMS.

Agogué, M., Cassotti, M., Hooge, S., & Parguel, B. 2015a. Nudging creativity: The effect of priming on individual ideation. EMAC conference Oslo 2016.

Agogué, M., Kazakçi, A., Hatchuel, A., Masson, P., Weil, B., Poirel, N., & Cassotti, M. 2014a. The Impact of Type of Examples on Originality: Explaining Fixation and Stimulation Effects. ***The Journal of Creative Behavior***, 48(1): 1-12.

Agogue, M., Le Masson, P., Dalmasso, C., Houdé, O., & Cassotti, M. 2015. Resisting Classical solutions: the creative mind of engineers and designers. ***Psychology of Aesthetics, Creativity, and the Arts***.

Agogué, M., Le Masson, P., Dalmasso, C., Houdé, O., & Cassotti, M. 2015b. Resisting classical solutions: The creative mind of industrial designers and engineers. ***Psychology of Aesthetics, Creativity, and the Arts***, 9(3): 313.

Agogué, M., Le Masson, P., & Robinson, D. K. 2012. Orphan innovation, or when path-creation goes stale: a design framework to characterise path-dependence in real time. ***Technology Analysis & Strategic Management***, 24(6): 603-616.

Agogué, M., Poirel, N., Pineau, A., Houdé, O., & Cassotti, M. 2014b. The impact of age and training on creativity: a design-theory approach to study fixation effects. ***Thinking Skills and Creativity***, 11: 33-41.

Akin, Ö. 1990. Necessary conditions for design expertise and creativity. ***Design Studies***, 11(2): 107-113.

Al'tšuller, G. S. 1999. ***The innovation algorithm: TRIZ, systematic innovation and technical creativity***: Technical Innovation Center, Inc.

Amabile, T. 1996. ***Creativity in context***: Westview press.

Amabile, T. 2012. ***Componential theory of creativity***: Harvard Business School Boston, MA.

Amabile, T., & Gryskiewicz, S. S. 1987. ***Creativity in the R&D laboratory***: Center for Creative Leadership.

Amabile, T. M. 1979. Effects of external evaluation on artistic creativity. ***Journal of personality and Social Psychology***, 37(2): 221.

Amabile, T. M. 1983. The social psychology of creativity: A componential conceptualization. ***Journal of personality and social psychology***, 45(2): 357.

Amabile, T. M. 1998a. How to kill creativity: Harvard Business School Publishing Boston, MA.

Amabile, T. M. 1998b. ***How to kill creativity***: Harvard Business School Publishing Boston, MA.

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. 1996. Assessing the work environment for creativity. ***Academy of management journal***, 39(5): 1154-1184.

Anderson, N. R., & West, M. A. 1998. Measuring climate for work group innovation: development and validation of the team climate inventory. ***Journal of organizational behavior***: 235-258.

Avolio, B. J., & Gardner, W. L. 2005. Authentic leadership development: Getting to the root of positive forms of leadership. ***The leadership quarterly***, 16(3): 315-338.

Avolio, B. J., Kahai, S., & Dodge, G. E. 2001. E-leadership: Implications for theory, research, and practice. ***The Leadership Quarterly***, 11(4): 615-668.

Barsh, J., Capozzi, M. M., & Davidson, J. 2008. Leadership and innovation. ***McKinsey Quarterly***, 1: 36.

Baruah, J., & Paulus, P. B. 2009. Enhancing group creativity: the search for synergy, ***Creativity in groups***: 29-56: Emerald Group Publishing Limited.

Bass, B. M. 1991. From transactional to transformational leadership: Learning to share the vision. ***Organizational dynamics***, 18(3): 19-31.

Bass, B. M., & Avolio, B. J. 1993. Transformational leadership: A response to critiques. ***Leadership theory and research: perspectives and directions***: 49-80.

Bass, B. M., & Avolio, B. J. 1997. ***Full range leadership development: Manual for the Multifactor Leadership Questionnaire***: Mind Garden Palo Alto, CA.

Bass, B. M., & Stogdill, R. M. 1990. Handbook of leadership. ***Theory, Research & Managerial Applications***, 3.

Bassett-Jones, N. 2005. The paradox of diversity management, creativity and innovation. ***Creativity and innovation management***, 14(2): 169-175.

Baughman, W. A., & Mumford, M. D. 1995. Process-analytic models of creative capacities: Operations influencing the combination-and-reorganization process. ***Creativity Research Journal***, 8(1): 37-62.

Benedek, M., Franz, F., Heene, M., & Neubauer, A. C. 2012. Differential effects of cognitive inhibition and intelligence on creativity. ***Personality and individual differences***, 53(4): 480-485.

Bennis, W., & Nanus, B. 1985. The strategies for taking charge. ***Leaders, New York: Harper. Row***.

Berkun, S. 2010. ***The myths of innovation***: " O'Reilly Media, Inc.".

Beverland, M., & Farrelly, F. J. 2007. What Does It Mean to Be Design-led? ***Design Management Review***, 18(4): 10-17.

Biggerstaff, J. K. 2012. The relationship between teacher perceptions of elementary school principal leadership style and teacher job satisfaction.

Binns, A., Harreld, J. B., O'Reilly, C., & Tushman, M. L. 2014. The art of strategic renewal. ***MIT Sloan Management Review***, 55(2): 21.

Blake, R. R., Mouton, J. S., & Bidwell, A. C. 1962. Managerial grid. ***Advanced Management-Office Executive***.

Bolden, R., Gosling, J., Marturano, A., & Dennison, P. 2003. A review of leadership theory and competency frameworks: Centre for Leadership Studies, University of Exeter Exeter.

Bonnardel, N. 2000. Towards understanding and supporting creativity in design: analogies in a constrained cognitive environment. ***Knowledge-Based Systems***, 13(7): 505-513.

Bonnardel, N., & Marmèche, E. 2004. Evocation processes by novice and expert designers: Towards stimulating analogical thinking. ***Creativity and Innovation Management***, 13(3): 176-186.

Bonnardel, N., & Marmèche, E. 2005. Towards supporting evocation processes in creative design: A cognitive approach. ***International Journal of Human-Computer Studies***, 63(4): 422-435.

Borst, G., Poirel, N., Pineau, A., Cassotti, M., & Houdé, O. 2013. Inhibitory control efficiency in a Piaget-like class-inclusion task in school-age children and adults: A developmental negative priming study. ***Developmental psychology***, 49(7): 1366.

Boyatzis, R. E. 2008. Competencies in the 21st century. ***Journal of management development***, 27(1): 5-12.

Brandt, R. L. 2011. ***The Google Guys: Inside the Brilliant Minds of Google Founders Larry Page and Sergey Brin***: Penguin.

Brown, V., Tumeo, M., Larey, T. S., & Paulus, P. B. 1998. Modeling cognitive interactions during group brainstorming. ***Small group research***, 29(4): 495-526.

Bruch, H., & Ghoshal, S. 2003. Unleashing organizational energy. ***MIT Sloan Management Review***, 45(1): 45.

Brun, J., Ezzat, H., & Weil, B. 2015. ***Managing the impacts of non-verbal devices on idea generation: a new challenge for creative leaders***. Paper presented at the European Academy of Management-EURAM, Warsaw, Poland.

Brungardt, C. 1997. The making of leaders: A review of the research in leadership development and education. ***Journal of Leadership & Organizational Studies***, 3(3): 81-95.

Burns, J. M. 1978. leadership. NY: Harper & Row.

Camarda, A., Borst, G., Agogué, M., Habib, M., Weil, B., Houdé, O., & Cassotti, M. . 2017. Do we need inhibitory control to be creative? Evidence from a dual-task paradigm. . ***Psychology of Aesthetics, Creativity and the Arts.***

Camarda, A., Ezzat, H., Cassotti, M., Agogué, M., Weil, B., & Le Masson, P. 2017. The Role of Expertise in Design Fixation: Managerial Implications for Creative Leadership.

Carmeli, A., & Paulus, P. B. 2015. CEO ideational facilitation leadership and team creativity: The mediating role of knowledge sharing. ***The Journal of Creative Behavior***, 49(1): 53-75.

Carr, A., & Tomasco, S. 2010. The most important leadership quality for CEOs? Creativity. ***Fast Company***(May 18).

Carson, P. P., & Carson, K. D. 1993. Managing Creativity Enhancement Through Goal-Setting and Feedback*. ***The Journal of Creative Behavior***, 27(1): 36-45.

Cassotti, M., Agogué, M., Camarda, A., Houdé, O., & Borst, G. 2016a. Inhibitory Control as a Core Process of Creative Problem Solving and Idea Generation from Childhood to Adulthood. ***New Directions for Child and Adolescent Development***, 2016(151): 61-72.

Cassotti, M., Camarda, A., Poirel, N., Houdé, O., & Agogué, M. 2016b. Fixation effect in creative ideas generation: Opposite impacts of example in children and adults. ***Thinking Skills and Creativity***, 19: 146-152.

Cassotti, M., & Moutier, S. 2010. How to explain receptivity to conjunction-fallacy inhibition training: Evidence from the Iowa Gambling Task. ***Brain and cognition***, 72(3): 378-384.

Chaffois, C., Gillier, T., Belkhouja, M., & Roth, Y. 2015. ***How task instructions impact the creativity of designers and ordinary participants in online idea generation***. Paper presented at the 22nd innovation & product development management conference.

Chemers, M. 2014. ***An integrative theory of leadership***: Psychology Press.
Cheng, L., Hu, W., Jia, X., & Runco, M. A. 2016. The different role of cognitive inhibition in early versus late creative problem finding. ***Psychology of Aesthetics, Creativity, and the Arts***, 10(1): 32.
Chi, M. T., Feltovich, P. J., & Glaser, R. 1981. Categorization and representation of physics problems by experts and novices. ***Cognitive science***, 5(2): 121-152.
Chrysikou, E. G., & Weisberg, R. W. 2005. Following the wrong footsteps: fixation effects of pictorial examples in a design problem-solving task. ***Journal of Experimental Psychology: Learning, Memory, and Cognition***, 31(5): 1134.
Chu, P., & Hung, C. 2009. The relationship of paternalistic leadership and organizational citizenship behavior: The mediating effect of upward communication. ***Journal of Human Resource and Adult Learning***, 5(2): 66-73.
CHUA, R. Y. J., & Iyengar, S. S. 2008. Creativity as a matter of choice: Prior experience and task instruction as boundary conditions for the positive effect of choice on creativity. ***The Journal of Creative Behavior***, 42(3): 164-180.
Coget, J.-F., Shani, A., & Solari, L. 2014. The lone genius, or leaders who tyrannize their creative teams. ***Organizational Dynamics***, 43(2): 105-113.
Conger, J. A. 1999. Charismatic and transformational leadership in organizations: An insider's perspective on these developing streams of research. ***The leadership quarterly***, 10(2): 145-179.
Corrigan, P. 1999. ***Shakespeare on management: leadership lessons for today's managers***: Kogan Page Publishers.
Cox, T. H., Lobel, S. A., & McLeod, P. L. 1991. Effects of ethnic group cultural differences on cooperative and competitive behavior on a group task. ***Academy of management journal***, 34(4): 827-847.
Crilly, N. 2015. Fixation and creativity in concept development: The attitudes and practices of expert designers. ***Design Studies***, 38: 54-91.
Crilly, N., & Cardoso, C. 2017. Where next for research on fixation, inspiration and creativity in design? ***Design Studies***, 50: 1-38.
Daft, R. 2014. ***The leadership experience***: Cengage Learning.
Davenport, T. H., Leibold, M., & Voelpel, S. C. 2007. ***Strategic Management in the Innovation Economy: Strategic Approaches and Tools for Dynamic Innovation Capabilities***: John Wiley & Sons.
Day, D. V. 2001. Leadership development: A review in context. ***The Leadership Quarterly***, 11(4): 581-613.
De stobbeleir, K. E., Ashford, S. J., & Buyens, D. 2008. Feedback-Seeking Behavior as a Self-Regulation Strategy for Creative Performance. ***Academy of Management Journal***, 54(4): 811-831.
De Stobbeleir, K. E., Ashford, S. J., & Buyens, D. 2011. Self-regulation of creativity at work: The role of feedback-seeking behavior in creative performance. ***Academy of Management Journal***, 54(4): 811-831.
Denis, J.-P. 2014. ***Introduction au hip-hop management***: Éditions EMS.
Denison, D. R., Hooijberg, R., & Quinn, R. E. 1995. Paradox and performance: Toward a theory of behavioral complexity in managerial leadership. ***Organization Science***, 6(5): 524-540.
Denti, L., & Hemlin, S. 2012. Leadership and innovation in organizations: A systematic review of factors that mediate or moderate the relationship. ***International Journal of Innovation Management***, 16(03): 1240007.
Dess, G. G., & Picken, J. C. 2001. Changing roles: Leadership in the 21st century. ***Organizational dynamics***, 28(3): 18-34.
Deutschman, A. 2001. ***The second coming of Steve Jobs***: Crown Business.
Dewett, T. 2007. Linking intrinsic motivation, risk taking, and employee creativity in an R&D environment. ***R&D Management***, 37(3): 197-208.
Dow, S. P., & Klemmer, S. R. 2011. The efficacy of prototyping under time constraints, ***Design Thinking***: 111-128: Springer.
Dugosh, K. L., & Paulus, P. B. 2005. Cognitive and social comparison processes in brainstorming. ***Journal of experimental social psychology***, 41(3): 313-320.
Duncker, K., & Lees, L. S. 1945. On problem-solving. ***Psychological monographs***, 58(5): i.
Dyer, J. H., Gregersen, H. B., & Christensen, C. M. 2009. The innovator's DNA. ***Harvard business review***, 87(12): 60-67.
Elliot, J., & Simon, W. 2011. ***The Steve Jobs way: iLeadership for a new generation***: Vanguard.
Elmquist, M., & Le Masson, P. 2009. The value of a 'failed'R&D project: an emerging evaluation framework for building innovative capabilities1. ***R&d Management***, 39(2): 136-152.

Elsbach, K. D., & Kramer, R. M. 2003. Assessing creativity in Hollywood pitch meetings: Evidence for a dual-process model of creativity judgments. ***Academy of Management journal***, 46(3): 283-301.

Erez, A., Lepine, J. A., & Elms, H. 2002. Effects of rotated leadership and peer evaluation on the functioning and effectiveness of self-managed teams: a quasi-experiment. ***Personnel Psychology***, 55(4): 929-948.

Evans, J. S. B., & Frankish, K. E. 2009. ***In two minds: Dual processes and beyond***: Oxford University Press.

Ezzat, H., Agogué, M., Cassotti, M., Le Masson, P., & Weil, B. 2016. Leadership-driven Ideation: The Cognitive Effects of Directive Feedbacks on Creativity, ***European Academy of Management - EURAM***. Paris, France.

Ezzat, H., Agogué, M., Le Masson, P., & Weil, B. 2016. Solution-oriented versus Novelty-oriented Leadership Instructions: Cognitive Effect on Creative Ideation, ***DCC'16 (Design Computing & Cognition 2016)***. Chicago, United States.

