THE INTERACTIVE EFFECT OF WORKPLACE STRESSORS AND MOOD ON CREATIVITY AND IMPLEMENTATION ACTIVITIES: A DUAL LEVEL APPROACH

CLAUDIA A. SACRAMENTO

Doctor of Philosophy

Aston University

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Aston University

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Thesis Summary

This thesis analyses the impact of workplace stressors and mood on innovation activities. Based on three competitive frameworks offered by cognitive spreading activation theory, mood repair perspective, and mood-as-information theory, different sets of predictions are developed. These hypotheses are tested in a field study involving 41 R&D teams and 123 individual R&D workers, and in an experimental study involving 54 teams of students. Results of the field study suggest that stressors and mood interact to predict innovation activities in such a way that with increasing stressors a high positive (or negative) mood is more detrimental to innovation activities than a low positive (or negative) mood, lending support to the mood repair perspective. These effects are found for both individuals and teams. In the experimental study this effect is replicated and potential boundary conditions and mediators are tested. In addition, this thesis includes the development of an instrument to assess creativity and implementation activities within the realm of task-related innovative performance.

Keywords: Creativity; Implementation of Innovation; Stressors; Mood; Teams;

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Publications:

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Dedication

I dedicate this thesis to my father, who taught me that nothing is worth more than knowledge.

Acknowledgments

What we are is no more than the result of an interaction between what were born with and what our families made of us. As such, I am eternally grateful to my father, who has always been my source of confidence, to my mother, who made me always feel loved, and to my most feared reviewer, my sister, whose constant criticisms made me try always harder. And to Yves, just for making my life so much happier.

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I will never be able to thank her enough for her intellectual insights, her caring support, her thoughtful tutoring, her patience towards my despiteful procrastination… However, most importantly, her integrity, competence and thoughtfulness have provided me with a role model which I will always use to guide my work as an academic.

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Chapter 1

Thesis overview

1.1 Introduction

Being an innovative organisation is a critical success factor in the current marketplace (Anderson & King, 1993; West & Farr, 1990). With the influence of globalisation, rapid changes in technology and market diversification, organisations face an increasingly competitive marketplace where the continuous development of ideas and innovation is critical to their ability to stay ahead of the competition (Lengnick-Hall, 1992). Companies such as Google and Apple have a star status and are recognised and respected by the general public and investors largely because of their ability to be highly innovative. The need to be innovative is felt particularly strongly in the R&D sector. The nature of the R&D work is by definition creative, as a consequence the success of a company is directly dependent on their creative potential and creativity is heralded as the key to continuous success.

However, innovation does not occur in a vacuum and organisations are dependent on the contributions of individuals and teams to develop and implement original ideas that can in turn result in successful services or products. This raises the question; which factors foster or impair individual and team innovative performance?

1.2 Research problem

Anecdotal evidence suggests that people have their most brilliant ideas when they are relaxed and feeling happy. The often told story about how Archimedes discovered the principle of buoyancy while he was having a bath is a paragon of such popular beliefs. Having this in mind, the environment of today's organisations, in particular of those in the R&D sector, is characterised by a vast range of stressors such as time pressure, difficulty of work and job insecurity. These stressors are largely a consequence of the need each company has to face up to its competitors, however, they appear to be all but conducive to innovative performance.

Workplace stressors play an important role for a variety of other work related outcomes such as wellbeing and performance (Kahn & Byosiere, 1992; Sonnentag & Frese, 2002). It is therefore important to understand how different stressors affect the innovative performance of individuals and teams in charge of innovative projects.

The negative influence of stressors on cognitive processing has been previously documented, endorsing information processing as one of the possible pathways for a negative impact of stressors on innovative performance (Hamilton, 1982). Information processing is however also affected by a range of other variables that can moderate the impact of stressors and it is therefore important to identify these factors.

Organisations have lately been described as affect laden environments (Hartel, Zerbe, & Ashkanasy, 2005). Researchers have acknowledged that people do experience different feelings and moods when performing their tasks and these are likely to have a significant effect on work-related outcomes (George, 1995; Weiss, 2002). As is the case with stressors, the influence of mood on cognitive information processing has also been thoroughly analysed (e.g., Bower, 1981; Clapham, 2000; Murray, Sujan, Hirt, & Sujan, 1990). Given their common ground of influence, it is likely that stressors and mood interact to influence the performance of individuals and teams involved in the development of innovation activities, defined as the creative and implementation activities necessary to the execution of an R&D project. This leads to the research questions that this thesis aims to address:

How do stressors affect innovation activities?

How does mood affect innovation activities?

How do these two variables interplay to affect innovation activities?

This thesis adopts an information processing framework to analyse the above questions. This framework was selected based on analyses of what the different models of creativity and innovation share in common, which will be described over the next chapter, and on the extent to which R&D work is dependent on information processing activities. The design developed to address these questions includes a field study involving R&D professionals, and an experimental study using a sample of student teams. In addition, this project also includes the development of new scales to assess innovation activities which were deemed necessary to address the research questions forwarded. Next follows an overview of the present thesis.

1.3 Thesis structure

This thesis is comprised of ten chapters. Chapter one introduces the reader to the research problem.

In chapter two a brief overview of the creativity and innovation literature is offered with special reference as to where this project is positioned in terms of domain and level of analysis and theoretical approach.

In chapter three the theoretical framework that guides this project is developed. Three theories are explored as potential frameworks to explain how the interplay between individual stressors and individual mood affects innovation activities.

Chapter four reports the development of "innovation activities" scales that were deemed necessary to accurately tap into this project's research questions. The development of these scales was conducted in three sequential studies in which exploratory and confirmatory factor analysis were executed.

In chapter five the rationale for the methodological approach adopted in this project is explained. In this chapter is also included a detailed description of the research design adopted in the field study and of the sample characteristics, comprised of 41 R&D teams and 123 R&D team members.

In chapter six the hypotheses drawn in chapter three regarding the impact of individual stressors and mood on innovation activities are tested.

In chapter seven the framework developed at the individual level is extended to the team level. Similarly to chapter three, three competitive frameworks are developed in order to account for the interplay between team stressors and team mood to predict team innovation activities.

Chapter eight presents the testing of the hypotheses developed in chapter seven.

In chapter nine an experimental study using a student sample of 54 teams of students is presented. This was designed to test the framework developed and to also test an extension of this framework. To this end this study tests the same hypotheses outlined in chapter seven and further extends this model by exploring potential mediators and boundary conditions of the relationship between stressors-mood and innovation activities.

Finally, chapter ten provides the reader with a concluding discussion.

1.4 Contribution to knowledge

The contribution of this thesis to the understanding of innovative behaviour in organisations is twofold:

Firstly, it contributes to the understanding of the innovation process in individuals and teams by raising awareness for the different types of innovation activities that are necessary for the completion of an innovative product and by developing a measure that captures these activities.

Secondly, it contributes to the understanding of factors that influence innovative behaviour by unveiling how different stressors in the workplace interplay with mood to predict engagement in relevant innovation activities, in a context where innovative behaviour is expected.

Chapter 2

Creativity and Innovation: Brief overview

Domain and level of analysis, underlying framework, definitions

The purpose of this chapter is twofold. Firstly, it aims to provide a critical review of the literature that relates to the outcomes under analysis in this project in order to introduce the major approaches to the study of innovation in organisations. Secondly, it aims to explain where this research project is positioned in terms of level and unit of analysis, research approach, and definitions adopted.

2.1 Introduction

In their lay use, the terms creativity and innovation are applied indistinctively in different contexts. They are often used to characterise individuals, products, or the process that leads to the development of new products. It is for example common to see the word "creative" or "innovative" in reference to Shakespeare, the iPod, or the interactions a team engages in when working together to develop something new.

The lay indistinctive application of these terms is somewhat reflected in the academic literature. The terms "creativity" and "innovation" are often used interchangeably to refer to different phenomena, which leads to some ambiguity regarding the object of study, the level of analysis, or the underlying framework adopted in a given study. In order to avoid such ambiguity and clearly delineate the scope of this project, the next sections will describe the different existent orientations in terms of the domain of analysis, the unit of analysis, and the underlying approach to the study of creativity and innovation, with reference to where this project is positioned. In doing so, this chapter also offers a brief literature review of the general research on creativity and innovation that is of most relevance for this project. This chapter concludes with a presentation of the definitions related to the innovation activities adopted here.

2.2 Conceptualisation of the innovation process

It is important at this stage to clarify the distinction between creativity, implementation and innovation by briefly describing how the innovation process is conceptualised within this thesis. This project adopts West's (2002) terminology and perceives innovation as the general process that encapsulates both creativity and implementation of innovation. Creativity refers to the activities associated with the generation of ideas whereas implementation of innovation refers to the activities that enable the execution of such ideas. Henceforth when referring to both creativity and implementation activities the terms *innovative behaviour* or *innovation/innovative activities* are applied. These definitions will be explained later in more detail.

So far, the dominant approach to innovation conceptualises it as a circular, non-linear, process in which different stages, characterised by different actions, succeed each other. Although the succeeding stages perspective has been challenged, as will be discussed later in this chapter, such a framework can be useful when analysing innovation at a macro-level because it enables an understanding of the development of phases that can be so distinct that they are often allocated to different departments of an organisation (Damanpour, 1988, 2001). However, this approach is not particularly useful in advancing research that focuses on a micro-level unit of analysis because the individual activities throughout the development of an innovative project continually require a combination of creativity and implementation activities. As such, Kanter's (1988) proposal is adopted in this study and the innovation process is perceived not as a linear sequence of stages but as a set of tasks or activities carried out at the micro-level by individuals and groups. This idea of tasks or activities is also well aligned with the commonly held notion of innovation as a circular process including both ideation and implementation, in which people move from one stage to the next and then back to the previous one (West, 2002). Given their relevance, creativity and implementation activities are the focus of this study.

2.3 Domain of analysis

Innovation can take place in many different domains (Lubart & Guignard, 2004). People are innovative when they find a new way of saving on their domestic activities, when they offer suggestions on how to make their work environment a more environmentally-friendly place, or when they develop a new software update to correct an error of a former version. This project focuses on the understanding of innovation in the workplace, more specifically in R&D teams. Therefore, innovative behaviour displayed in arts, sports, or daily life is outside the scope of this project. Consistently, with a few exceptions that were found of significant relevance for understanding innovative behaviour in work settings, most of the creativity literature that underpins the theoretical rationale of this study is related to work settings.

2.4 Types of creativity

There are several different types of reasons as to why new ideas, as starting points for innovation, develop. Unsworth (2001) attempted to systematise these reasons and concluded that creativity could not be fully understood if conceptualised as a unitary construct. In line with this conclusion, the author developed a matrix including four different types of creativity.

The development of a taxonomy of creativity types is important because it enables a better understanding of how different facets of the same phenomenon can be affected differently by the same factors. For instance, voluntary creativity acts and creativity acts that are expected to occur as part of the job description are different in nature and consequently are bound to be enhanced by different variables, or even to be affected differently by the same variables. As a consequence, in order to obtain a more comprehensive understanding of creativity in the workplace it is important to disentangle the different types of creativity and focus on one category at a time. This section aims to clarify the type of creativity that this project is focused on by adopting Unsworth's (2001) typology.

Unsworth's (2001) four types of creativity result from the cross between two dimensions, driver for creativity and type of problem. The first dimension, the driver for creativity, refers to why people engage in the creative process. People might engage in the development of a creative output because such behaviours are expected as part of their job description, but they can also do so in a voluntary basis, when such a requirement is not formally part of their job role. This dimension ranges from externally driven engagement (the former case) to internally driven engagement (the latter case). The second dimension is the initial state of the trigger, and relates to the extent to which the problem to be solved is open or closed. Open problems require people to find, invent, or discover the problems whereas a closed problem is one that is presented to the individual when the method for solving is already known. This dimension ranges from closed, presented problems to open, discovered problems.

Each of the four possible combinations between driver type and problem type corresponds to one type of creativity. The categories that fall under the internal driver type are *contributory creativity* (when the problem is closed) and *proactive creativity* (when the problem is open). Contributory creativity occurs when there is a clearly formulated problem and it is the individual's decision to contribute to its solution. It consists mostly of helping behaviours. An example of such type of creativity occurs when an employee decides to engage in creativity to solve a problem that did not involve him or her directly in order to help the colleague in charge of handling the situation (e.g., Eisenberger, Fasolo, & Davis-LaMastro, 1990). When the driver is also internal but the problem is self discovered the creativity type is referred to as proactive creativity. This occurs when individuals driven by internal motivators actively search for problems to solve. An example is employees' contributions to a suggestion scheme (e.g., Frese, Teng, & Wijnen, 1999).

As stated earlier, this project aims to study innovation within R&D teams. In the R&D industry being innovative is generally part of the job requirements, as the large majority of, if not all, R&D projects involves developing something that is at least to some extent new. As such, this project aims to understand innovative behaviour in situations where such behaviour is part of the role description, and therefore externally driven. Of course, it is natural to expect that, at least to some extent, R&D professionals will also be intrinsically motivated to perform their tasks. R&D is usually a challenging environment that attracts people who enjoy solving problems. R&D professionals will very likely feel intrinsically motivated to work in a certain allocated project if they judge it to be intellectually stimulating and interesting. Nevertheless, the initial driver to engage in such projects of an innovative character is dictated firstly by R&D role descriptions. It is then argued that this project is focusing on a type of creativity that falls under the external drive dimension of Unsworth's (2001) taxonomy. Consequently, the categories that fall under the external drive type, *responsive creativity* and *expected creativity*, are of more relevance. Responsive creativity occurs when the driver is external and the problem is closed. This is one of the most restrictive types of creativity in terms of individual control and is illustrated for example in the work of think-tanks that are specifically arranged to solve a particular problem (e.g., Owens, 1969; Scott & Bruce, 1994). Expected creativity takes place when the driver is also external but the problem is open. In this case there is an external expectation but with a self-discovered problem (e.g., Amabile, 1979, 1985). Unsworth (2001) suggests quality circles and total quality management practices as examples of expected creativity.

There is some ambiguity in the description of the second dimension, type of problem, which causes some difficulties in determining in which category the work of R&D teams would be most appropriately classified. It is not clear whether the criterion refers to open versus closed solutions, meaning the problem having or not having a correct solution that is known to others but not to the one in charge of solving it, or if instead the criterion relates to presented versus discovered problems, meaning if the problem was presented by another person or discovered by the individual. This has implications in terms of where R&D work would be categorised. If we take the first interpretation, we find that most of the projects R&D teams are faced with do not have an objective and optimal solution that is already known. Instead, there are many possible pathways that the team has to anticipate and decide which is most adequate. This would place R&D work in the expected creativity category (open). On the other hand, if we take the second interpretation, the majority of the projects are assigned to

R&D teams by their hierarchical superiors rather than discovered by them (it is also the case that companies offer incentives to R&D professionals to spend part of their time thinking about potential future projects, which would fit under the dimension of discovered problems, but if one idea that results from these actions is subsequently selected for development, it will then be allocated to a given team and it will then assume the quality of an assigned project), and this would place R&D work in the responsive creativity category (presented). It seems that the work of R&D teams falls into *two* categories: they are confronted mostly with open problems; but while working on those problems, they will encounter other ones, some of which are likely to be closed ones. Similar to many other innovation endeavours, the projects of R&D teams will very like require individuals to be creative repeatedly throughout the project. The type of creativity required will vary.