Ezzat, H., Agogué, M., Le Masson, P., & Weil, B. 2017a. Solution-oriented versus Novelty-oriented Leadership Instructions: Cognitive Effect on Creative Ideation, ***Design Computing and Cognition'16***: 99-114: Springer.

Ezzat, H., Camarda, A., Cassotti, M., Agogué, M., Houdé, O., Weil, B., & Le Masson, P. 2017b. How minimal executive feedback influences creative idea generation. ***PloS one***, 12(6): e0180458.

Ezzat, H., Le Masson, P., & Weil, B. 2017c. ***Leading in the Unknown with Imperfect Knowledge: Situational Creative Leadership Strategies for Ideation Management***. Paper presented at the 24th Innovation and Product Development Management (IPDM) Conference.

Fiedler, F. E. 1964. A contingency model of leadership effectiveness. ***Advances in experimental social psychology***, 1: 149-190.

Gardner, H. 1988. Creativity: An interdisciplinary perspective. ***Creativity Research Journal***, 1(1): 8-26.

Goffee, R., & Jones, G. 2007. Leading clever people. ***Harvard Business Review***, 85(3): 72.

Graen, G. B., & Uhl-Bien, M. 1995. Relationship-based approach to leadership: Development of leader-member exchange (LMX) theory of leadership over 25 years: Applying a multi-level multi-domain perspective. ***The leadership quarterly***, 6(2): 219-247.

Green, S. G., & Mitchell, T. R. 1979. Attributional processes of leaders in leader—member interactions. ***Organizational Behavior and Human Performance***, 23(3): 429-458.

Greenleaf, R. K. 1977. Servant leadership: New York: Paulist Press.

Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D. 2012. ***Structured decision making: a practical guide to environmental management choices***: John Wiley & Sons.

Gruber, H. E., & Davis, S. N. 1988. 10 Inching our way up Mount Olympus: the evolving-systems approach to creative thinking. ***The nature of creativity: Contemporary psychological perspectives***, 243.

Guilford, J. P. 1959. Traits of creativity. ***Creativity and its cultivation***: 142-161.

Harackiewicz, J. M., & Elliot, A. J. 1993. Achievement goals and intrinsic motivation. ***Journal of personality and social psychology***, 65(5): 904.

Haselton, M. G., Nettle, D., & Murray, D. R. 2005. The evolution of cognitive bias. ***The handbook of evolutionary psychology***.

Hatchuel, A., Le Masson, P., & Weil, B. 2001. ***From R&D to RID: Design strategies and the management of innovation fields***. Paper presented at the 8th international product development management conference.

Hatchuel, A., Le Masson, P., & Weil, B. 2009. ***Design theory and collective creativity: a theoretical framework to evaluate KCP process***. Paper presented at the International conference on engineering design, ICED.

Hatchuel, A., Le Masson, P., & Weil, B. 2011. Teaching innovative design reasoning: How concept–knowledge theory can help overcome fixation effects. ***Artificial Intelligence for Engineering Design, Analysis and Manufacturing***, 25(01): 77-92.

Hatchuel, A., & Weil, B. 2002. ***CK theory***. Paper presented at the Proceedings of the Herbert Simon International Conference on «Design Sciences.

Hatchuel, A., & Weil, B. 2003. ***A new approach of innovative Design: an introduction to CK theory***. Paper presented at the DS 31: Proceedings of ICED 03, the 14th International Conference on Engineering Design, Stockholm.

Hatchuel, A., & Weil, B. 2009. CK design theory: an advanced formulation. ***Research in engineering design***, 19(4): 181.

Hemlin, S., Allwood, C. M., & Martin, B. R. 2008. Creative knowledge environments. ***Creativity Research Journal***, 20(2): 196-210.

Heracleous, L., & Jacobs, C. D. 2008. Developing strategy: the serious business of play.
Hersey, P., Blanchard, K. H., & Johnson, D. E. 1988. Management of organizational behavior.
Hersey, P., Blanchard, K. H., & Natemeyer, W. E. 1979. Situational leadership, perception, and the impact of power. ***Group & Organization Studies***, 4(4): 418-428.
Hollander, E. P. 1980. ***Leadership and social exchange processes***: Springer.
Hooge, S., Agogué, M., & Gillier, T. 2012. ***A new methodology for advanced engineering design: Lessons from experimenting CK Theory driven tools***. Paper presented at the International Design Conference-Design 2012.
Houdé, O. 1997. The problem of deductive competence and the inhibitory control of cognition. ***Current Psychology of Cognition***, 16(2): 108-113.
Houdé, O. 2007. First insights on "neuropedagogy of reasoning". ***Thinking & Reasoning***, 13(2): 81-89.
Houdé, O., & Moutier, S. 1996. Deductive reasoning and experimental inhibition training: The case of the matching bias. ***Cahiers de psychologie cognitive***, 15(4): 409-434.
Houdé, O., & Moutier, S. 1999. Deductive reasoning and experimental inhibition training: The case of the matching bias. New data and reply to Girotto. ***Cahiers de psychologie cognitive***, 18(1): 75-85.
Houdé, O., & Tzourio-Mazoyer, N. 2003. Neural foundations of logical and mathematical cognition. ***Nature Reviews Neuroscience***, 4(6): 507-514.
Houdé, O., Zago, L., Crivello, F., Moutier, S., Pineau, A., Mazoyer, B., & Tzourio-Mazoyer, N. 2001. Access to deductive logic depends on a right ventromedial prefrontal area devoted to emotion and feeling: Evidence from a training paradigm. ***Neuroimage***, 14(6): 1486-1492.
Houdé, O., Zago, L., Mellet, E., Moutier, S., Pineau, A., Mazoyer, B., & Tzourio-Mazoyer, N. 2000. Shifting from the perceptual brain to the logical brain: The neural impact of cognitive inhibition training. ***Journal of cognitive neuroscience***, 12(5): 721-728.
House, R. J. 1971. A path goal theory of leader effectiveness. ***Administrative science quarterly***: 321-339.
House, R. J., & Howell, J. M. 1992. Personality and charismatic leadership. ***The Leadership Quarterly***, 3(2): 81-108.
Hunter, S. T., Thoroughgood, C. N., Myer, A. T., & Ligon, G. S. 2011. Paradoxes of leading innovative endeavors: Summary, solutions, and future directions. ***Psychology of Aesthetics, creativity, and the arts***, 5(1): 54.
Imbimbo, A. 2009. ***Steve Jobs: the brilliant mind behind Apple***: Gareth Stevens.
Jagersma, P. K. 2003. Innovative or die. ***Journal of Business Strategy***, 24(1): 25-28.
Janis, I. L. 1972. Victims of groupthink: a psychological study of foreign-policy decisions and fiascoes.
Jansson, D. G., & Smith, S. M. 1991. Design fixation. ***Design studies***, 12(1): 3-11.
Jaussi, K. S., & Dionne, S. D. 2003. Leading for creativity: The role of unconventional leader behavior. ***The Leadership Quarterly***, 14(4): 475-498.
John Jr, R., & Raven, B. H. 1959. The bases of social power.
Kachelmeier, S. J., & Williamson, M. G. 2010. Attracting creativity: The initial and aggregate effects of contract selection on creativity-weighted productivity. ***The Accounting Review***, 85(5): 1669-1691.
Kahneman, D. 2011. ***Thinking, fast and slow***: Macmillan.
Keeney, R. L. 1994. Creativity in decision making with value-focused thinking. ***Sloan Management Review***, 35(4): 33.
Kelley, D., & Kelley, T. 2013. ***Creative confidence: Unleashing the creative potential within us all***: Crown Pub.
KELLEY, T. A. 2001. ***The art of innovation: Lessons in creativity from IDEO, America's leading design firm***: Broadway Business.
Kohn, N. W., & Smith, S. M. 2011. Collaborative fixation: Effects of others' ideas on brainstorming. ***Applied Cognitive Psychology***, 25(3): 359-371.
Korth, W. L. 1973. ***Training in creative thinking: The effect on the individual of training in the" synectics" method of group problem solving***. ProQuest Information & Learning.
Kothari, V. B. 2010. Leadership Myths, ***Executive Greed***: 41-49: Springer.
Kouzes, J. M., & Posner, B. Z. 2010. ***The truth about leadership: The no-fads, heart-of-the-matter facts you need to know***: John Wiley & Sons.
Kowaltowski, D. C., Bianchi, G., & De Paiva, V. T. 2010. Methods that may stimulate creativity and their use in architectural design education. ***International Journal of Technology and Design Education***, 20(4): 453-476.
Kudrowitz, B. M., & Wallace, D. 2013. Assessing the quality of ideas from prolific, early-stage product ideation. ***Journal of Engineering Design***, 24(2): 120-139.

Le Guern, N. 2017. Contribution of the European Kodak Research Laboratories to Innovation Strategy at Eastman Kodak.

Le Masson, P., Hatchuel, A., & Weil, B. 2016. ***Innovation theory and the logic of generativity: from optimization to design, a new post-decisional paradigm in management science***. Paper presented at the European Academy of Management (EURAM 2016).

Le Masson, P., Weil, B., & Hatchuel, A. 2010. ***Strategic management of innovation and design***: Cambridge University Press.

Lehman, J., & Stanley, K. O. 2011. Abandoning objectives: Evolution through the search for novelty alone. ***Evolutionary computation***, 19(2): 189-223.

Lewin, K., Lippitt, R., & White, R. K. 1939. Patterns of aggressive behavior in experimentally created "social climates". ***The Journal of Social Psychology***, 10(2): 269-299.

Lewis, H. S. 1974. ***Leaders and followers: Some anthropological perspectives***: Addison-Wesley Reading, MA:.

Licuanan, B. F., Dailey, L. R., & Mumford, M. D. 2007. Idea evaluation: Error in evaluating highly original ideas. ***The Journal of Creative Behavior***, 41(1): 1-27.

Linsey, J. S., Tseng, I., Fu, K., Cagan, J., Wood, K. L., & Schunn, C. 2010. A study of design fixation, its mitigation and perception in engineering design faculty. ***Journal of Mechanical Design***, 132(4): 041003.

Litchfield, R. C. 2009. Brainstorming rules as assigned goals: Does brainstorming really improve idea quantity? ***Motivation and Emotion***, 33(1): 25-31.

Lloréns Montes, F. J., Ruiz Moreno, A., & Miguel Molina Fernández, L. 2004. Assessing the organizational climate and contractual relationship for perceptions of support for innovation. ***International Journal of manpower***, 25(2): 167-180.

Locke, E. A., & Latham, G. P. 1990. ***A theory of goal setting & task performance***: Prentice-Hall, Inc.

Luchins, A. S. 1942. Mechanization in problem solving: The effect of Einstellung. ***Psychological monographs***, 54(6): i.

Magnusson, P. R., Netz, J., & Wästlund, E. 2014. Exploring holistic intuitive idea screening in the light of formal criteria. ***Technovation***, 34(5): 315-326.

Magnusson, P. R., Wästlund, E., & Netz, J. 2016. Exploring users' appropriateness as a proxy for experts when screening new product/service ideas. ***Journal of Product Innovation Management***, 33(1): 4-18.

Maier, N. R. 1931. Reasoning and learning. ***Psychological review***, 38(4): 332.

Makri, M., & Scandura, T. A. 2010. Exploring the effects of creative CEO leadership on innovation in high-technology firms. ***The Leadership Quarterly***, 21(1): 75-88.

Markov, A. 1971. Extension of the limit theorems of probability theory to a sum of variables connected in a chain.

McGregor, D. 1960. The human side of enterprise. ***New York***, 21: 166.

McLean, L. D. 2005. Organizational culture's influence on creativity and innovation: A review of the literature and implications for human resource development. ***Advances in Developing Human Resources***, 7(2): 226-246.

Meyer, D. E., & Schvaneveldt, R. W. 1971. Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. ***Journal of experimental psychology***, 90(2): 227.

Moreno, D. P., Yang, M. C., Hernández, A. A., Linsey, J. S., & Wood, K. L. 2015. A step beyond to overcome design fixation: a design-by-analogy approach, ***Design Computing and Cognition'14***: 607-624: Springer.

Mueller, J. S., Goncalo, J. A., & Kamdar, D. 2011. Recognizing creative leadership: Can creative idea expression negatively relate to perceptions of leadership potential? ***Journal of Experimental Social Psychology***, 47(2): 494-498.

Mumford, M. D., Connelly, S., & Gaddis, B. 2003. How creative leaders think: Experimental findings and cases. ***The Leadership Quarterly***, 14(4): 411-432.

Mumford, M. D., & Hunter, S. T. 2005. Innovation in organizations: A multi-level perspective on creativity, ***Multi-level issues in strategy and methods***: 9-73: Emerald Group Publishing Limited.

Mumford, M. D., Hunter, S. T., Eubanks, D. L., Bedell, K. E., & Murphy, S. T. 2007. Developing leaders for creative efforts: A domain-based approach to leadership development. ***Human Resource Management Review***, 17(4): 402-417.

Mumford, M. D., Scott, G. M., Gaddis, B., & Strange, J. M. 2002. Leading creative people: Orchestrating expertise and relationships. ***The Leadership Quarterly***, 13(6): 705-750.

Nagai, Y., & Taura, T. 2009. Design motifs: Abstraction driven creativity. ***Special Issue of Japanese Society for the Science of Design***, 16(2): 62.

Nijstad, B. A., De Dreu, C. K., Rietzschel, E. F., & Baas, M. 2010. The dual pathway to creativity model: Creative ideation as a function of flexibility and persistence. ***European Review of Social Psychology***, 21(1): 34-77.

Nijstad, B. A., & Stroebe, W. 2006. How the group affects the mind: A cognitive model of idea generation in groups. ***Personality and social psychology review***, 10(3): 186-213.

Nutt, P. C. 2004. Expanding the search for alternatives during strategic decision-making. ***The Academy of Management Executive***, 18(4): 13-28.

Osborn, A. 1957. Applied imagination. New York: Scribners's, 1957: For.

Osborn, A. F. 1953. Applied imagination.

Otto, K. N., & Wood, K. L. 1998. Product evolution: a reverse engineering and redesign methodology. ***Research in Engineering Design***, 10(4): 226-243.

Parnes, S. J., & Meadow, A. 1959. Effects of" brainstorming" instructions on creative problem solving by trained and untrained subjects. ***Journal of Educational Psychology***, 50(4): 171.

Pasquella, D. 1974. Imagination, Awareness, and Ideas: Helping The Student Become More Creative. ***Journal of the University Film Association***: 31-54.

Paulus, P. B., Kohn, N. W., & Arditti, L. E. 2011. Effects of quantity and quality instructions on brainstorming. ***The Journal of Creative Behavior***, 45(1): 38-46.

Paulus, P. B., & Nijstad, B. A. 2003. ***Group creativity: Innovation through collaboration***: Oxford University Press.