Despite the lack of clarity regarding the type of problem dimension, this framework is very useful for this project in the sense that by disentangling "extra-role" creativity, and task related creativity, it clarifies its domain of analysis. By focusing on R&D teams this project is mainly concerned with the antecedents that lead to the type of creativity in which the driver is an external one, or in other words, is related to task performance rather than contextual performance (Motowidlo & Van Scotter, 1994; Unsworth, 2001)

2.5 Level of analysis

Having defined the domain of this study, it is important at this stage to clarify the focus of this project in terms of its level of analysis.

Organisations are multilevel systems (Kozlowski & Klein, 2000). They are composed of individuals, individuals are usually nested in teams, teams are often aggregated into departments, the entire range of departments constitutes the organisation, which in turn is also part of a broader social context. Each of these different social elements – individual, group, department, organisation, society – constitutes a level of analysis in which phenomena that are relevant for organisational performance take place.

As is the case with other phenomena, innovation is not bounded to a single level but is relevant and occurs at different levels such as the individual, the team and the organisational. Although multilevel researchers argue for an integrated approach to the study of organisations (Klein, Tosi, & Cannella, 1999; Rousseau, 1985), researchers tend to adopt a more sliced perspective of the organisation turning each of the different levels into the province of different disciplines, theories and approaches (Kozlowski & Klein, 2000). In fact, when it comes to innovation and creativity, several research streams have developed in different directions in order to account for the plethora of factors that can influence innovation at each of these levels. These streams can be roughly divided into two approaches, a micro-level approach, which is more concerned with the experiences of small groups or individuals, and tends to focus on the individual or on the team, and macro-level approach, which is essentially concerned with organisational processes and outputs.

One of the objectives of this project is to respond to the pleas for more integrated research in organisations. Following Hackman's (2003) suggestion for bracketing - studying one focal phenomenon by attending to constructs at both higher and lower levels of analyses - this project focuses on two levels of analysis rather than on a single level. The unit of analysis is defined as the activities developed by both individual team members and the team as a whole within the context of a specific R&D project, which places it within a micro and meso-level approach. In order to better understand how this project differs from studies that assume a macro-level approach it is useful to provide here a brief description of the main objectives and units of analysis subscribed by research conducted within the latter approach.

Wolfe (1994) identified three different streams of macro-level research, each of them addressing innovation from a different perspective. The first of these streams focuses on diffusion of innovation, which is defined as the speed with which an innovation can spread through populations of potential adopters. This line of research attempts to explain how and why an innovation diffuses over time (e.g., Easingwood, Mahajan, & Muller, 1983; Rogers, 1983). The unit of analysis is the innovation *per se.*

The second stream focuses on the organisational factors that support innovation. It aims to uncover the determinants of an organisation's propensity to innovate. The unit of analysis is the organisation. Although other factors have been considered, most studies have focused on the impact of organisational size or structure on organisational innovation (Damanpour, 1992; Damanpour & Evan, 1992).

The last stream identified by Wolfe (1994) concerns process theory models. This stream investigates the innovation process throughout its phases and it aims to understand the stages and processes involved in organisational innovation. The unit of analysis is the innovation process.

Wolfe differentiates between two generations of process models. The first generation is characterised by stage models which conceptualise innovation as a series of stages that unfold over time and aim to determine whether the innovation process involves identifiable stages, what they are, and what their order is. They are normative in the sense that they seek to describe the process how it usually occurs and they suggest a sequence of developmental stages, each of which must be passed (King & Anderson, 2002). Several process models of innovation were developed within this tradition (e.g., Daft, 1978; Zaltman, Duncan, & Holbeck, 1973). As an example of such models, Zaltman and colleagues (1973) described innovation as consisting essentially of two stages, initiation and implementation, in which the transition from one to the other is determined by the firm's decision to implement the innovation at stake. Although each model proposes a unique sequence of stages, they share in common three core stages, idea conception, organisational adoption, and implementation. A criticism often made is that these proposals rely more on theoretical speculation than on observations of real innovation processes, as they lack the required empirical evidence (King & Anderson, 2002). The few studies that were conducted found little support for the existence of discrete developmental stages (Pelz, 1987; Witte, 1972).

The second generation of models is characterised by a more descriptive and less normative approach, making use of in-depth longitudinal studies in order to describe the sequence and conditions that determine innovation processes. An example is Schroeder and colleagues' proposal developed based on longitudinal data obtained within the comprehensive Minnesota Innovation Research Program (1989). Their alternative model describes a series of common features of innovations but does not attempt to place them in discrete stages. King (1992) compared Zaltman's normative model with Schroeder and colleagues' (1989) more flexible proposal in a study analysing the development of innovation on a hospital ward. He found that although Schroeder and colleagues' (1989) proposal was not fully corroborated, this model found more support than the normative one.

Although there is not much in common in terms of objectives between the diffusion of innovation stream and this project, some similarities with the other two streams can be identified. As with the process models, this project also aims to identify the different activities that are relevant during an innovation process, but instead of trying to identify stages that are largely embedded in an organisational level framework (for example the organisation's decision to adopt), this project aims to identify the individual and team innovative activities that are involved in an innovation project. Furthermore, this project also aims to unveil antecedents of innovation, but rather than conceptualising organisational innovation as the outcome, the outcomes under scrutiny are the innovative activities undertaken during the execution of a project. Note that more detailed classifications of the innovation process models have been proposed (e.g., Saren, 1984), however, such fine grained analysis is not relevant within the scope of this study.

Although, as discussed earlier, the existence of demarked stages in the innovation process is questionable, it is useful for the sake of clarity to identify where the unit of analysis of the present study would fit in within a typical innovation model. In doing so the scope of this project is clearly circumscribed and the innovation facets that are not intended to be covered are also made explicit.

R&D teams commonly work in projects that were assigned to them by the organisation's management. One can then conclude that the decision to undertake a given project was made by the organisation. This decision to accept a project is analogous to the decision to adopt an innovation in the sense that an R&D project by definition encompasses some type of innovation. The project is then allocated to a certain team, and from here onwards the innovation process has to be analysed one level down. This means that what is relevant at this stage is to understand the activities undertaken by individuals and teams that enable the generation of ideas and their execution. Only when the team concludes its work is the innovation again transferred to the organisational domain. The activities performed by the team from the conception of the project until its conclusion (or at least conclusion of the component for which the team is responsible) are the unit of analysis of this project. This can be thought of as a micro and meso-level innovation process (since it involves both individual and team activities) that is embedded in the implementation stage of the organisational level. This is illustrated in figure 2.1.

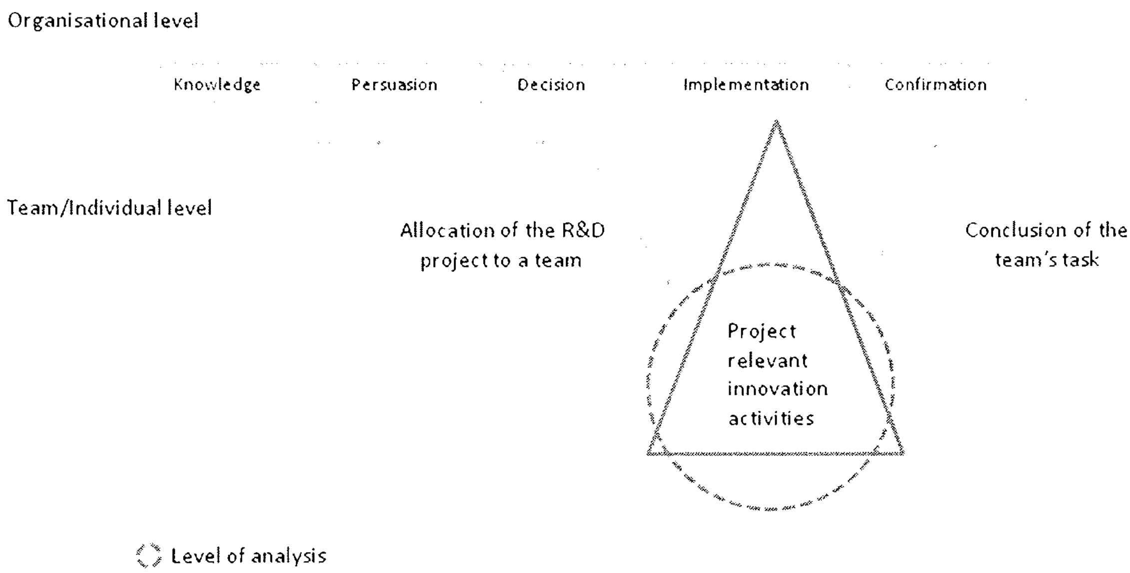


Figure 2.1: Level of Analysis
Organisational innovation stage model based on Rogers (1983)

2.6 Approaches to the study of creativity and theoretical framework adopted

Information processing is at the heart of creativity and this assumption is the common ground that underlies the different approaches to its study. All perspectives agree that creativity involves being able to combine two (or more) existing concepts in a way that is new and useful. The ability to do this involves engaging in a series of cognitive actions. Individuals have firstly to filter from the environment the stimuli that are relevant for them via attention processes. These stimuli are to be subsequently encoded and stored. In a later stage, the stimuli have to be subjected to elaboration processes that will finally enable the individual to retrieve an output that is qualitatively different from any of the stimuli he or she had previously assimilated (Lachman, Lachman, & Butterfield, 1979). These actions described above are generally referred to as information processing, and in ultimate analyses they constitute the basis for creativity. Although not all approaches make it centre-stage, they all rely on a conceptualisation of creativity that is dependent on the occurrence of information processing.

The following sections review the main approaches to the study of innovation activities. Even though they differ strongly from each other, they all share more or less implicit assumptions about cognitive activities involved in creativity. While reviewing these approaches the explicit or implicit assumptions about the role assigned to cognitive activities will be highlighted.

2.6.1 The person approach

The person approach has a long and significant history in the study of creativity. According to this perspective, creativity can be defined as the constellation of personality and intellectual traits shown by individuals who, when given sufficient autonomy, spend significant amounts of time engaged in the creative process (Findlay & Lumsden, 1988). A person is considered creative to the extent that he or she exhibits certain abilities, achievements or personality traits. Typical of the person approach is the attempt to identify personality characteristics associated with creativity in different domains.

This perspective contributes to the understanding of some of the individual factors that influence the display of creativity (e.g., James & Asmus, 2000; MacKinnon, 1962). For example, in a comprehensive literature review Barron and Harrington (1981) were able to summarise some of the personality characteristics of creative people, identifying amongst them attraction to complexity, high energy, independence of judgment and a firm sense of self as creative. Furthermore, in the only meta-analytic study of personality and creativity, Feist (1998) concluded that the most distinguishing personality dimensions of creative people are openness, conscientiousness, self-acceptance, hostility, and impulsivity. Another contribution of the person approach is the development of creative personality scales, such as Gough's adjective check list (Gough, 1979) or Kirton's inventory (Kirton, 1976, 1989).

On its own this line of research is of limited value in the organisational context, where contextual factors are more important predictors of creativity than personal variables, as it was concluded in recent meta-analytic studies (e.g., Eder & Sawyer, 2007). Also within the person approach there is another line of research that takes into account the impact of contextual factors as well, the life-span perspective (Simonton, 1991). This perspective has focused instead on understanding how creativity emerges and unfolds over the lifespan of an individual. Usually studies within this tradition use psychobiographical methods to analyse the life of eminent creators or people whose job implies being creative (e.g., Gruber, 1996; Richards, Kinney, Benet, & Merzel, 1988; Simonton, 1991). Simonton was able to identify certain consistencies behind the variation in creative careers, and ultimately this perspective enables a prediction of the display of creativity over the life span of an individual, indicating for example when creativity should be at its peak. However, the display of creativity varies across occupations and there is not at this stage sufficient research to support any predictions on for example when an R&D professional will reach his or her creative peak. However, by capturing the entire lifespan of an individual this approach has the advantage of encompassing a large range of influences that would not be captured otherwise.

The person approach does not place special emphasis on the role of information processing, yet a critical analysis of the premises of this approach leads to the conclusion that it is the quality of information processing in which an individual engages in that ultimately would lead others to consider him or her as more or less in possession of creative traits. This approach says that certain traits, for instance openness to experience, lead to the display of higher levels of creativity, but fails to explain how and why. There is a black box between the creativity traits and the creativity outputs. It is suggested here that the reason why certain traits are more or less associated with creativity has to do with how they influence the information processing undertaken by the individual. For example, people high in openness to experience might have exposed themselves to more different situations than people low in the same construct. This exposure promotes the storage of a vast range of stimuli that are found in each situation. When faced with a given problem, people high in openness have then a much larger range of stimuli they can recall in order to provide an appropriate solution. In essence, although not recognised by this approach, the decision whether an individual holds or does not hold creative traits is based on the creativity of the outcomes produced by this person, which is dependent on information processing activities.

2.6.2 The process approach

Research conducted within the process approach is embedded in the cognitive tradition of psychology. The main objective ascribed by process researchers it to be able to describe the nature of the creative thinking process. It is important to notice that opposite to the macro-level stage models described earlier, this approach takes a fine-grained view and focuses on the cognitive mechanisms that enable idea generation and implementation. Within a process approach, creativity is defined as the engagement in creative processes, independently of the results (Drazin, Glynn, & Kazanjian, 1999).

Models of creative thinking are directly embedded in information processing theory. Given its cognitive underpinnings, the process approach is the one that more clearly highlights the relevance of information processing.

One of the seminal proposals on creative process models was the work developed by Wallas (1926). The author described the creative process as a sequence of four stages. In a first stage, designated *preparation*, the individual turns his or her focus of attention towards a given problem and screens the environment for relevant information. In the following stage, *incubation*, the individual engages in some degree of unconscious and involuntary work on the problem. In the third stage, *illumination*, the solution suddenly becomes evident, and in the final stage, *verification*, the individual uses logical and rational thought processes to shape the insight into a correct solution. This stage process model was later on incorporated in broader models of creativity such as Amabile's componential model (Amabile, 1983). After this initial model, other more sophisticated proposals have been advanced, such as the geneplore model (Finke, Ward, & Smith, 1992), which proposes that creative thinking involves both generative and exploratory processes, each of these processes having both conscious and unconscious components.

Given the particularities of its object of study, research within this stream has mainly been conducted within laboratory settings (e.g., Mumford, Baughman, Maher, Costanza, & Supinski, 1997; Mumford, Baughman, Supinski, & Maher, 1996; Mumford, Baughman, Threlfall, Supinski, & Costanza, 1996; Mumford, Supinski, Threlfall, & Baughman, 1996).