Posner, M. I. 1973. Cognition: An introduction.

Puccio, G. J., Mance, M., & Murdock, M. C. 2010. ***Creative leadership: Skills that drive change***: Sage Publications.

Ramaprasad, A. 1983. On the definition of feedback. ***Behavioral Science***, 28(1): 4-13.

Reiter-Palmon, R., & Illies, J. J. 2004. Leadership and creativity: Understanding leadership from a creative problem-solving perspective. ***The Leadership Quarterly***, 15(1): 55-77.

Rickards, T., & Moger, S. 2000. Creative leadership processes in project team development: an alternative to Tuckman's stage model. ***British Journal of Management***, 11(4): 273-283.

Runco, M. A., & Acar, S. 2012. Divergent thinking as an indicator of creative potential. ***Creativity Research Journal***, 24(1): 66-75.

Runco, M. A., & Chand, I. 1995. Cognition and creativity. ***Educational psychology review***, 7(3): 243-267.

Runco, M. A., & Charles, R. E. 1993. Judgments of originality and appropriateness as predictors of creativity. ***Personality and individual differences***, 15(5): 537-546.

Runco, M. A., Illies, J. J., & Eisenman, R. 2005a. Creativity, originality, and appropriateness: What do explicit instructions tell us about their relationships? ***The Journal of Creative Behavior***, 39(2): 137-148.

Runco, M. A., Illies, J. J., & Reiter-Ralmon, R. 2005b. Explicit Instructions to Be Creative and Original. ***The International Journal of Creativity & Problem Solving***, 15(1): 5-15.

Runco, M. A., & Mraz, W. 1992. Scoring divergent thinking tests using total ideational output and a creativity index. ***Educational and Psychological measurement***, 52(1): 213-221.

Runco, M. A., & Okuda, S. 1991. The instructional enhancement of the flexibility and originality scores of divergent thinking tests. ***Applied Cognitive Psychology***, 5(5): 435-441.

Sashkin, M. 1988. ***The visionary leader***: Jossey-Bass.

Shalley, C. E., & Gilson, L. L. 2004. What leaders need to know: A review of social and contextual factors that can foster or hinder creativity. ***The Leadership Quarterly***, 15(1): 33-53.

Shalley, C. E., & Oldham, G. R. 1985. Effects of goal difficulty and expected external evaluation on intrinsic motivation: A laboratory study. ***Academy of Management Journal***, 28(3): 628-640.

Singh Panesar, S., & Markeset, T. 2008. Industrial service innovation through improved contractual relationship: A case study in maintenance. ***Journal of Quality in Maintenance Engineering***, 14(3): 290-305.

Sio, U. N., Kotovsky, K., & Cagan, J. 2015. Fixation or inspiration? A meta-analytic review of the role of examples on design processes. ***Design Studies***, 39: 70-99.

Smith, S. M., & Blankenship, S. E. 1991. Incubation and the persistence of fixation in problem solving. ***The American journal of psychology***: 61-87.

Smith, S. M., & Linsey, J. 2011. A three-pronged approach for overcoming design fixation. ***The Journal of Creative Behavior***, 45(2): 83-91.

Smith, S. M., Paulus, P. B., & Nijstad, B. A. 2003. The constraining effects of initial ideas. ***Group creativity: Innovation through collaboration***: 15-31.

Smith, S. M., Ward, T. B., & Schumacher, J. S. 1993. Constraining effects of examples in a creative generation task. ***Memory & cognition***, 21(6): 837-845.

Sosik, J. J., Kahai, S. S., & Avolio, B. J. 1998. Transformational leadership and dimensions of creativity: Motivating idea generation in computer-mediated groups. ***Creativity Research Journal***, 11(2): 111-121.

Stasser, G., & Birchmeier, Z. 2003. Group creativity and collective choice. ***Group creativity: Innovation through collaboration***: 85-109.

Stempfle, J. 2011. Overcoming organizational fixation: creating and sustaining an innovation culture. ***The Journal of Creative Behavior***, 45(2): 116-129.

Sternberg, R., & Lubart, T. 1995. Ten keys to creative innovation. ***R & D Innovator***, 4(3): 8-11.

Sternberg, R. J. 1999. ***Thinking styles***: Cambridge University Press.

Sternberg, R. J. 2006. Creating a vision of creativity: The first 25 years. ***Psychology of Aesthetics, Creativity, and the Arts***(1): 2.

Sternberg, R. J. 2007. A systems model of leadership: WICS. ***American Psychologist***, 62(1): 34.

Sternberg, R. J., Kaufman, J. C., & Pretz, J. E. 2003. A propulsion model of creative leadership. ***The Leadership Quarterly***, 14(4): 455-473.

Sternberg, R. J., & Lubart, T. I. 1991. Creating creative minds. ***The Phi Delta Kappan***, 72(8): 608-614.

Stogdill, R. M. 1974a. Handbook of leadership: A survey of the literature: New York: Free Press.

Stogdill, R. M. 1974b. ***Handbook of leadership: A survey of theory and research***: Free Press.

Stoll, L., & Temperley, J. 2009. Creative leadership: A challenge of our times. ***School Leadership and Management***, 29(1): 65-78.

Strange, J. M., & Mumford, M. D. 2002. The origins of vision: Charismatic versus ideological leadership. ***The Leadership Quarterly***, 13(4): 343-377.

Stringer, R. 2000. How to manage radical innovation. ***California management review***, 42(4): 70-88.

Sukhov, A., Magnusson, P. R., & Olsson, L. E. 2015. ***A conceptual model of the idea construct in innovation contexts***. Paper presented at the Academy of Management Proceedings.

Tesluk, P. E., Farr, J. L., & Klein, S. R. 1997. Influences of organizational culture and climate on individual creativity. ***The Journal of Creative Behavior***, 31(1): 27-41.

Tierney, P., Farmer, S. M., & Graen, G. B. 1999. An examination of leadership and employee creativity: The relevance of traits and relationships. ***Personnel psychology***, 52(3): 591-620.

Tseng, I., Moss, J., Cagan, J., & Kotovsky, K. 2008. ***Overcoming blocks in conceptual design: the effects of open goals and analogical similarity on idea generation***. Paper presented at the ASME 2008 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.

Tushman, M., & O'Reilly, C. 1996. Winning Through Innovation (Harvard Business School Press, Boston, MA).

Uhl-Bien, M., Marion, R., & McKelvey, B. 2007. Complexity leadership theory: Shifting leadership from the industrial age to the knowledge era. ***The leadership quarterly***, 18(4): 298-318.

Van de Ven, A. H., Polley, D., & Garud, R. 2008. ***The innovation journey***: Oxford University Press, USA.

Van Seters, D. A., & Field, R. H. 1990. The evolution of leadership theory. ***Journal of organizational change management***, 3(3): 29-45.

Vise, D. 2007. The google story. ***Strategic Direction***, 23(10).

Viswanathan, V., & Linsey, J. 2013. Mitigation of Design Fixation in Engineering Idea Generation: A Study on the Role of Defixation Instructions, ***ICoRD'13***: 113-124: Springer.

Vroom, V. H., & Yetton, P. W. 1973. ***Leadership and decision-making***: University of Pittsburgh Pre.

Wallas, G. 1926. Thr art of thought.

Wang, H.-C. 2008. ***Modeling idea generation sequences using Hidden Markov Models***. Paper presented at the Proceedings of the 30th Annual Meeting of the Cognitive Science Society.

Ward, T. B., Patterson, M. J., & Sifonis, C. M. 2004. The role of specificity and abstraction in creative idea generation. ***Creativity Research Journal***, 16(1): 1-9.

Weber, M. 1947. The theory of economic and social organization. ***Trans. AM Henderson and Talcott Parsons. New York: Oxford University Press***.

Woodman, R. W., Sawyer, J. E., & Griffin, R. W. 1993. Toward a theory of organizational creativity. ***Academy of management review***, 18(2): 293-321.

Youmans, R. J., & Arciszewski, T. 2014. Design fixation: a cloak of many colors, ***Design Computing and Cognition'12***: 115-129: Springer.

Yukl, G. A. 1994. ***Leadership in organizations***: Pearson Education India.

Zaccaro, S. J., Kemp, C., & Bader, P. 2004. Leader traits and attributes. ***The nature of leadership***, 101: 124.

Zahner, D., Nickerson, J. V., Tversky, B., Corter, J. E., & Ma, J. 2010. A fix for fixation? Rerepresenting and Abstracting as Creative Processes in the Design of Information Systems. ***Artificial Intelligence for Engineering Design, Analysis and Manufacturing***, 24(02): 231-244.

Zhou, J. 1998. Feedback valence, feedback style, task autonomy, and achievement orientation: Interactive effects on creative performance. ***Journal of applied psychology***, 83(2): 261.

Zhou, J. 2003. When the presence of creative coworkers is related to creativity: role of supervisor close monitoring, developmental feedback, and creative personality. ***Journal of applied psychology***, 88(3): 413.

Zhou, J., & George, J. M. 2003. Awakening employee creativity: The role of leader emotional intelligence. ***The leadership quarterly***, 14(4): 545-568.

Zhou, J., & Woodman, R. 2003. Managers' recognition of employees' creative ideas: a social-cognitive model. ***The International Handbook on Innovation, Elsevier Science Ltd, Amsterdam***: 631-640.

Zhou, M.-j., & Li, S.-k. 2013. ***Can supervisor feedback always promote creativity? The moderating role of employee self-monitoring***. Paper presented at the Information Management, Innovation Management and Industrial Engineering (ICIII), 2013 6th International Conference on.

Zuckerman, M. 1979. Attribution of success and failure revisited, or: The motivational bias is alive and well in attribution theory. ***Journal of personality***, 47(2): 245-287.

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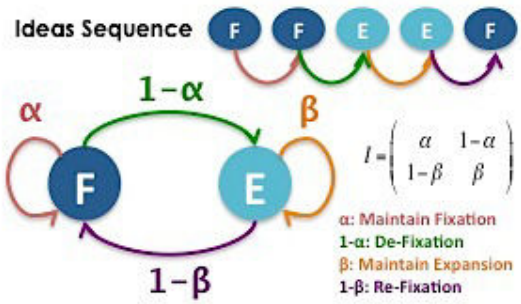
Appendix I: Categories of Solutions of the Hen's Egg Task

Meta Categories	Categories
After the fall	Replace the broken egg / cloning
Before the fall	Drop the egg from +/- 10 meters Break the egg in advance Separate egg yolk and egg white Drop the egg slowly Not dropping the egg
Damping the shock	Put a mattress / soft surface Use a spring Use a trampoline Drop the egg in the water / swimming pool
Interrupting the fall	Egg's Disintegration Catch the egg with a net Prevent the fall by catching the egg
Modifying the properties of the egg	Change hen's properties Egg's regeneration Boil the egg Plastic egg Freezing the egg Change the properties of the egg
Protecting the egg	Use a protective cover for the egg Use a bouncy protection for the egg
Slowing the fall	Use a lift Use an airplane Use a vacuum Staircase Avatar style Use a rocket engine Ascending air flow Use a geyser Acoustic levitation Seismic levitation Use a parachute Use an elastic Use a hang-glider Foam funnel Use a fan Use a ramp / circuit Use a pulley Use a balloon / Montgolfier
Using the natural properties	Hatching process of the egg Arrangement of eggs Use natural properties of the egg (axis)

Using the properties of the environment	Stop the time Drop the egg inside a black hole We rely on luck Use magnetism Use pro-egg religion Drop the egg in a spatial-temporal tunnel Murphy's law Modify the air pressure
With a living device	Sport Celebrities: Kouchner/Chabal Super-heroes: Spiderman / Superman Human who catches the egg The egg is inside the hen Train an animal to catch the egg We jump with the egg

Appendix II: Full Markov-Based Leadership-driven Ideation Model

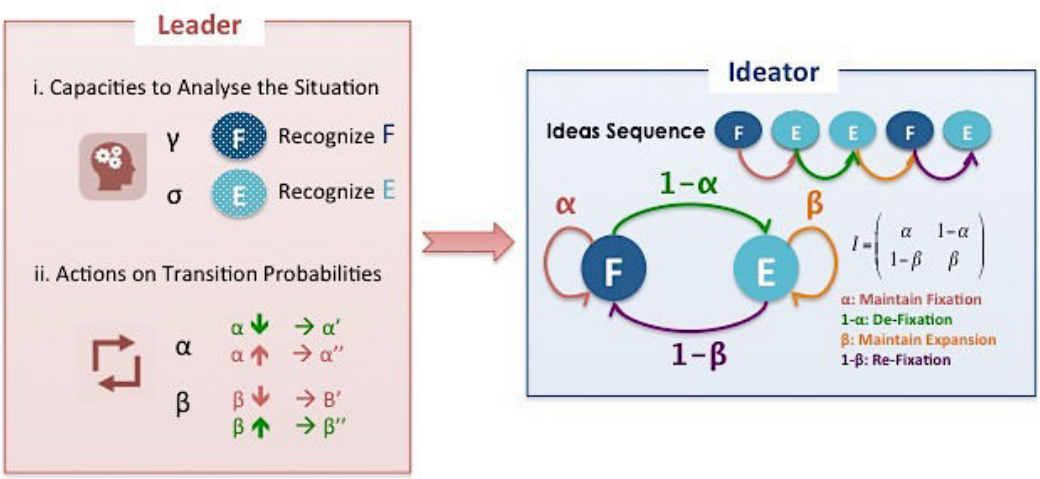


At the beginning let's consider the two-state Markov model above. This simple model illustrates the ideation process exclusively from an ideator's "I" perspective. The model comprises two states (fixation "F", and expansion "E"), and two parameters (α, and β). Each idea generated by an ideator at any time t is either in the state F or in the state E. If we consider that the ideator generates the idea sequence (F F E E F), we then have four different probabilities:

- **The probability of maintaining the state of fixation (α)**: it refers to the probability that ideators generate an idea in fixation after having generated an idea in fixation. This probability refers to the incapacity of ideators to defixate. In the figure below, it is illustrated by the transition (in red) from the first idea to the second one.
- **The probability of de-fixation (1-α)**: it refers to the probability that ideators generate an idea in expansion after having generated an idea that was inside fixation. In other words, it is the probability that ideators defixate themselves. In the figure below, it is illustrated by the transition (in green) from the second idea to the third one. The more the defixation parameter is high, the more the ideator has the capacity to overcome fixation. However, we

will see later that overcoming fixation is desirable but not enough to attain high creative performance.

- **The probability of maintaining the state expansion (β)**: it refers to the probability that ideators generate an idea that was inside expansion after having generated an idea in expansion. It is the probability that ideators maintain the flow of creative ideas. In the figure below, it is illustrated by the transition (in orange) from the third idea to the fourth one. This parameter represents a certain level of persistence of the ideator in his/her creative performance. The more the probability of maintaining the state of expansion is high, the more the ideator is able to generate many creative ideas (ideas outside fixation) successively.
- **The probability of re-fixation (1-β)**: it refers to the probability that ideators generate an idea in fixation after having generated an idea in expansion. In other words, it is the probability that ideators become re-fixated again. In the figure below, it is illustrated by the transition (in purple) from the fourth idea to the last one.