The process approach raised awareness of the role of information processing and the idea that the generation of creative ideas involves different cognitive activities.

2.6.3 The Social-Psychology approach

The social-psychology approach contributed to the merger of two different traditions that are equally relevant to understanding innovation in work settings, the study of individual creativity and the study of organisational innovation.

Research on individual creativity and on organisational innovation developed in two separate pathways that only recently started to find a common ground. Initially, creativity was mostly restricted to experimental research and scholars were focused on identifying personality, cognitive and motivational factors that influenced the generation of ideas. Innovation researchers, on the other hand, operated at a higher level of analysis, usually the organisation (or less frequently the team), and were concerned with matters described earlier when referring to the macro-level approach to innovation, such as the strategic factors that would facilitate organisational innovation or the factors that would influence the diffusion of new products (Damanpour, 1991; Damanpour & Evan, 1992; Wolfe, 1994). Amabile's (1988) componential model of creativity in organisations set the stage for the study of creativity in work settings and since then the two streams became more closely interlinked (e.g., Woodman, Sawyer, & Griffin, 1993).

The componential model of creativity in organisations, as well as other theoretical perspectives that follow a social-psychology approach, is underlined by a definition of creativity that focuses on the idea (rather than the individual or the process). Creativity is defined as "the production of novel and useful ideas by an individual or small group of individuals working together" (Amabile 1988, p. 126). The ideas can refer to products, processes or services within the organisation's line of business or ideas about new procedures or policies within the organisation itself. On the other hand, organisational innovation is conceptualised as the successful implementation of creative ideas within an organisation.

The organisational componential model is grounded on Amabile's individual componential model of creativity, which the author developed and tested earlier (1982; 1983). The initial model described creativity as the product of the combination of three factors: domain relevant skills, which refer to factual knowledge and expertise in a certain domain; creativity-relevant skills, which refer to the strategies and cognitive styles that influence idea production; and intrinsic motivation, conceptualised as the individual's genuine interest in the task. Amabile attributes special relevance to intrinsic motivation because she considers this component to make the difference between what one can do (determined by domain relevant skills and creativity-relevant skills) and what one will in fact do. It is intrinsic motivation that determines the extent to which domain relevant skills and creativity-relevant skills will be fully and appropriately applied towards successful creative performance. Amabile also integrated in her model a five stage process model similar to the one developed by Wallas (1926) and developed a set of propositions describing at which stage each of the components would have stronger impact.

As referred to earlier, this model was later adapted to the organisational context and extended in order to account for the organisational innovation process and the relevant intervening organisational factors (Amabile, 1988). Three organisational level components, somewhat analogous to the ones defined earlier for the individual model, were then introduced: motivation to innovate, which is dependent of the basic orientation of the organisation towards innovation; resources in the task domain, which refers to everything the organisation has available to aid work in the task domain; and skills in innovation management, which includes management at both the level of the organisation as a whole and at the level of individual departments and projects. This last component pertains to the existence of management skills and styles that are conducive to individual creativity and organisational innovation. Furthermore, similar to the individual level model, it also includes here a five-stage process depicting the organisational innovation process. The extent to which each of the stages is influenced by the organisational factors is also described.

In this conceptualisation the social world is given special relevance because it has the potential to influence any of the three components that are conducive to creativity, in particular intrinsic motivation. Amongst the major contributions of this model are the awareness of the impact of social factors on creativity and the generation of tools that enable a diagnosis of the extent to which an environment is, or is not, conducive of creativity (e.g., Amabile & Conti, 1999; Amabile, Conti, Coon, Lazenby, & Herron, 1996; Amabile, Schatzel, Moneta, & Kramer, 2004; M. Baer & Frese, 2003; Shalley, 1991, 1995; Shalley, Gilson, & Blum, 2000; Shalley & Oldham, 1997).

Another theoretical proposal of significant relevance within the social-psychology approach is the interactionist model of organisational creativity developed by Woodman and colleagues (1993), in which creativity is depicted as an individual, group and organisational outcome. Consequently, creativity is influenced by characteristics that pertain to each of these entities, as well as by interactions that occur across the three levels. Although Amabile's (1983; 1988) model also stressed the influence of contextual factors, Woodman and colleagues' (1993) model is unique in stressing the importance of the interaction between the person and the situation.

The interactionist model systematised a vast range of social and contextual factors that influence creativity at each level, generating an extensive research agenda. At the individual level the authors considered the role of cognitive abilities or style, intrinsic motivation, knowledge and personality. The group factors discussed included group composition (diversity), group characteristics (cohesiveness, size) and group processes (problem-solving strategies, social information processes). Finally, at the organisational level factors such as culture, resources, rewards, strategy, structure and technology were included.

It is clearly noticeable in the interactionist model the integration of the micro and macro level approaches to the study of innovation described previously. The two major contributions of this model to the study of creativity and innovation at work are somewhat underpinned by this integration: the development of a multilevel model of organisational creativity and a theoretical framework informing about which factors are expected to influence each of the different levels and how they interact.

This proposition led to the development of an important research stream focused on analysing the interplay between individual characteristics and contextual features that dramatically extended our understanding of creativity. To cite just a few examples, some of the most relevant studies have looked at the interaction between personality factors and feedback or task characteristics (George & Zhou, 2001; Zhou, 2003); mood and rewards (George & Zhou, 2002; Madjar, Oldham, & Pratt, 2002); achievement orientation and feedback (Zhou, 1998); job dissatisfaction and support for creativity (Zhou & George, 2001); rewards, cognitive style and job complexity (Baer, Oldham, & Cummings, 2003); and leader style and employee characteristics (Scott & Bruce, 1994; Shin & Zhou, 2003; Tierney, Farmer, & Graen, 1999). The study of the impact of individual's networks and creativity is also embedded in this multilevel proposal (Perry-Smith, 2006; Perry-Smith & Shalley, 2003).

The last theoretical proposal to be considered in this section is West's (2002) model of team creativity and implementation. As alluded to earlier, West describes the innovation process as a cyclical process in which the generation of ideas, or creativity, is dominant at the earlier stages to be superseded at a later stage by the implementation of innovation. Creativity and innovation implementation are then different stages of the innovation process: creativity is the generation of ideas and innovation implementation is implementation of those ideas.

The model suggests that team's activities regarding creativity and innovation implementation are influenced by the group's task, the group's knowledge, skills and characteristics, external demands and group processes. Amongst the group processes, this proposal includes participation in decision-making, support for innovation, clarity of objectives and reflexivity. Particular to this model is the suggestion that some predictors might influence creativity and innovation implementation in a different manner. Specifically, it is suggested that external demands, the external context of the group's work usually operationalised as uncertainty, time constraints or competition, have a negative impact on creativity but a positive impact on innovation implementation. It is argued that creativity requires and undemanding environment, whereas innovation implementation involves changing the *status quo*, which implies resistance, conflict, and a requirement for sustained effort. The effort required is motivated in part by the presence of external demands (West, 2002; West, Sacramento, & Fay, 2005). One of the major contributions of this model was to bring awareness of the fact that different facets of the innovation process might be influenced differently by certain variables. This project is directly influenced by West's model in the sense that it also explores whether certain predictors influence different activities of the innovation process differently.

It is important to note that the role of information processing mechanisms is recognised by at least two of the theoretical models described above. Amabile's (1988) conceptual model incorporates a process model based on the one initially proposed by Wallas (1926), which has a strong cognitive underpinning; and Woodman and colleagues' interactionist model takes into account information processing when referring to the relevance of cognitive styles and abilities.

Given that the underlying assumption of the importance of information processing for creativity, and subsequently implementation of ideas, is the common ground that underlies the major approaches to this topic, this project analyses how, from an information processing perspective, variables pertaining to the individual and the team interplay with contextual variables.

2.7 Definitions

The definitions subscribed to in this study are grounded on the social-psychology approach and underlined by a cognitive perspective, but adapted to fit the context of this project. As explained earlier, innovation is conceptualised as the overall process, including both the generation of ideas and their implementation. This project takes a more flexible approach to the innovation process and the term "activities" is preferred to the term "stages" (Kanter, 1983).

The conceptualisation of the innovation process in this study reflects the merging of creativity and innovation literatures in the sense that it focuses both on individual's generation of ideas and on the activities that ultimately lead to the execution of innovation. In line with previous studies, creativity is defined as the generation of ideas (Amabile, 1988; West, 2002), but with the particularity of the domain of ideas being restricted to the project at hand, focusing on task rather than on contextual performance (Motowidlo & Van Scotter, 1994; Unsworth, 2001). Implementation activities consist of the activities that enable the ideas generated to be developed and transformed into a final product or service. As stated earlier in this chapter, the terms *innovative behaviour* or *innovative/innovation activities* are applied when referring to both creative and implementation activities.

In the following chapter the theoretical rationale that guides this project is developed.

Chapter 3

The impact of stressors and mood on individual innovation activities: Review of literature and development of conceptual framework

The purpose of this chapter is to present the development of the conceptual framework that guides this research. In the first part of this chapter, the theoretical conceptualisations of stressors and mood are summarised. In the second part, the theoretical and empirical literature relating stressors and mood to innovation activities is critically reviewed. The final section presents a set of competing hypotheses about how stressors may interplay with mood to predict innovation activities according to three different frameworks.

3.1 Introduction

As described in the previous chapter, organisational innovation can be perceived as a fundamentally cognitive phenomenon (Glynn, 1996). A reflection of this conceptualisation is that R&D team members are typically engaged in innovation activities which are largely dependent on information processing by individuals and teams. However, information processing activities are influenced by a wide range of factors, among them factors residing within the individual actors involved in innovation and factors that characterise the context within which they operate. In order to maximise the effectiveness of individuals in R&D teams, it is necessary to better understand the impact of these factors. This research focuses on mood experienced at work and workplace stressors.

Interest in the influence of stressors and affect in organisations has sharply increased in the recent years (e.g., S. Barsade, Brief, & Spataro, 2003; Jex, 1998; Weiss & Cropanzano, 1996), which is justified by the relevance and prominence of these factors in work settings. As a consequence of increasing competition, organisations are faced with high levels of pressure which are transferred to employees in the form of performance-affecting stressors like time pressure. On the other hand, work is an affect-laden environment (Fineman, 1993), and several empirical contributions have demonstrated the role of affect on work-related outcomes such as task quality, productivity and efficiency (Beal, Weiss, Barros, & MacDermid, 2005; Brief & Weiss, 2002; George, 1991; Staw & Barsade, 1993; Staw, Sutton, & Pelled, 1994). Stressors and affect have both been shown to impact on cognition and information processing (Hamilton, 1982; Zajonc & Markus, 1984) and have also been linked to creativity, though not in a completely confirmatory way (Amabile, Barsade, Mueller, & Staw, 2005; Andrews & Farris, 1972; George & Zhou, 2002; Isen, Dauban, & Nowicki, 1987).

Despite the ubiquity of stressors in the workplace and that teams are affectively laden environments, to the author's knowledge it has not yet been investigated how these factors interplay to predict innovation activities. The role of mood as a moderator of the relationship between stressors and performance was proposed by Ivancevich & Matteson (1980) but has not yet been empirically explored. The idea that the two factors interact is based on the observation that both have an impact on cognitive resources and information processes, and the latter are key for effective innovation activities. This chapter develops a framework to account for how, from an information processing perspective, R&D team members are influenced by stressors and mood when developing their projects.

3.2 Information processing framework

Information processing can be defined as a sequence of operations within the human mind that takes information in, transforms it and produces some sort of output (Lachman et al., 1979). Although there are several models of information processing, they generally share the same core elements. In broad terms, information processing is usually depicted as a feedback loop model in which, as a first step, information retrieved from the environment via an attention filter is encoded, stored and retrieved in a so called processing workspace. In this processing workspace the information is integrated and schematically processed on the basis of many different rules and procedures, leading to a final response for which the feedback obtained will provide new information to be filtered (Hinsz,. Tindale, &. Vollrath, 1997). The processing workspace is, however, very likely to be affected by variables such as stressors and mood. Given the intellectually demanding nature of their innovative work, R&D teams are highly dependent on team members' information processing capabilities (Salas & Fiore, 2004). The extent to which these capabilities are affected by variables such as stressors and mood will therefore determine the success of innovation activities.

3.3 Stressors in the workplace

The amount of stressors employees are exposed to has increased considerably over the last century (Cooper, Dewe, & O'Driscoll, 2001), justifying the interest of scholars in analysing the effect of this construct upon organisational outcomes such as performance, creativity or organisational citisenship behaviour (Baer & Oldham, 2006;

Fay & Sonnentag, 2002; Jex, Adams, Bachrach, & Sorensen, 2003; LePine, Podsakoff, & LePine, 2005).

Stress has been conceptualised in terms of stimulus, response and process. The stimulus approach focuses on the conditions or events that are stressful (Kahn & Byosiere, 1992). The response perspective perceives the physiological reactions to be the crucial element of stress (Selye, 1956). Lastly, the process approach is focused on the transaction between the situation and the person. Thus stress is seen as a product of the interaction between the individual and the environment (Lazarus & Folkman, 1984). Since it is not the objective of this study to assess the effect of strain or coping mechanisms on creativity and implementation activities, but rather to focus on the effect of stressors as environmental features assessed as objectively as possible (Frese & Zapf, 1999; Spector, 1999), the stimulus approach is the one in which this research is embedded. Within this approach, job stressors are environmental events in the workplace requiring some type of adaptive response (Jex, Beehr, & Roberts, 1992).

The range of stressors in the workplace is considerable. In a comprehensive literature review, Sonnentag and Frese (2002) grouped stressors into seven categories: physical stressors; work-related stressors (time pressure, work load, high complexity, monotonous work and disruptions); role stressors (role load, role ambiguity and role conflict); social stressors (poor social interactions with supervisors and conflicts at the workplace); time-related stressors; career-related stressors (job insecurity, career opportunities, traumatic events and exposure to disasters); and organisational change (mergers or the implementation of new technologies). So far, the stressors most commonly studied with regard to their impact on job performance are time pressure, role conflict and role ambiguity (Jackson & Schuler, 1985). Role overload (Jamal, 1984, 1985) and situational constraints (Peters & O'Connor, 1980) have been also analysed, albeit not as thoroughly. More recently, the impact on job performance of stressors outside the job sphere has also been approached (e.g., Aryee, 1992).

In this study the selection of stressors was informed by two criteria. Firstly, the stressors selected should be the ones of utmost relevance in R&D work settings. Secondly, given the role of information processing activities in R&D, the stressors selected should be likely to exert their influence via their impact on cognitive mechanisms. After informal discussions with R&D professionals and a review of the literature, the following stressors were selected: quantitative job demands (or time pressure), qualitative demands (or difficulty of work), and role ambiguity.