Now, consider that a leader "L" is participating in the ideation process of the ideator. This leader proceeds in two steps:

i) **The leader analyzes the situation** and tries to recognize if the idea generated by the ideator is in state F or E. Therefore, we consider two parameters to define these capacities to recognize F or E:

   a. **The probability of fixation recognition (γ)**: it refers to the probability that leaders recognize that an idea is in fixation. If γ tends to one, it means that the leader could perfectly recognize if an idea is in fixation.

b. **The probability of expansion recognition (σ)**: it refers to the probability that leaders recognize that an idea is in expansion. If σ tends to one, it means that the leader could perfectly recognize if an idea is in expansion.

ii) According to this analysis in i), **the leader acts during the ideation process** (by positive or negative feedbacks) either to modify the probability of the ideator to maintain the state of fixation (α), or to modify the probability of the ideator to maintain the state of expansion (β). The leader can either:

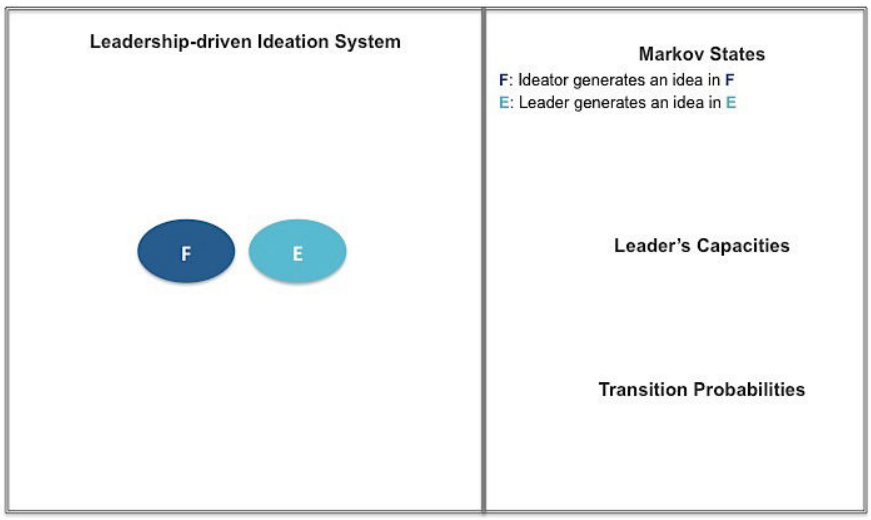
a. Decrease the probability of the ideator to maintain the state of fixation (α), which means that leader **transforms α into a another α' (α'<α)**

b. Increase the probability of the ideator to maintain the state of fixation (α), which means that leader **transforms α into a another α'' (α''>α)**

c. Decrease the probability of the ideator to maintain the state of expansion (β), which means that leader **transforms β into a another β' (β'<β)**

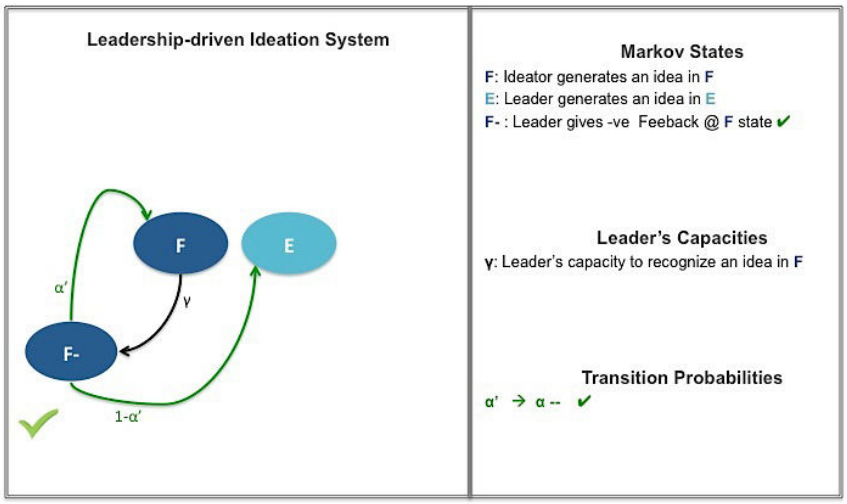
d. Increase the probability of the ideator to maintain the state of expansion (β), which means that leader **transforms β into a another β'' (β''>β)**

In what follows, we present a step-by-step illustration of the full Markov-based leadership-driven ideation model after integrating the role of the leader. At the beginning (see figure below), consider that the model comprises only two states: fixation (F) and expansion (E).

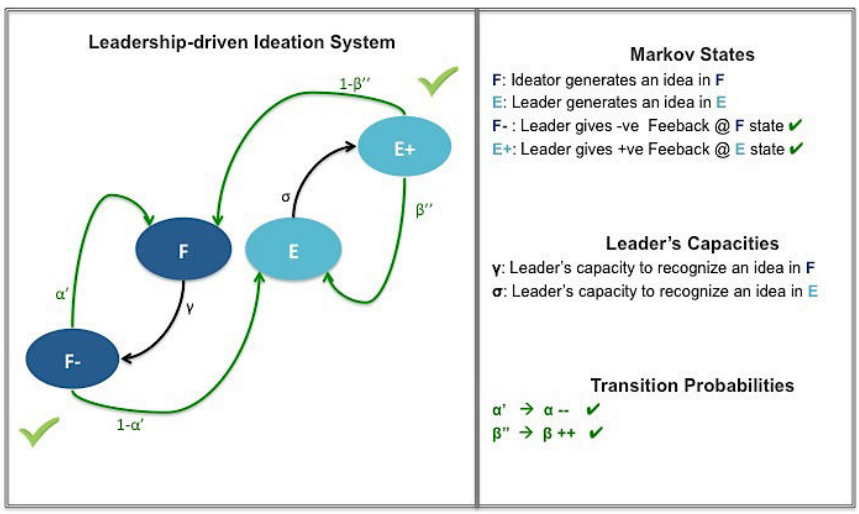


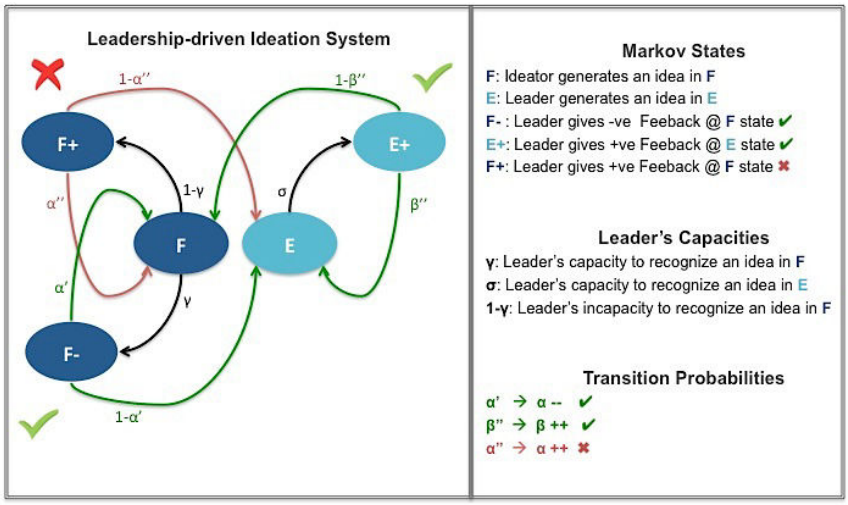
In the second step (see figure below), we added a new parameter in the category "leader's capacities". This new parameter is the **probability of fixation recognition (γ)**, which is the probability that the leader recognizes that an idea is in the state fixation. In this case, the system moves into a **new state called F-**, which means that the leader (who recognized the idea is in state F) would give

the ideator a negative feedback. Theoretically, this negative feedback will tend to decrease the probability of the ideator to maintain the state of fixation (α), hence the leader **transforms α into a new α' ($\alpha'<\alpha$)**. **This case is desirable since the aim of a good defixator leader is to decrease α.**

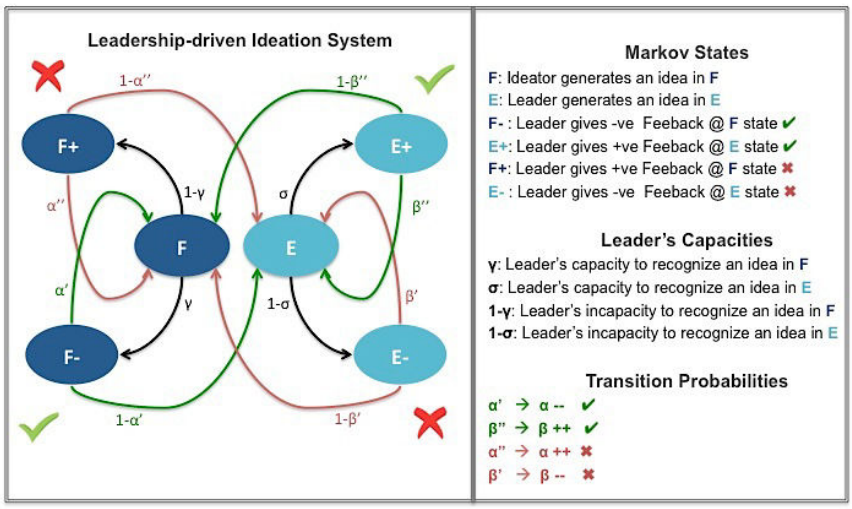


In the third step (see figure below), we added another new parameter in the category "leader's capacities". This new parameter is the **probability of expansion recognition (σ)**, which is the probability that the leader recognizes that an idea is in the state expansion. In this case, the system moves into a **new state called E+**, which means that the leader (who recognized the idea is in state E) would give the ideator a positive feedback. Theoretically, this positive feedback will tend to increase the probability of the ideator to maintain the state of expansion (β), hence the leader **transforms β into a new β'' ($\beta''>\beta$)**. **This case is also desirable since the aim of a good defixator leader is to increase β.**



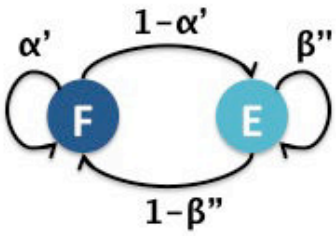


In the fourth step (see figure above), we added to the system the **probability of fixation non-recognition (1-γ)**, which is the probability that leaders do not recognize that an idea is in fixation. In other words, it is the incapacity of leaders to perfectly recognize if an idea is in fixation. In this case, the system moves into a **new state called F+**, which means that the leader (who did not recognize that the idea is in state F) would erroneously give the ideator a positive feedback instead of a negative feedback (thinking that the current idea is in expansion). Theoretically, this positive feedback will tend to increase the probability of the ideator to maintain the state of fixation (α), hence the leader **transforms α into a new α'' ($\alpha''>\alpha$). This case is undesirable since the aim of a good defixator leader is not to increase α.**



In the fifth step, we added to the system the **probability of expansion non-recognition (1-σ)**, which is the probability that leaders do not recognize that an idea is in expansion. In other words, it is the incapacity of leaders to perfectly recognize if an idea is in expansion. In this case, the system moves into a **new state called E-**, which means that the leader (who did not recognize that the idea is in state E) would erroneously give the ideator a negative feedback instead of a positive feedback

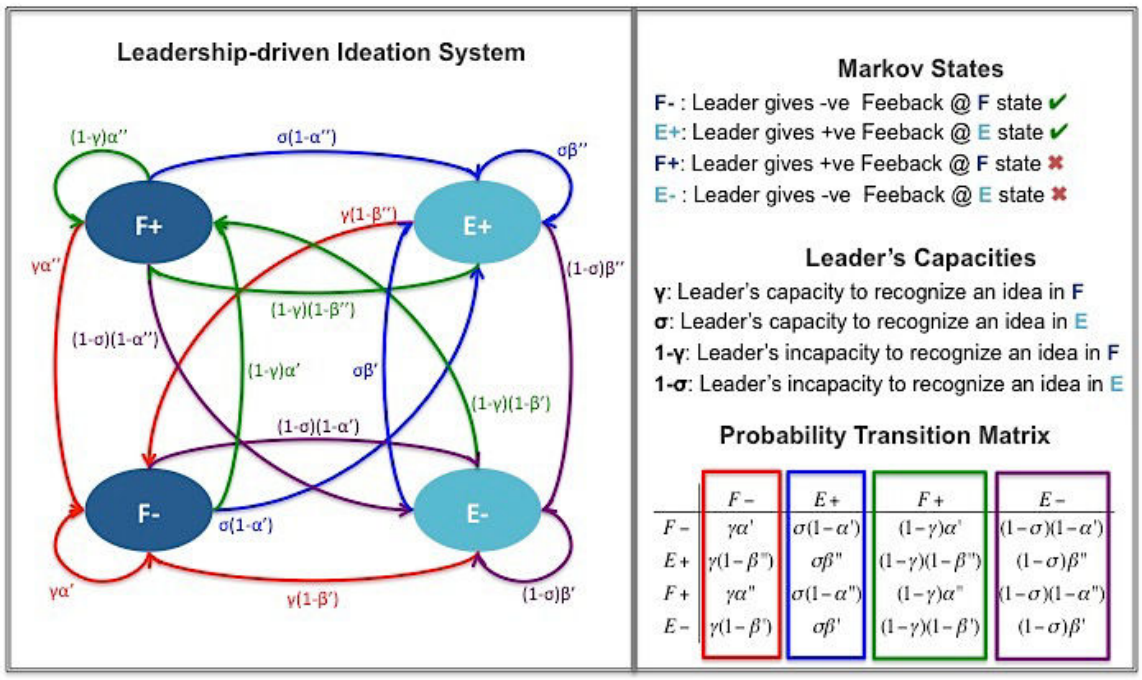
(thinking that the current idea is in fixation). Theoretically, this negative feedback will tend to decrease the probability of the ideator to maintain the state of expansion (β), hence the **leader transforms β into a new β' (β'<β). This case is undesirable since the aim of a good defixator leader is not to decrease β.**



If we consider the best case in the figure above, in which **the leader is perfect at recognizing fixation (which means γ=1), and perfect at recognizing expansion (which means σ=1)**, we would find back the initial two-state Markov Model and notice the following:

- If the ideator generates an idea in fixation (state F), the system would always move to state F- (which means **state F= state F-**), since the leader would be always trying to get the ideator out of this state by decreasing α (through a negative feedback).
- If the ideator generates an ideation in expansion (state E), the system would always move to state E+ (which means **state E=state E+**), since the leader would be trying to maintain the ideator in this state by increasing β (through a positive feedback).

Now, since there are no direct transitions between state F and state E, the system can be reduced into a 4-state Markov model as follows:



Now let's try to find the relationship between the expansion rate E (sum of E+ and E-); the leader capacities to recognize fixation and expansion: γ, and σ; as well as the transition probabilities of the system: α, α', β', and β''. The associated probability transition matrix (PTM) **T** is:

$$T = \begin{array}{c|cccc} & F- & E+ & F+ & E- \\ \hline F- & \gamma\alpha' & \sigma(1-\alpha') & (1-\gamma)\alpha' & (1-\sigma)(1-\alpha') \\ E+ & \gamma(1-\beta'') & \sigma\beta'' & (1-\gamma)(1-\beta'') & (1-\sigma)\beta'' \\ F+ & \gamma\alpha'' & \sigma(1-\alpha'') & (1-\gamma)\alpha'' & (1-\sigma)(1-\alpha'') \\ E- & \gamma(1-\beta') & \sigma\beta' & (1-\gamma)(1-\beta') & (1-\sigma)\beta' \end{array}$$

Based on the above 4x4 matrix, we could obtain the 5 following equations for each of the states (F-, E+, F+, E-):

$$(1): F_- = \gamma[\alpha' F_- + (1-\beta'')E_+ + \alpha'' F_+ + (1-\beta')E_-]$$
$$(2): E_+ = \sigma[(1-\alpha')F_- + \beta'' E_+ + (1-\alpha'')F_+ + \beta' E_-]$$
$$(3): F_+ = (1-\gamma)[\alpha' F_- + (1-\beta'')E_+ + \alpha'' F_+ + (1-\beta')E_-]$$
$$(4): E_- = (1-\sigma)[(1-\alpha')F_- + \beta'' E_+ + (1-\alpha'')F_+ + \beta' E_-]$$
$$(5): F_- + E_+ + F_+ + E_- = 1$$

If we add equations (1) and (3), we obtain the following formula:

$$(1)+(3): F_- + F_+ = \alpha' F_- + (1-\beta'')E_+ + \alpha'' F_+ + (1-\beta')E_-$$
$$(1)+(3): (1-\alpha')F_- + (1-\alpha'')F_+ = (1-\beta'')E_+ + (1-\beta')E_-$$

If we replace the above formula in (1), we obtain the following equations (6), (7) and (8):

$$(1): F_- = \gamma[\alpha' F_- + (1-\beta'')E_+ + \alpha'' F_+ + (1-\beta')E_-]$$
$$(1): F_- = \gamma[\alpha' F_- + \alpha'' F_+ + (1-\beta'')E_+ + (1-\beta')E_-]$$
$$(1)+(3)\,\&\,(1): F_- = \gamma[\alpha' F_- + \alpha'' F_+ + (1-\alpha')F_- + (1-\alpha'')F_+]$$
$$(6): F_- = \gamma(F_+ + F_-)$$
$$(7): F_- = \frac{\gamma}{1-\gamma} F_+$$
$$(8): F_+ = \frac{1-\gamma}{\gamma} F_-$$

Similarly, if we replace the above formula in (2), we obtain the following equations (9), (10) and (11):

$$(2): E_+ = \sigma[(1-\alpha')F_- + \beta'' E_+ + (1-\alpha'')F_+ + \beta' E_-]$$
$$(2): E_+ = \sigma[(1-\alpha')F_- + (1-\alpha'')F_+ + \beta' E_- + \beta'' E_+]$$
$$(1)+(3)\,\&\,(2): E_+ = \sigma[(1-\beta'')E_+ + (1-\beta')E_- + \beta' E_- + \beta'' E_+]$$
$$(9): E_+ = \sigma(E_+ + E_-)$$
$$(10): E_+ = \frac{\sigma}{1-\sigma} E_-$$
$$(11): E_- = \frac{1-\sigma}{\sigma} E_+$$

Now, using equations (6), (9) and (5) we could obtain the following equation (12):

$$(6): F_- = \gamma(F_+ + F_-) \Leftrightarrow \frac{F_-}{\gamma} = F_+ + F_-$$
$$(9): E_+ = \sigma(E_+ + E_-) \Leftrightarrow \frac{E_+}{\sigma} = E_+ + E_-$$
$$(5): F_- + E_+ + F_+ + E_- = 1$$
$$(12): \frac{F_-}{\gamma} + \frac{E_+}{\sigma} = 1$$

Now, we replace (8) and (11) in (1), and we obtain the following equation (13):

$$(1): F_- = \gamma[\alpha' F_- + (1-\beta'')E_+ + \alpha'' F_+ + (1-\beta')E_-]$$
$$(1): \frac{F_-}{\gamma} = \alpha' F_- + \alpha'' F_+ + (1-\beta'')E_+ + (1-\beta')E_-$$
$$(8)\,\&\,(1): \frac{F_-}{\gamma} = \alpha' F_- + \alpha'' \frac{1-\gamma}{\gamma} F_- + (1-\beta'')E_+ + (1-\beta')E_-$$
$$(11)\,\&\,(1): \frac{F_-}{\gamma} = \alpha' F_- + \alpha'' \frac{1-\gamma}{\gamma} F_- + (1-\beta'')E_+ + (1-\beta')\frac{1-\sigma}{\sigma} E_+$$
$$(13): \frac{F_-}{\gamma} = \alpha' F_- + \alpha'' \frac{1-\gamma}{\gamma} F_- + (1-\beta'')E_+ + (1-\beta')\frac{1-\sigma}{\sigma} E_+$$

From (13), we could deduce the equations (14) for α^*, the new probability to maintain fixation (F→F) and (15) for 1-β* (the new probability of re-fixation E→F):

$$(13): \frac{F_-}{\gamma} = \alpha' F_- + \alpha'' \frac{1-\gamma}{\gamma} F_- + (1-\beta'')E_+ + (1-\beta')\frac{1-\sigma}{\sigma} E_+$$
$$(13): \frac{F_-}{\gamma} = [\gamma\alpha' + (1-\gamma)\alpha''] \frac{F_-}{\gamma} + [\sigma(1-\beta'') + (1-\sigma)(1-\beta')] \frac{E_+}{\sigma}$$
$$(13): \frac{F_-}{\gamma} = \alpha^* \frac{F_-}{\gamma} + (1-\beta^*) \frac{E_+}{\sigma}$$
$$(14): \alpha^* = \gamma\alpha' + (1-\gamma)\alpha''$$
$$(15): 1-\beta^* = \sigma(1-\beta'') + (1-\sigma)(1-\beta')$$

Using (5) and (13), we could deduce the following equations (16) and (17):

$$(13): \frac{F_-}{\gamma} = \alpha^* \frac{F_-}{\gamma} + (1-\beta^*)\frac{E_+}{\sigma}$$

$$(5)\,\&\,(13): \frac{F_-}{\gamma} = \alpha^* \frac{F_-}{\gamma} + (1-\beta^*)(1-\frac{F_-}{\gamma})$$

$$(16): \frac{F_-}{\gamma} = \frac{1}{1+\frac{1-\alpha^*}{1-\beta^*}}$$

$$(17): \frac{E_+}{\sigma} = \frac{1}{1+\frac{1-\beta^*}{1-\alpha^*}}$$

Finally, we deduce from (6) and (16), the equation for the fixation rate in equation (18), as well as from (9) and (17) the equation for the expansion rate in equation (19):

$$(18): F_{rate} = F_- + F_+ = \frac{1}{1+\frac{1-\alpha^*}{1-\beta^*}}$$

$$(18): F_{rate} = F_- + F_+ = \frac{1}{1+\frac{1-[\gamma\alpha' + (1-\gamma)\alpha'']}{\sigma(1-\beta'') + (1-\sigma)(1-\beta')}}$$

$$(19): E_{rate} = E_+ + E_- = \frac{1}{1+\frac{1-\beta^*}{1-\alpha^*}} \Leftrightarrow (1-\beta^*) = \frac{1-E_{rate}}{E_{rate}}(1-\alpha^*)$$

$$(19): E_{rate} = E_+ + E_- = \frac{1}{1+\frac{\sigma(1-\beta'') + (1-\sigma)(1-\beta')}{1-[\gamma\alpha' + (1-\gamma)\alpha'']}}$$

If we now explore the variation of expansion rate depending on the values of γ and σ (leader types), we could find the following formulas:

1. Case of the **expert congruent leader (γ=1, σ=1)**:

$$E_{rate}(\gamma = 1; \sigma = 1) = \frac{1}{1+\frac{1-\beta''}{1-\alpha'}}$$

In this case the expansion rate is the highest and would tend to one, since (1-β'') would tend to 0, and (1-α') would tend to 1.

2. Case of the **incongruent leader (γ=0, σ=0)**:

$$E_{rate}(\gamma = 0; \sigma = 0) = \frac{1}{1+\frac{1-\beta'}{1-\alpha''}}$$

In this case the expansion rate is the lowest and would tend to 0, since (1-β') would 1, and (1-α'') would tend to 0.

3. Case of the **expert in fixation leader (γ=1, σ=0)**:

$$E_{rate}(\gamma=1;\sigma=0)=\frac{1}{1+\frac{1-\beta'}{1-\alpha'}}$$

In this case the expansion rate would theoretically tend to 0.5, since (1-β') would tend to 1, and (1-α') would also tend to 1. However, it is interesting to note that if the ideator is more or less fixated, the leader would have more chances to manipulate α than β, and hence the expansion rate would be higher in this case.

4. Case of the **expert in expansion leader (γ=0, σ=1)**:

$$E_{rate}(\gamma=0;\sigma=1)=\frac{1}{1+\frac{1-\beta''}{1-\alpha''}}$$

Similarly to the previous case of the expert in fixation, in this case the expansion rate would theoretically tend to 0.5, since (1-β'') would tend to 0, and (1-α'') would similarly tend to 0. However, it is again interesting to note that if the ideator is more or less defixated, the leader would have more chances to manipulate β than α, and hence the expansion rate would be higher in this case.

5. Case of the **random leader (γ=0.5, σ=0.5)**:

$$E_{rate}(\gamma=0,5;\sigma=0,5)=\frac{1}{1+\frac{1-\frac{\beta'+\beta''}{2}}{1-\frac{\alpha'+\alpha''}{2}}}$$

In this case, the leader is misleading the ideator whether the ideator is more or less fixated or defixated, since β' is compensating β'' (new β* is just the mean of β' and β''), and similarly α' is compensating α'' (new α* is just the mean of α' and α'').

Appendix III: Publications

The **papers associated with this Ph.D. thesis** are as follows (see **Volume 2**):

- **Journal Papers:**

1. A journal paper entitled: "How Minimal Executive Feedback Influences Creative Idea Generation", in PLoS ONE, (Ezzat et al., 2017b).

2. A journal paper entitled: “Specificity and Abstraction of Examples: Opposite Effects on Fixation for Creative Ideation”, submitted to Journal of Creative Behaviour.
3. A journal paper entitled: “Shaping Leadership Roles for Defixation in Organisations using Laboratory Experiments”, submitted to CERN IdeaSquare Journal of Experimental Innovation.

- **Book Chapter:**

4. A book chapter entitled: “Solution-oriented versus Novelty-oriented Leadership Instructions: Cognitive Effect on Creative Ideation”, in the book “Design Computing & Cognition – Springer DCC 2016” (Ezzat, Agogué, Le Masson, & Weil, 2017a).

- **Conference Proceedings:**

5. A conference paper entitled “Leading in the Unknown with Imperfect Knowledge: Situational Creative Leadership Strategies for Ideation Management”, Innovation and Product Development Management – IPDM 2017 (Ezzat, Le Masson, & Weil, 2017c), Reykjavik (Iceland) 2017.
6. A conference paper entitled: “Leadership-driven Ideation: The Cognitive Effects of Directive Feedbacks on Creativity”, European Academy of Management – EURAM 2016 (Ezzat, Agogué, Cassotti, Le Masson, & Weil, 2016), Paris (France) 2016.
7. A conference paper entitled: “Solution-oriented versus Novelty-oriented Leadership Instructions: Cognitive Effect on Creative Ideation”, Design Computing and Cognition Conference (Ezzat, Agogué, Le Masson, & Weil, 2016), Chicago (United States of America) 2016
8. A conference paper entitled: “Managing the Impacts of Non-Verbal Devices on Idea Generation: A New Challenge for Creative Leaders”, European Academy of Management – EURAM 2015 (Brun, Ezzat, & Weil, 2015), Warsaw (Poland) 2015.

   ***** *This paper was awarded second best paper in the Innovation Special Interest Group of EURAM*
9. A conference paper entitled “The Role of Expertise in Design Fixation: Managerial Implications for Creative Leadership”, Innovation and Product Development Management – IPDM 2017 (Camarda, Ezzat, Cassotti, Agogué, Weil, & Le Masson, 2017), Reykjavik (Iceland) 2017.

The above-mentioned papers are available in volume 2 of the Ph.D. Thesis.

Appendix IV : Résumé en français de la thèse

Leader pour la Créativité : Modéliser et Expérimenter un Leadership orienté Défixation

Table des matières

Chapitre I : Introduction et principales questions de recherche

Pourquoi certains secteurs sont-ils très innovants et d'autres stagnent ? Comment comprendre que certaines industries soient en pleine croissance alors que d'autres ne sont pas très innovantes ? Quelles sont les conditions qui conduisent un collectif d'acteurs à s'enfermer sur des idées, des paradigmes technologiques qui ont montré leurs limites et ne permettent pas de susciter des avancées innovantes ? Comment expliquer les difficultés à innover dans certains contextes industriels alors même que de nombreuses conditions favorables pour innover sont réunies (financements, ressources en R&D, attentes sur le marché, entre autres) ?

Une des causes de ce blocage est bien connue dans le contexte des sciences cognitives. Plusieurs travaux ont permis de caractériser le rôle des biais cognitifs dans les situations de créativité. Parmi ces biais, on distingue particulièrement les effets de fixation cognitifs (Jansson and Smith, 1991), c'est à dire les connaissances et solutions habituelles qui viennent spontanément à l'esprit des individus lors d'une situation de créativité (tâche de créativité, de génération d'idées, ou de résolutions de problèmes créatifs), et qui contraignent la génération d'idées et de solutions nouvelles et plus créatives (Agogué et al., 2014). Ces différentes études ouvrent plusieurs pistes pour enrichir la gestion de ces biais cognitifs dans les processus d'innovation.

Contexte de recherche : Une économie dépendante de l'innovation

L'économie basée sur l'innovation est désormais venue remplacée l'économie qui était jusque-là basée sur le savoir et la connaissance. Pour illustrer ce phénomène, le magazine américain Business Week commémore son 75ème anniversaire avec numéro spécial intitulé « l'économie de l'innovation » présentant le succès de grand leaders innovateurs tél que Steve Jobs, et le créateur du web Tim Berners-Lee.