3.4 Affect in the workplace

3.4.1 Conceptualisation of affective constructs

The study of affect in the workplace has burgeoned over the recent years, reflecting researchers' awareness of the fact that individuals' work-related judgments, behaviours and satisfaction are influenced by the way they feel (Isen & Barron, 2001; Judge & Ilies, 2004; Judge & Larsen, 2001).

The terminology used to refer to affect-related constructs varies slightly across researchers. For instance, according to Frijda (1993) affect should be conceptualised as a broader concept encompassing both mood and emotions. These two constructs differ in terms of duration and object. Emotions last for short periods of time and are a reaction to particular persons or events, whereas moods are longer lasting affective states which are not directed at a specific object. Recently Cropanzano and colleagues (2003) further elaborated upon these definitions by suggesting that affective states should be conceptualised as a family of constructs including moods and discrete emotions. Additionally, mood and emotions share some common features: they are both states that describe transient psychological experiences; they share a common subjective (or feeling) component; they appear to be accompanied by physiological reactions; and they have an evaluative component associated with them. The central distinction between moods and emotions is diffuseness - whereas emotions have an object of interest or a defining event that is part of the subjective experience itself, moods lack such an object or defining event. Moods are affective experiences disconnected from their proximate causes.

Barsade (2000) proposed a slightly different terminology but still with some points of convergence. The author distinguished between three types of affective constructs: dispositional affect, which is a long term stable variable; emotions, described as intense and relatively short term reactions to specific stimuli; and moods, which are weaker, more diffuse and short-term affective reactions to general environment or stimuli.

This project focuses on an affective construct which does not have a specific target and refers to a state rather than a trait. This is partially represented in all conceptualisations of mood described above. A convergent definition of mood, which is adopted in this project by virtue of its consensual character, was suggested by Clore and colleagues (2001), who defined it as a state of feeling that may or may not be appraisal-based but for which the object is not salient or has become diffuse and which may last from a few moments to weeks.

It is also important at this stage to clarify another issue related to the terminology applied throughout this thesis. The more general term affect and the more specific term mood have often been used interchangeably in the literature. Certain studies reviewed used the term "affect" or "emotion" where the term "mood" would have been more appropriate. When reviewing the literature it was the author's concern to verify if the construct under analysis would fit the criteria of the definition of mood adopted in this project (i.e. diffuseness of object, state rather than trait) or would represent a different affective construct. Studies using the term "affect" or "emotions" in reference to an affective construct other than "mood", were not included in this review unless considered particularly relevant. When referring to studies that used the terms affect or emotions but captured a construct that would fit the present definition of mood, the author chose to retain the original designations unless doing so would hinder the coherence of the argument.

3.4.2 The structure of affect

There is no lack of controversy in the literature when it comes to the structure of human affect. Among the different formulations are Russel's (1980) circumplex model, Watsons and Tellegen's (1985) bi-dimensional model of positive and negative affect, Thayer's (1989) proposal centred on tense and energetic arousal, as well as Larsen and Diener's (Larsen & Diener, 1992) eight combinations of pleasantness and activation, to cite just a few. Overall, the major point of contention relates to the bipolar character of affect. Whereas some authors argue for a bipolar structure which depicts positive and negative affect as are opposite poles of the same dimension (Green, 1993; Green & Salovey, 1999; Russell, 1978, 1979, 1980), other theorists argue for a bi-dimensional character, which emphasises the distinctiveness and independence of positive and negative affective states (Watson & Tellegen, 1999).

The idea of mood as a bipolar dimension is found in early models of affect, including the seminal circumplex model developed by Russel (1980). Based on multidimensional scaling techniques, the author proposed that affective states should be represented in a circular model around the perimeter of a two-dimensional bipolar space. Although being also bi-dimensional, this model makes the assumption that positive and negative affect are captured in a single dimension, dubbed pleasantness, which explains the majority of the variance and it is characterised by the valence of the emotion. The second dimension is named arousal and relates to the intensity of affect, rather than its valence. Within this framework pleasant (e.g., happy) and unpleasant (e.g., sad) emotions are opposite poles of the same dimension.

The view that positive and negative affect are not opposite ends of a single dimension can be traced back to studies of well-being conducted by Bradburn and colleagues (Bradburn, 1969; Bradburn & Caplovitz 1965). The more recent and highly influential theoretical framework developed by Watson and Tellegen (1985) builds upon this perspective. The authors also suggested that affect is a bi-dimensional construct but, in contrast with Russel's (1980) conceptualisation, they considered positive and negative affect to be orthogonal dimensions rather than opposite poles of the same dimension. The strong poles of these two dimensions, high positive affect and high negative affect, are characterised by high levels of activation, whereas the weak poles are characterised by low levels of activation. When people are high in positive affect, they tend to feel energetic, enthusiastic and excited, whereas when people are low in positive affect, these feelings tend to be absent but this does not mean that they are experiencing negative affect. On the other hand, when people are high in negative affect they tend to experience feelings such as anxiety, distress and anger, whereas when people are low in negative affect these feelings are absent but, again, this does not mean that positive affect is present. Only the high ends of each factor represent the experience of affect per se, whereas the low ends reflect the relative absence of emotional involvement.

None of the perspectives is without criticism. Opponents of the idea of a bi-dimensional structure of positive and negative affect have argued that the independence between the two constructs can only be found when looking at long timeframes. According to them, positive and negative affect are only orthogonal when considering emotions over a long period of time, since it is unlikely that individuals will feel positive and negative emotions at the same moment (Diener & Emmons, 1985). Watson (1988) refuted this claim by showing that when affect was measured using the Positive and Negative Affect Scales (PANAS; Watson, Clarck & Tellegen, 1988) the time interval had at best a small effect on the correlation between the measures of negative and positive mood, meaning there were no significant changes in the correlations between positive and negative affect when considering each of the six different time intervals "moment", "today", "past", "few days", "past few weeks", "year" and "general".

Green (1993) also challenged the proposed bi-dimensional structure of positive and negative affect. He argued that the evidence that purportedly showed the independence of seemingly opposite mood states, meaning the low correlations between positive and negative moods was no more than an artifact, resulting from the failure to consider biases due to random and non-random response error. The author empirically demonstrated that when these sources of error were taken into account using multiple methods of mood assessment, a largely bipolar structure of affect emerged. In response to this, Tellegen and colleagues (1999a; 1999b) used a different technique to estimate response errors and concluded that, although not completely orthogonal, positive and negative affect were still different factors.

Cropanzano and colleagues (2003) summarised the discussion and clarified the differences between the two structures subscribed to by different researchers. Researchers that advocated the bipolarity of affect tended to subscribe to an un-rotated factor structure that organised affect states and traits around two broad bipolar constructs. The first factor was hedonic tone, also referred to as pleasantness-unpleasantness (Larsen & Diener, 1992; Watson & Tellegen, 1985; Weiss & Cropanzano, 1996) or mood valence (Russell & Carroll, 1999a), anchored at the high (or positive) pole by pleasant feelings (like happiness) and at the low (or negative) pole by unpleasant feelings (such as sadness). The second factor was affect intensity, which referred to the power or force with which a feeling is experienced, characterised at the high pole by a profound experience and at the low pole by a mild and weak experience. In such a framework, one would expect positive (e.g., happiness) and negative (e.g., sadness) feelings to be negatively correlated, reflecting opposite poles of the same dimension. On the other hand, researchers that argued for the independence of affective constructs based their arguments on a 45° rotated factor structure that tended to show positive and negative affect as separate orthogonal dimensions. As outlined above, the cluster of pleasant emotions has been dubbed positive affect while the cluster of negative emotions has been termed negative affect. In this framework, it is natural to expect positive (such as enthusiastic, excited) and negative (such as irritable, hostile) feelings to be separate dimensions. So, while the first structure incorporates positive and negative emotions on a single axis (hedonic tone), the other separates them into positive and negative affect.