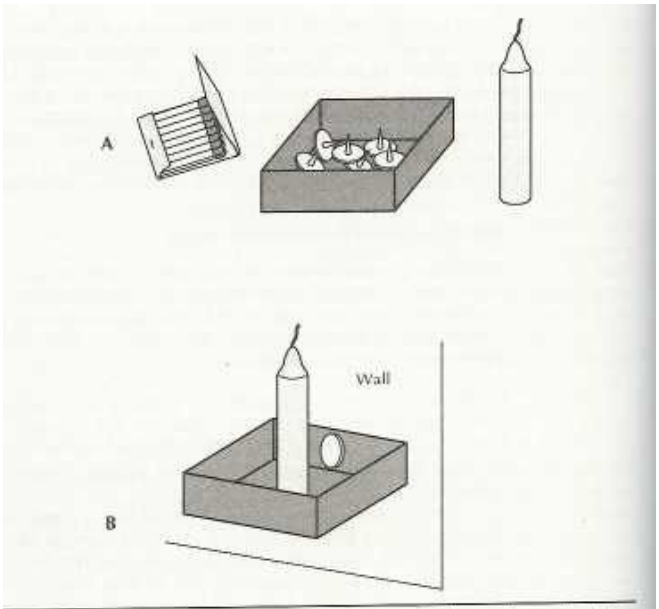
Dans cette nouvelle économie mondiale, la créativité s'impose comme étant un élément primordial. En effet, la créativité est reconnue comme étant un élément important, voir indispensable dans les organisations d'aujourd'hui. Pour cette raison, la plupart des métiers requièrent aujourd'hui un certain niveau de créativité. La créativité est souvent décrite comme étant la capacité générer des idées qui sont originales et utiles (Amabile, 1996).

Cependant, la créativité n'est pas facile, et les organisations d'aujourd'hui font face à de sérieux blocages lors des toutes premières phases du processus d'innovation (l'idéation) : lorsque leurs employés doivent générer des idées innovantes ou solutions créatives à des problèmes. Une des causes possibles de ces blocages des processus d'innovation peuvent s'inscrire dans une dimension purement cognitive. En effet, il existe des biais cognitifs, et un grand nombre d'études montrent aujourd'hui que la capacité à générer de nouvelles idées sont contrainte par des « heuristiques intuitives » (Agogué et al., 2014; Crilly and Cardoso, 2017; Jansson and Smith, 1991; Smith et al., 2003), connue sous le nom des effets de fixation.

Chapitre II : La fixation : un défi majeur pour le leadership créatif

En effet, les travaux en psychologie cognitive ont mis en évidence l'existence d'effets de fixation dans des situations de conception. Plusieurs expériences exigeant d'explorer des idées/solutions innovantes ont permis d'étudier les conditions dans lesquelles des individus ne parviennent pas à générer des idées innovantes, et en particulier les effets de fixation (initialement connue sous le nom de « fixité fonctionnelle »).

Les études sur les biais cognitifs en situation de conception montre que des effets de fixation et de conformité dans les activités de génération d'idées créatives se produisent lorsque les individus doivent concevoir des objets ou dispositifs nouveaux pour remplir des fonctions spécifiques (Torrance, 1974). Ces études montrent en effet que les concepteurs sont limités dans la génération de solutions alternatives.



Duncker's (1945) Candle Problem The subjects are asked to attach a candle to the wall and are given a box of tacks, candles, and matches, as shown in panel A. The solution is shown in panel B.

Une des expérience les plus classiques illustrant ce phénomène de fixation est le problème de la bougie (Duncker and Lees, 1945). Duncker fait entrer des sujets dans un salle

dans laquelle se trouve une table, une bougie, une boite d'allumettes, un tableau, et des punaises. L'expérimentateur leur demande ensuite de fixer la chandelle au mur du tableau sans que la cire tombe sur la table située en dessous. Une solution typique du problème est de vider la boite d'allumettes, de fixer la bougie dans cette dernière, et d'utiliser des punaises pour fixer la boite d'allumettes au tableau (voir image ci-dessus). Plusieurs participants de l'expérience sont « fixés » à l'utilisation classique de la boite d'allumette, i.e les connaissances classiques sur la boite d'allumette, et n'arrivent pas à la voir autrement pour résoudre le problème posé. Certains d'entre eux tentent sans succès de fixer directement la chandelle au mur avec des punaises, ou en faisant fondre une partie de la cire de la bougie pour la coller directement au mur.

Chapitre III : Le leadership d'aujourd'hui peut-il jouer un rôle défixateur ?

Le leadership est reconnu pour avoir un rôle fondamental à jouer pour aider une équipe à surmonter ces effets de fixation dans un écosystème en situation de créativité (Mumford et al., 2003; Reiter-Palmon and Illies, 2004). Le leadership est définit comme étant un « processus d'influence social dans lequel un ou plusieurs acteurs (jouant le rôle de leaders) emmènent d'autres acteurs (leurs équipes) à atteindre un objectif commun » (Chemers, 2014). La créativité est définit comme étant la production d'idées ou de solutions à des problèmes de telle sorte que ces idées ou solutions soient originales et utiles (Amabile, 1983). Lorsque leadership et créativité sont comparés, ils passent souvent pour antagonistes - soit que les leaders soient « créatifs » à la place de leurs équipes, soit que l'autorité doive disparaître pour libérer leurs créativités.

Mais, qu'appelle-t-on alors le « leadership pour la créativité » ? Qui sont les leaders créatifs ? Comment gèrent-ils les processus d'innovation ?

La revue de littérature sur le leadership et la créativité présente deux archétypes distincts du leader pour la créativité : les innovateurs et les facilitateurs (Mumford et al., 2003; Sternberg et al., 2003). Les premiers sont des leaders innovateurs et très créatifs, qui stimulent la créativité et l'innovation en faisant le travail innovant eux-mêmes, comme par exemple Steve Jobs et Elon Musk. Contrairement aux premiers, les deuxièmes n'ont pas les idées innovantes eux-mêmes, mais sont excellents à faciliter le travail créatif pour leurs équipes, et ceci en gérant la plupart des facteurs contextuels qui sont favorables à la créativité : tél que le climat et l'environnement de travail (Carmeli and Paulus, 2015; Shalley and Gilson, 2004). Des exemples de leaders facilitateurs du processus d'innovation sont : Larry Page, Sergey Brin ou David Kelley. Néanmoins, les facilitateurs ont l'inconvénient d'être beaucoup moins impliqués que les innovateurs dans le processus créatif de leurs équipes. La question se pose alors : quelles seraient les figures de « leader pour la créativité » intermédiaires ? Où trouver ces figures intermédiaires ? comment les mettre en évidence ?

Dans un cadre de recherche multidisciplinaire combinant science de gestion (management des processus d'innovation), sciences cognitives (biais cognitifs à la créativité) et science de la conception innovante (outils et théories de la conception innovante), l'objectif de la thèse était de mettre en évidence des figures de leadership créatifs pouvant jouer des rôles cruciaux pour aider leurs équipes à surmonter les effets de fixations.

De plus, ces règles expérimentales ont ensuite été contextualisées dans des conditions plus générales en organisation, et ceci via les outils de gestion du leadership organisationnel classique (recrutement, allocations de temps et de ressources, motivation, prise de la décision, évaluation, création de climat, spécification des objectifs, etc..). En effet, les méthodes de recherches utilisés pour cette contextualisation organisationnelle consistent à i) mettre en place des protocoles expérimentaux permettant d'isoler les phénomènes de blocages cognitifs dans des situations de créativité ; ii) à générer des règles expérimentales de défixation

cognitive dans des contextes bien contrôlés (laboratoire); et iii) à contextualiser ces règles expérimentales de défixation cognitive en utilisant des études de biographies de grands leaders créatifs de l'histoire tél que : Steve Jobs, Thomas Edison ou Mark Zuckerberg.

Chapitre IV : comment mettre en évidence des « leaders défixateurs » ?

La question de recherche devient donc : comment mettre en œuvre des leaders défixateurs ?

Cette question de recherche principale peut être décomposée en trois sous questions de recherches :

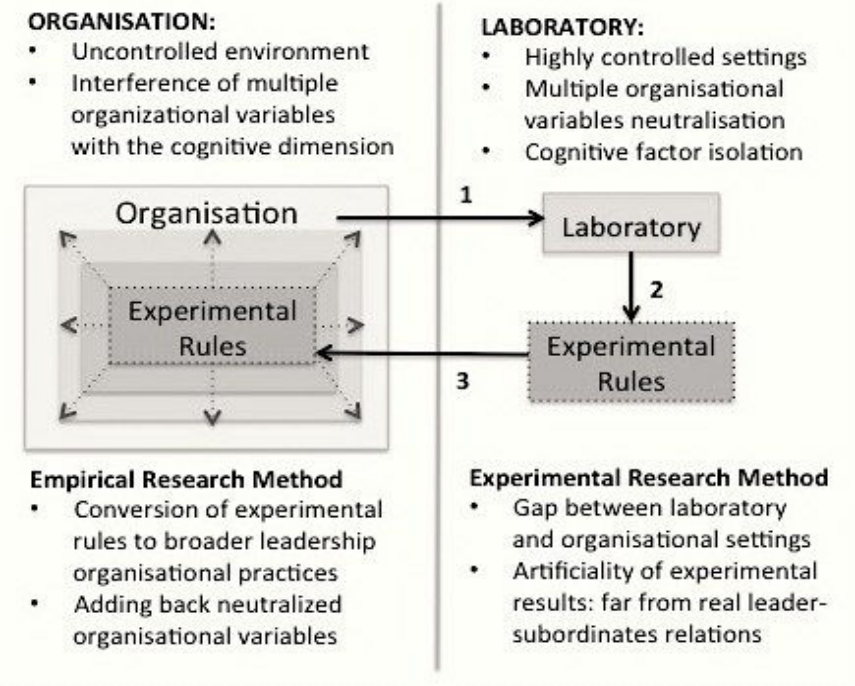
1. Quelles actions doivent être performées par les leaders défixateurs ?

2. Quelles sont les compétences minimales requises pour un leader défixateur ?

3. Comment les leaders défixateurs doivent ils se comporter en fonction du niveau d'expertise de leurs équipes ?

L'hypothèse implicite du travail de thèse serait qu'un bon leader (un leader défixateur) pourrait faire une différence et faciliter les employés à se defixer (ainsi qu'à maintenir leur état de défixation), et par la présente produire plus de créativité dans le travail.

Méthode de recherche



Afin de répondre aux questions de recherche, nous avons adopté une méthode de recherche qui articule entre deux environnements différents : le laboratoire et l'organisation. Cette méthode de recherche se constitue de trois étapes principales :

- **Etape 1** : le passage de l'environnement organisationnel au laboratoire

  La première étape est un constat basé sur les études du « leadership pour la créativité ». En effet, la revue de la littérature sur le leadership et la créativité montre que le contrôle précis du processus de défixation est difficile dans un contexte complexe tél que l'organisation. En effet, en organisation plusieurs variables organisationnelles (tél que le recrutement, la motivation, le climat, la prise de décision, l'évaluation, l'allocation de ressource et de temps, etc..) viennent interférer avec la variable cognitive, et rend donc le contrôle de cette dernière difficile. Pour cette raison, des expériences devraient être réaliser afin de neutraliser ces variables organisationnelles multiples et d'isoler et de contrôler précisément le rôle du

leadership pour la défixation. Cependant, cette décomposition de variables nécessite toutefois la conception d'un « modèle d'idéation guidé par un leader ».

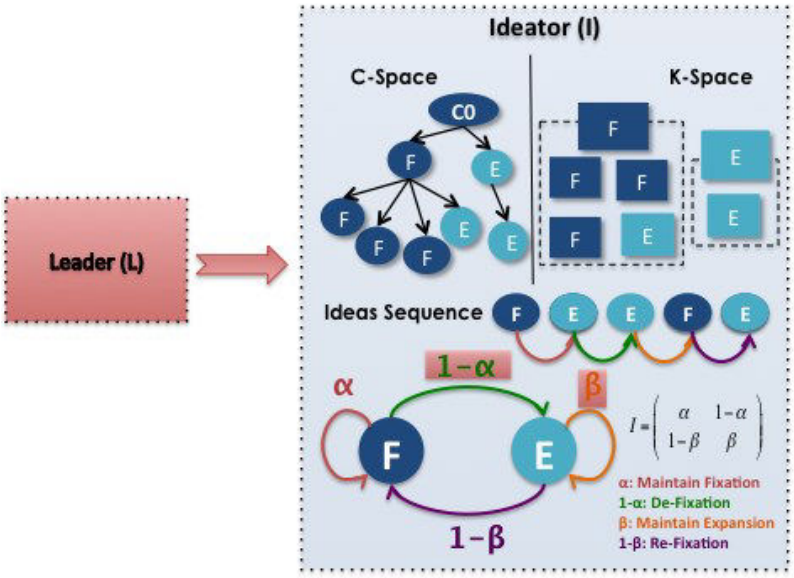
- **Etape 2** : Génération de règles expérimentales pour la défixation guidée par un leader

  La deuxième étape de notre méthode de recherche consiste d'une part à modéliser le rôle d'un leader défixateur en situation d'idéation créative, et d'autres part à le tester expérimentalement. La première phase de cette étape nécessite la mise en place de « theory-driven experiments » (d'expériences guidées par la théorie), afin d'au mieux prédire les moyens d'actions, les compétences minimales, ainsi que les stratégies contingentes requises par le leader pour défixer ses équipes. La deuxième phase de cette étape consiste à expérimenter ce leadership défixateur pour en générer des règles précise de défixation guidée par un leader.

- **Etape 3** : Conversion des règles expérimentales au contexte organisationnel

  La troisième étape consiste à étendre les règles de l'étape précédente à un contexte plus complexe, qui est l'organisation. En effet, dans cette étape, les variables organisationnelles multiples neutralisées lors de l'étape initiale sont reprises en compte, afin de mieux comprendre le rôle des leviers d'actions du leader défixateur en organisation (ces leviers sont le recrutement, la prise de décision, l'évaluation de ses équipes de travail, etc..).

Chapitre V : Un modèle de l'idéation guidé par un leader : « Leadership-driven Ideation »

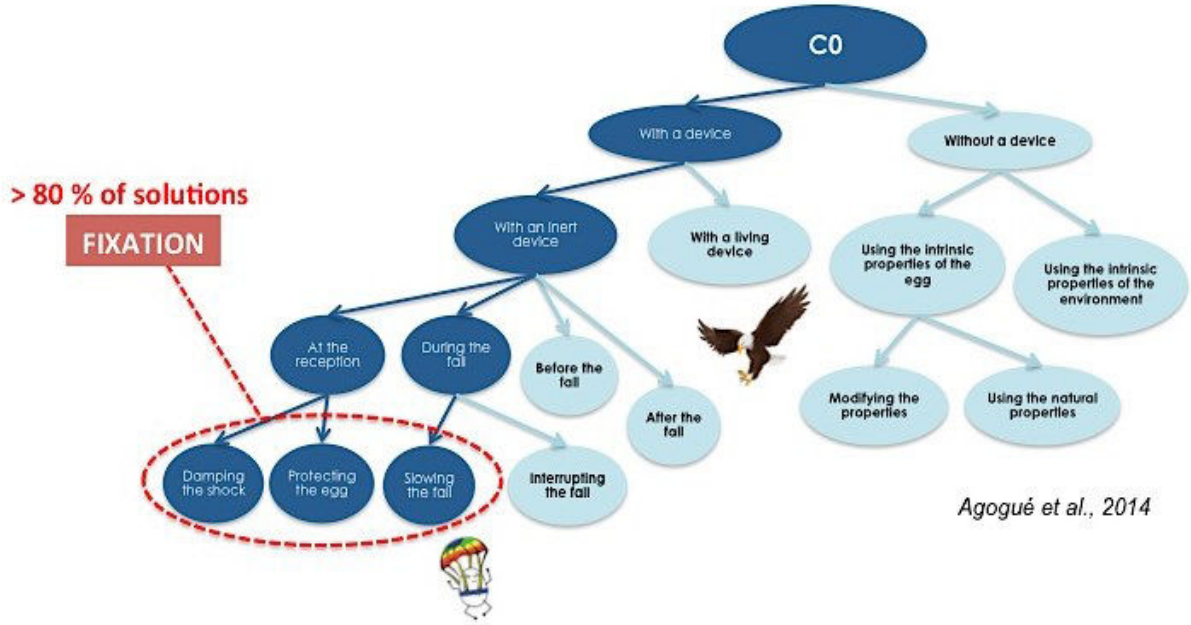


La théorie C-K peut être utilisée pour définir si une idée est fixée ou pas fixée (expansion des espaces C ou K) (Hatchuel et al., 2011). Cependant, vue que le processus d'idéation est une série d'idées générées qui pourraient osciller entre la fixation et l'expansion, nous utilisons la théorie des chaines de Markov pour une meilleure analyse de la séquence d'idéation. La théorie est utilisée pour définir les probabilités de maintenir la fixation – la défixation, maintenir l'expansion, et la re-fixation.

Par conséquence, à partir de ce modèle, nous constatons qu'un bon « leader défixateur » devrait aider son équipe à diminuer la probabilité de maintenir la fixation (probabilité 1-alpha) – les aider à se défixer, et augmenter la probabilité de maintenir l'expansion (probabilité beta). D'un point de vue contingent, la capacité du leader à détecter la fixation et l'expansion des idées, est donc cruciale.

Chapitre VI : Conception théorique des expériences : modéliser des figures de leaders défixateurs à partir du modèle de l'idéation guidé par un leader

La conception théorique des expériences qui sont conduites sont toutes basées sur un problème créatif déjà établi – le problème des œufs de poule (voir image ci-dessous).



A partir de cette « tâche de l'œuf », dans laquelle les sujets doivent *faire en sorte qu'un œuf de poule lâché d'une hauteur de 10 mètres ne se casse pas* et de la mobilisation des théories de la conception développée, des études précédentes ont démontré que 80% des participants qui ont réalisé cette tache sont « fixés » autour de trois catégorie de réponses (amortir le choc, ralentir la chute, et protéger l'œuf). Ces trois catégories de solution sont considérées comme étant en zone de fixation (Agogué et al., 2014, 2014; Agogue et al., 2015). D'autres réponses en dehors de ces trois catégories de fixation tél que (modifier les propriétés de l'œuf, utiliser un dispositif vivant, etc.…) sont considérées comme étant en zone d'expansion.

Grace à notre modèle de l'idéation guidée par un leader, nous avons ensuite examiné l'influence d'un leader pilotant l'idéation sur la créativité des réponses données par les participants, et basé sur la théorie quatre leaders défixateurs potentiels sont à tester dans les expériences. Ces leaders sont :

1. **Leader Défixateur 1**, qui a la connaissance de fournir un exemple restrictif. Les hypothèses sont que les exemples formulés à un niveau d'abstraction élevé atténuent la fixation, tandis que dans le cas contraire ils renforcent la fixation.
2. **Leader Défixateur 2** donne juste des feedbacks à chaque idée. Deux types de feedbacks sont définit, le premier (le changeur) encourage constamment l'idéateur à changer de piste ; l'autre (le mainteneur) encourage les idéateurs à continuer dans la même piste. Par conséquent, ces leaders n'ont pas besoin de connaissance du tout vue que leurs feedbacks sont toujours indépendants des idées.
3. **Leader défixateur 3** a la capacité de reconnaitre si une idée est en fixation ou en expansion. Le leader utilise ensuite une stratégie congruente pour encourager les idéateurs à changer de piste si l'idée est en fixation, ou continuer si elles sont en expansion. Une stratégie contreproductive incongruente est aussi définit dans les expériences.
4. **Leader défixateur 4** est moins compètent que le leader défixateur 3. Il a juste la capacité de décider parfaitement si une idée est dans la fixation, ou en dehors de la fixation. Deux types sont définit : l'expert en fixation, et l'expert en expansion.

Chapitre VII : Expérimenter de nouvelles figures de leaders défixateurs

Expérience 1 : leader défixateur 1

Dans la première expérience, nous testons deux comportements du leader defixateur 1 :

- Le leader défixateur 1 « **abstract** » impose des contraintes aux participants sur un niveau d'abstraction élevé des idées en fixations, i.e. les catégories d'idées en fixation (« générer des idées à ce problème sachant *que vous ne devez ni amortir le choc, ralentir la chute ou protéger l'œuf* »).
- Le leader défixateur 1 « **specific** » impose des contraintes aux participants sur un niveau d'abstraction bas des idées en fixations (« générer des idées à ce problème sachant *que vous ne devez ni utiliser de matelas, de parachute, ou de* papiers bulles »).

Expérience 2 : leader défixateur 2

Dans la deuxième expérience, nous testons deux comportements du leader defixateur 2 :

- Le leader défixateur 2 « **changer** » demande aux participants de « chercher une autre piste » à chaque idée générée par eux, indépendamment de la nature de l'idée, ce leader essaye de pousser les sujets à toujours changer de piste.
- Le leader défixateur 2 « **maintainer** », contrairement au leader « changer », demande aux participants de « continuer sur cette piste » à chaque idée générée par eux, indépendamment de la nature de l'idée, ce leader essaye de pousser les sujets à maintenir la même piste.

Expérience 3 : leader défixateur 3

Dans la troisième expérience, nous testons deux comportements du leader defixateur 3 :

- Le leader défixateur 3 « **congruent** » demande aux participants de « chercher une autre piste » à chaque idée générée par eux en fixation, tandis que si l'idée est générée en expansion (en dehors de la fixation), ce leader demande aux participants de « continue sur cette piste ».
- Le leader défixateur 3 « **incongruent** », contrairement au leader « congruent », demande aux participants de « continuer sur cette piste » à chaque idée générée par eux en fixation, tandis que si l'idée est générée en expansion (en dehors de la fixation), ce leader demande aux participants de « chercher une autre piste ».

Expérience 4 : leader défixateur 4

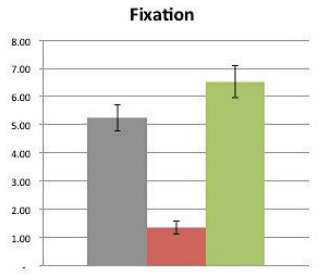
Dans la quatrième expérience, nous testons trois comportements du leader defixateur 4 :

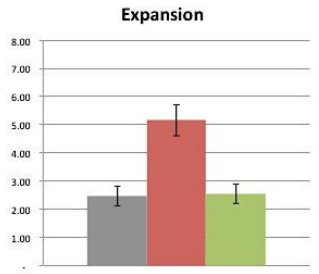
- Le leader défixateur 4 « **random** » n'est bon à reconnaitre ni les idées en fixation, ni les idées en expansion. En effet, ce leader se trompe une fois sur deux en demandant aux participants de « chercher une autre piste » tandis que l'idée est en expansion, ou « continue sur cette piste » tandis que l'idée est en fixation.
- Le leader défixateur 4 « **expansion-expert** » est expert à reconnaitre les bonnes idées (en expansion) uniquement. En effet, si l'idée est en expansion, ce leader demande aux participants de « continue sur cette piste ». Cependant, ce leader se trompe une fois sur deux en demandant aux participants de « continuer sur cette piste » tandis que l'idée est en fixation.

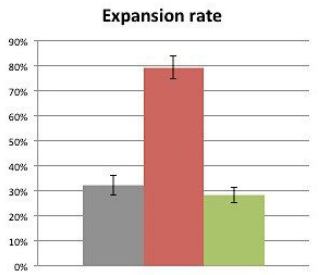
- Le leader défixateur 4 « **fixation-expert** » est expert à reconnaitre les mauvaises idées (en fixation) uniquement. En effet, si l'idée est en fixation, ce leader demande aux participants de « cherche une autre piste ». Cependant, ce leader se trompe une fois sur deux en demandant aux participants de « cherche une autre piste » tandis que l'idée est en expansion.

Résultats expérimentaux

Les résultats de l'expérience 1 montre que leader défixateur 1 « **abstract** » divise par 4 le nombre d'idées en fixation et double le nombre d'idées en expansion, tandis que le leader défixateur 1 « **specific** » au contraire augmente le nombre d'idées en fixation et ne change pas le nombre d'idées en expansion (voir ci-dessous).



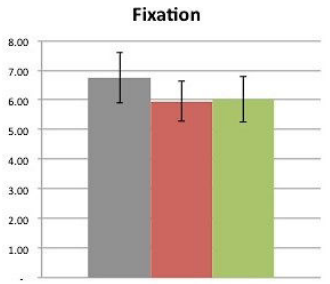


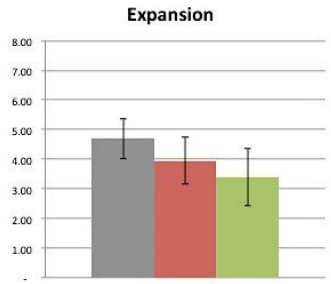


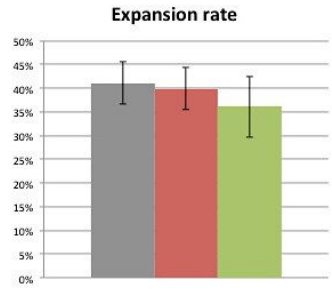
Mean	Fixation	Expansion	Expansion rate
Group control	5,240	2,480	0,321
Group "abstract"	1,360	5,160	0,791
Group "specific"	6,520	2,560	0,282

Standard Error of the Mean			
Group control	0,470	0,356	0,038
Group "abstract"	0,230	0,552	0,046
Group "specific"	0,560	0,348	0,031

Les résultats de l'expérience 2 montre que ni le leader défixateur 2 « **changer** » ni le leader défixateur 2 « **maintainer** » n'arrive à avoir un effet sur le nombre d'idées en fixation ou en expansion. Cela montre que le fait de donner un feedback indépendant de l'idée émise par le participant nuit au processus d'idéation créatif (voir ci-dessous).



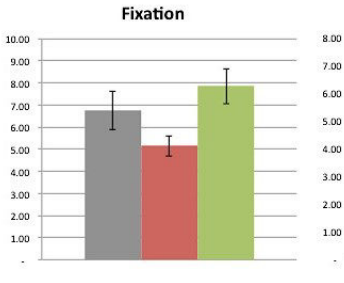


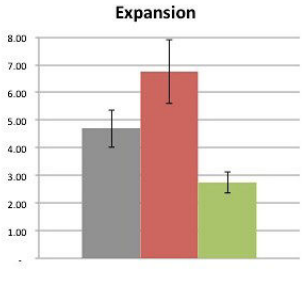


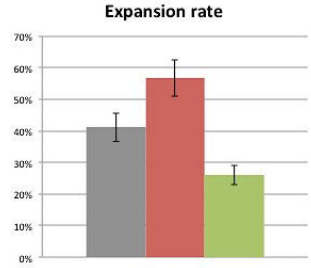
Mean	Fixation	Expansion	Expansion rate
Group control	6,750	4,700	0,410
Group "changer"	5,950	3,950	0,399
Group "maintainer"	6,030	3,400	0,361

Standard Error of the Mean			
Group control	0,861	0,680	0,044
Group "changer"	0,678	0,803	0,044
Group "maintainer"	0,772	0,980	0,064

Les résultats de l'expérience 3 montre que ni le leader défixateur 3 « **congruent** » arrive à diminuer le nombre d'idées émises par les participants en fixation, et augmente le nombre d'idées en expansion. Le leader défixateur 3 « **incongruent** » arrive au contraire à augmenter le nombre des idées des participants en fixation, et diminue fortement le nombre d'idées en expansion (voir ci-dessous).



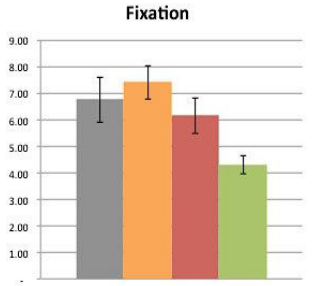


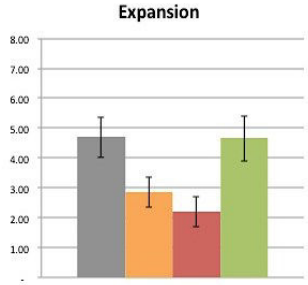


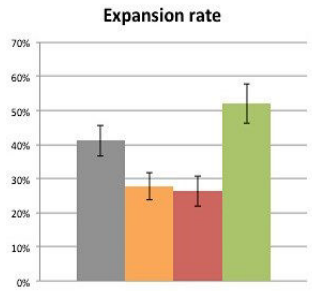
Mean	Fixation	Expansion	Expansion rate
Group control	6,750	4,700	0,410
Group "congruent"	5,150	6,750	0,567
Group "incongruent"	7,850	2,750	0,259

Standard Error of the Mean			
Group control	0,861	0,680	0,044
Group "congruent"	0,461	1,145	0,058
Group "incongruent"	0,796	0,382	0,030

Les résultats de l'expérience 4 montre que ni le leader défixateur 4 « **random** » et leader défixateur 4 « **expansion-expert** » ont tous deux un effet négatif sur les participants en termes de nombre d'idées en fixation et expansion (voir ci-dessous). Cependant, seul le leader défixateur 4 « **fixation-expert** » arrive à diminuer le nombre d'idées émises par les participants en fixation, sans changer le nombre d'idées en expansion (voir ci-dessous).





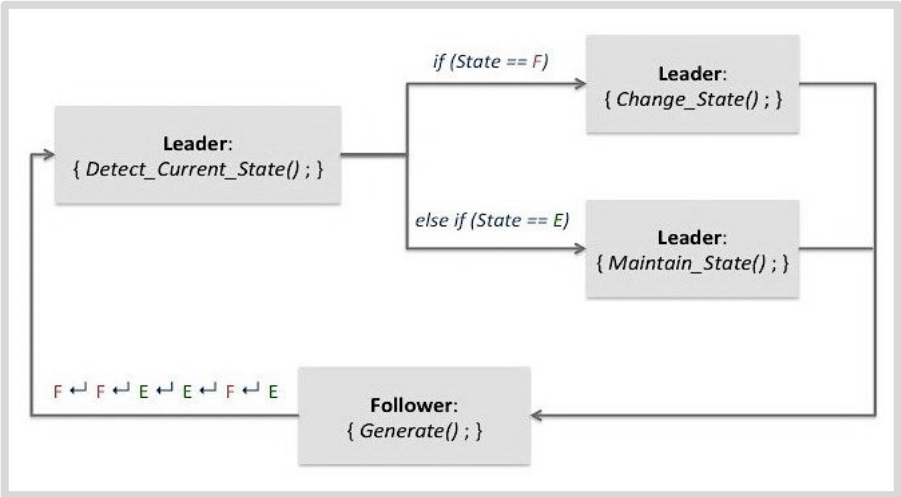


Mean	Fixation	Expansion	Expansion rate
Group control	6,750	4,700	0,410
Group "random"	7,400	2,850	0,278
Group "expansion expert"	6,150	2,200	0,263
Group fixation expert"	4,300	4,650	0,520

Standard Error of the Mean			
Group control	0,861	0,680	0,044
Group "random"	0,626	0,499	0,040
Group "expansion expert"	0,670	0,501	0,044
Group fixation expert"	0,341	0,755	0,058

Chapitre VIII : Comment des expériences en laboratoires peuvent-elles mettre en évidence les leviers managériaux du leadership défixateur en organisation ?

Nous avons montré dans nos expériences que selon des règles expérimentales très précises et contrôlées, consistant d'une part à détecter les phénomènes de blocage (la fixation), et d 'autres part à entreprendre les modes d'actions appropriés pour les surmonter, les leaders arrivent à aider les participants à sortir des effets de fixation et maintenir leur performance créative (Brun et al., 2015; Ezzat et al., 2016a, 2016b, 2017a, 2017b, 2017c). Ces règles peuvent être généralisé par le schéma suivant :



La question de notre thèse était donc: comment traduire ces leviers d'actions à un contexte plus complexe qu'est l'organisation ?

En effet, l'étape 3 de notre méthode de recherche consistait à valider les résultats expérimentaux par des données empiriques extraient de biographies de grands leaders innovateurs. Dans cette thèse nous nous focalisons sur 5 leaders innovateurs : *Kenneth Mees de Kodak, Steve Jobs de Apple, Larry Page et Sergey Brin de Google, et David Kelley de IDEO*.

A partir de données empiriques et historiques de ces 5 leaders, nous démontrons que nous pouvons aller au-delà des implications managériales classiques de nos expériences – et nous proposons une méthode qui permet d'articuler entre les règles de défixation obtenues dans la phase expérimentale, et leur utilité pour extraire des variables organisationnelles nouvelles qui n'étaient pas envisageables auparavant dans la littérature du leadership pour la créativité. En effet, nous mettons l'accent sur certaines variables organisationnelles de chacun des sept leviers d'actions typiques du leader en organisations (*le recrutement, la prise de décision, l'évaluation, la création de climat, la motivation, l'allocation de ressources et de temps, et la spécification d'objectifs*) qui étaient mises de côté dans la littérature. Quelques exemples de ces variables sont : "*la subordination dans le contrat de recrutement, le niveau*

de contraintes sur les allocations de ressources et de temps, l'engagement dans la prise de décision, le « nudging » positif ou négatif, la spécification de ce que n'est pas l'objectif, la création de climat fermé et stressant, la démotivation des équipes, etc..

Chapitre IX : Conclusion et discussions

La thèse permet de mettre en évidence quatre différentes figures de leaders défixateurs, qui sont des formes de leadership intermédiaires entre les innovateurs (déjà en possession des idées innovantes) et les facilitateurs (peu interventionniste dans le processus créatif de leurs équipes).

L'expérience 1 montre que si le leader arrive à formuler des idées en fixation à un niveau d'abstraction élevé, i.e. catégorisation des idées en fixation, le leader peut diminuer la fixation et donc stimuler la créativité de son équipe.

L'expérience 2 montre que si le leader adopte une stratégie constante, qui consiste soit à pousser son équipe à toujours chercher des idées différentes (un stratégie « novelty search » tél qu'utilisait dans les algorithmes de robotiques évolutionniste (Lehman and Stanley, 2011)), ou au contraire une stratégie consistant à toujours encourager toutes les idées émises par son équipe (règles de brainstorming de Osborn (Agogué, 2016; Osborn, 1957, 1953), cette stratégie peut nuire à la performance créative de son équipe.

L'expérience 3 montre que si le leader est capable de détecter la frontière entre la fixation et l'expansion d'un projet créatif, i.e. c'est-à-dire reconnaitre les idées fixantes et défixantes de son équipe, le leader peut avoir un effet positif pour réduire la fixation, i.e. pousser son équipe en dehors de la zone de fixation, et augmenter l'expansion, i.e. maintenir la performance créative de son équipe.

L’expérience 4 montre que si le leader peut au moins reconnaitre la zone de fixation (en se trompant dans la reconnaissance des idées créatives), il peut aussi aider son équipe à devenir plus créatif.

Ces expériences permettent d’extraire des règles de défixation guidée par un leader « leadership defixation rules » qui consiste d’une part à détecter les phénomènes de blocage (la fixation), et d ‘autres part à entreprendre les modes d’actions appropriés pour les surmonter, et aider une équipe à sortir des effets de fixation et maintenir leur performance créative (modéliser comme l’expansion dans nos expériences). Ces règles permettent ensuite d’éclairer des variables organisationnelles qui était jusqu’alors mis de côté dans la littérature du leadership pour la créativité.

La contribution principale du travail de thèse est qu’il est possible pour un leader de pousser les employés à devenir plus créatifs et que le control du leadership ne tue pas toujours la créativité, i.e. en contradiction avec quelques arguments de la littérature sur la créativité (Amabile, 1998). La thèse au contraire démontre qu’il est possible pour un leader avec une connaissance appropriée (principalement la reconnaissance de la frontière entre la fixation et l’expansion) de faciliter les employés à se défixer dans leur réflexion et donc de générer des idées plus créatives.

Références

Agogué, M., 2016. Alex F. Osborn - Le brainstorming, premier outil de support à la pensée créative. Éditions EMS.

Agogué, M., Kazakçi, A., Hatchuel, A., Masson, P., Weil, B., Poirel, N., Cassotti, M., 2014. The Impact of Type of Examples on Originality: Explaining Fixation and Stimulation Effects. J. Creat. Behav. 48, 1–12.

Agogue, M., Le Masson, P., Dalmasso, C., Houdé, O., Cassotti, M., 2015. Resisting Classical solutions: the creative mind of engineers and designers. Psychol. Aesthet. Creat. Arts.

Amabile, T., 1996.

Amabile, T.M., 1998. How to kill creativity. Harvard Business School Publishing, Boston, MA.

Amabile, T.M., 1983. The social psychology of creativity: A componential conceptualization. J. Pers. Soc. Psychol. 45, 357.
Brun, J., Ezzat, H., Weil, B., 2015. Managing the impacts of non-verbal devices on idea generation: a new challenge for creative leaders. Eur. Acad. Manag.-EURAM.
Carmeli, A., Paulus, P.B., 2015. CEO ideational facilitation leadership and team creativity: The mediating role of knowledge sharing. J. Creat. Behav. 49, 53–75.
Chemers, M., 2014. An integrative theory of leadership. Psychology Press.
Crilly, N., Cardoso, C., 2017. Where next for research on fixation, in: Inspiration and Creativity in Design? Design Studies. pp. 1–38.
Duncker, K., Lees, L.S., 1945. On problem-solving. Psychol. Monogr. 58, i.
Ezzat, H., Agogué, M., Cassotti, M., Le Masson, P., Weil, B., 2016a. Leadership-driven Ideation: The Cognitive Effects of Directive Feedbacks. Creat. Eur. Acad. Manag. - EURAM.
Ezzat, H., Agogué, M., Le Masson, P., Weil, B., 2017a. Solution-oriented versus Novelty-oriented, in: Leadership Instructions: Cognitive Effect on Creative Ideation, Design Computing and Cognition' 16. Springer, pp. 99–114.
Ezzat, H., Agogué, M., Le Masson, P., Weil, B., 2016b. Solution-oriented versus Novelty-oriented, in: Leadership Instructions: Cognitive Effect on Creative Ideation, DCC'16 (Design Computing & Cognition. United States, Chicago.
Ezzat, H., Camarda, A., Cassotti, M., Agogué, M., Houdé, O., Weil, B., Le Masson, P., 2017b. How minimal executive feedback influences creative idea generation. PloS One 12, 0180458.
Ezzat, H., Le Masson, P., Weil, B., 2017c. Leading in the Unknown with Imperfect Knowledge: Situational Creative Leadership Strategies for Ideation Management, in: 24th Innovation and Product Development Management (IPDM) Conference.
Guilford, J.P., 1959. Traits of creativity. Creativity and its cultivation.
Hatchuel, A., Le Masson, P., Weil, B., 2011. Teaching innovative design reasoning: How concept–knowledge theory can help overcome fixation effects. Artif. Intell. Eng. Des. Anal. Manuf. 25, 77–92.
Jansson, D.G., Smith, S.M., 1991. Design fixation. Des. Stud. 12, 3–11.
Mumford, M.D., Connelly, S., Gaddis, B., 2003. How creative leaders think: Experimental findings and cases. Leadersh. Q. 14, 411–432.
Osborn, A., 1957. Applied imagination. Scribners's, New York.
Osborn, A.F., 1953. Applied imagination.
Purcell, T., Gero, J.S., 1996. Design and other types of fixation. Des. Stud. 17, 363–383.
Reiter-Palmon, R., Illies, J.J., 2004. Leadership and creativity: Understanding leadership from a creative problem-solving perspective. Leadersh. Q. 15, 55–77.
Shalley, C.E., Gilson, L.L., 2004. What leaders need to know: A review of social and contextual factors that can foster or hinder creativity. Leadersh. Q. 15, 33–53.
Smith, S.M., Paulus, P.B., Nijstad, B.A., 2003. The constraining effects of initial ideas, in: Group Creativity: Innovation through Collaboration. pp. 15–31.
Sternberg, R.J., Kaufman, J.C., Pretz, J.E., 2003. A propulsion model of creative leadership. Leadersh. Q. 14, 455–473.
Torrance, E.P., 1974. The Torrance Tests of Creative Thinking : Norms-Technical Manual. Personnel Press, Lexington, MA.

Résumé

Plusieurs travaux ont permis de caractériser le rôle des biais cognitifs dans les situations de créativité. Parmi ces biais, on distingue particulièrement les effets de fixation, c'est à dire les connaissances et solutions habituelles qui viennent spontanément à l'esprit des individus lors d'une situation de créativité (tâche de créativité, de génération d'idées, ou de résolutions de problèmes créatifs), et qui contraignent la génération d'idées et de solutions nouvelles et plus créatives. Ces différentes études ouvrent plusieurs pistes pour enrichir la gestion de ces biais cognitifs dans les processus d'innovation.

Le leadership est reconnu pour avoir un rôle fondamental à jouer pour aider une équipe à surmonter ces effets de fixation dans un écosystème en situation de créativité. Le leadership est définit comme étant un processus d'influence social dans lequel un ou plusieurs acteurs (jouant le rôle de leaders) emmènent d'autres acteurs (leurs équipes) à atteindre un objectif commun. Leadership et créativité passent souvent pour antagonistes - soit que les leaders soient « créatifs » à la place de leurs équipes, soit que l'autorité doive disparaître pour libérer leurs créativités.

Dans un cadre de recherche multidisciplinaire mixant science de gestion (management de l'innovation), sciences cognitives (biais cognitifs à la créativité) et science de la conception innovante (théorie C-K), les leaders créatifs peuvent jouer des rôles très importants pour aider leurs équipes à surmonter les effets de fixations, et ceci selon des règles expérimentales très précises et contrôlées, consistant d'une part à détecter les phénomènes de blocage (la fixation), et d 'autres part à entreprendre les modes d'actions appropriés pour les surmonter.

De plus, ces règles expérimentales peuvent être contextualisées dans des conditions plus générales en organisation, et ceci via les outils de gestion du leadership organisationnel classique (recrutement, allocations de temps et de ressources, motivation, prise de la décision, évaluation, création de climat, spécification des objectifs, etc..). En effet, les méthodes de recherches utilisées pour cette contextualisation organisationnelle consistent à i) mettre en place des protocoles expérimentaux permettant d'isoler les phénomènes de blocages cognitifs dans des situations de créativité ; ii) à générer des règles expérimentales de défixation cognitive dans des contextes bien contrôlés (laboratoire); et iii) à contextualiser ces règles expérimentales de défixation cognitive en utilisant des études de biographies de grands leaders créatifs de l'histoire tél que : Steve Jobs, Thomas Edison ou Mark Zuckerberg.

Mots Clés

Leadership, Créativité, Idéation, Management de l'innovation, Cognition, Fixation

Abstract

Several studies have helped to characterize the role of cognitive biases, which appear in situations of creativity. Among these cognitive biases, we can particularly distinguish the fixation effects, that is to say, the obvious knowledge and solutions that comes spontaneously in individuals' mind during a situation of creativity (creativity task, idea generation, or creative problem-solving), and which consequently constrain the generation of novel and creative ideas and solutions. These different studies open new sights to enrich the management of these cognitive biases in innovation processes.

Leadership is recognized as having a fundamental role to play in helping a team overcome these fixation effects in an ecosystem in situation of creativity. Leadership is commonly defined as a process of social influence, in which one or more actors (acting as leaders), lead other actors (their teams) to achieve a common goal. Leadership and creativity are often seen as antagonistic – whether leaders are « creative » in the place of their teams, or that the authority and control must disappear in order for creativity of their teams to flourish.

In a multidisciplinary research framework combining management science (innovation management), cognitive science (cognitive biases to creativity) and innovative design science (C-K theory), creative leaders can play very important roles to help their teams overcome fixation effects, and this according to very precise and controlled experimental rules, consisting on the one hand to detect the cognitive biases against creativity (the fixation), and on the other hand to undertake the appropriate modes of actions to overcome them.

In addition, these experimental rules can be contextualized in more general conditions, such as organizational contexts, using traditional leadership organizational tools (recruitment, resources and time allocations, motivation, decision-making, evaluation, climate creation, goal-settings, etc..). Indeed, the research methods used for this organizational contextualization of the defixation rules consist of i) building experimental protocols in order to isolate the cognitive effects related to the fixation effects in situations of creativity; ii) generating experimental rules of cognitive defixation in highly and well-controlled contexts (laboratory settings); and iii) contextualizing these experimental rules for cognitive defixation using biographical studies of great creative and innovative leaders in the history, such as for example: Steve Jobs, Thomas Edison or Mark Zuckerberg.

Keywords

Leadership, Creativity, Ideation, Innovation Management, Cognition, Fixation