The idea that pleasantness, which captures affective states such as happy and sad, is a bipolar dimension whereas positive and negative affect, which capture affective states such as arousal and irritation, are independent dimensions seems to find some agreement amongst researchers of different camps (although they still disagree which framework makes a more valid and useful contribution) (Russell & Carroll, 1999a, 1999b; Watson & Tellegen, 1999). Indeed, this idea was already incorporated in Watson and Tellegen's (1985) seminal work. The model illustrating their proposal features two pairs of dimensions. The first pair consists of the positive affect and negative affect (PA-NA) dimensions described earlier, whereas the second pair, which can be seen as a 45° rotation of PA-NA, consists of pleasantness vs. unpleasantness and engagement vs. disengagement dimensions (see figure 3.1). Accordingly, the authors distinguished between two types of positive and negative terms that correlate quite differently with one another. Markers of what they called high positive affect (e.g., active, enthusiastic, interested) and high negative affect (e.g., afraid, angry, guilty) are only weakly correlated, whereas indicators of pleasantness (e.g., happy, content, pleased) and "unpleasantness" (unhappy, sad, blue) are moderately to strongly correlated.

One problematic issue that derives from this lack of consensus is that researchers have been using the terms positive and negative affect (or mood) indiscriminately, either referring to the pleasantness of the affective state or to the content embodied by positive and negative affect as described by Watson and Tellegen (1985). Having identified this problem, Watson and Tellegen (1999) went as far as stating "… we again face the extremely confusing situation that researchers may report low, moderate – even strong – negative correlations between measures of positive affect and negative affect because of substantial differences in the descriptors used to create the scales. The literature is so confused at this point that the terms 'positive affect' and 'negative affect' perhaps should indeed be used only as inclusive terms referring to any positive and negative feeling states." (p. 603).

Ascertaining the impact of this dual conceptualisation of mood on creativity research is still a difficult exercise to undertake, given the limited amount of studies available at this stage. However, it is clear that researchers looking at the impact of mood on creativity have done so following the different conceptualisations, albeit using the same designation. This issue was noticed by James and colleagues (2004). In their conceptual model of affect and creativity at the workplace, the authors suggested that some of the contradictory results reported in the literature could be due to different conceptualisation and operationalisation of affective constructs. They claimed that different affective constructs could affect creativity in distinct ways based on their nature and intensity and researchers should therefore clearly identify the construct under analysis in relation to these factors. Roughly summarising, approximately all experimental studies that manipulated mood did so by inducing happy or sad moods, subscribing to the valence-based definition of mood that places positive and negative affect on opposite ends of the same dimension, whereas the majority of studies that assessed mood in field settings made use of one of the instruments embedded in the theoretical school that advocates the independence of positive and negative affect. Although the results of studies based on either operationalisation are informative and valid, it is important to consider such distinction.

Affect models with a stronger conciliatory character have been developed in the meanwhile (Tellegen et al., 1999b; Yik, Russell, & Barrett, 1999). For instance, Cropanzano and colleagues (2003), in an adaptation of the earlier circumflex model, proposed a comprehensive framework of affect in which positive and negative affectivity are integrated. Although this model integrates both ideas (positive and negative affect as opposites or as orthogonal constructs), it is still necessary to adopt one or the other perspective in order to inform how the constructs should be assessed when conducting empirical research.

Overall, it seems that the conceptualisation of positive and negative affect as two independent dimensions is more valid and useful. Even when only considering the domain of pleasant and unpleasant emotions, there is evidence illustrating that people can experience sadness and happiness at the same time. This simultaneously suggests that positive and negative affect may not necessarily be opposite poles and that there is advantage in considering them separately (Larsen, McGraw, & Cacioppo, 2000). Furthermore, experimental studies with induced happy and sad moods, as well as field studies that focused on positive and negative affect in terms of Watson and Tellegen's (1985) conceptualisation, show that positive and negative affect can make independent contributions to creativity (Fong, 2006; George & Zhou, 2007).

Based on this reasoning, this study subscribes to a bi-dimensional structure of affect in which positive mood and negative mood are independent dimensions rather than opposite poles of the same dimension.

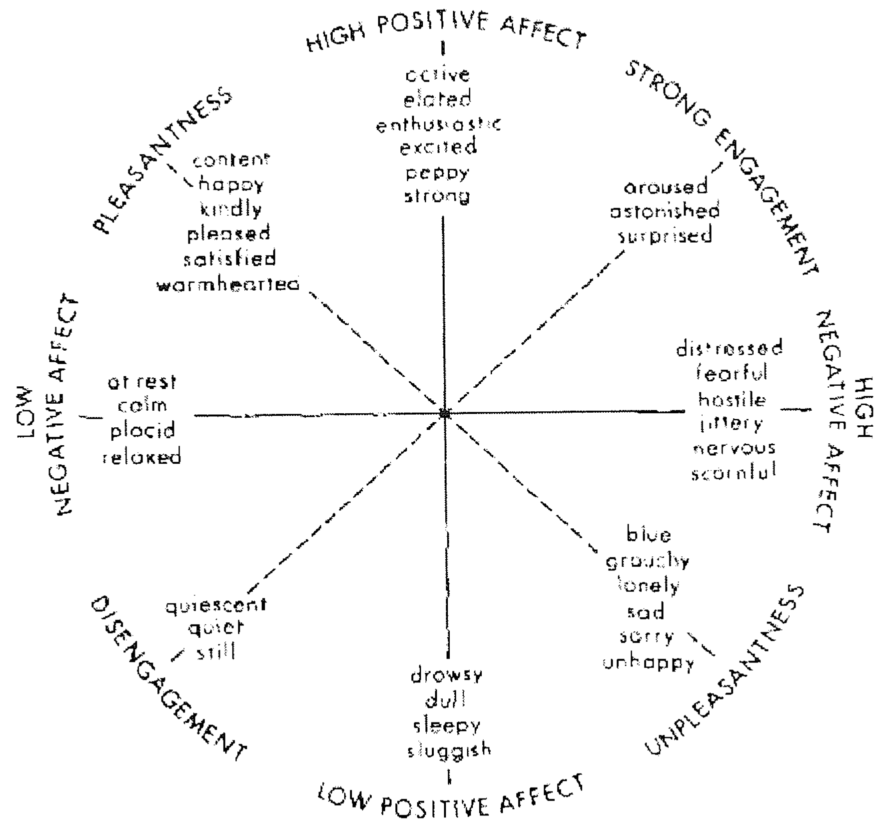


Figure 3.1: The two-factor structure of affect (Watson & Tellegen, 1985)

3.5 Innovation activities: creativity and implementation activities

It is relevant at this stage to briefly recap the conceptualisation of the outcome variables in this study and at the same time refer to how they are underpinned by information processing. Creativity activities consist of the generation of new and useful ideas within a given project, whereas implementation activities are those that enable such ideas to be executed. As will be described in more detail in the next chapter, implementation is conceptualised here as encapsulating three major dimensions: decision-making, consisting of the ability to make decisions about the ideas generated; avoiding procrastination, described as the capacity to move forward and avoid wasting time, which is likely to occur in tasks that are challenging, involve a certain degree of anxiety and over which professionals have a high level of autonomy (van Eerde, 2003); and focus and obstacles, which is paramount considering the high level of uncertainty associated with R&D projects.

The two types of innovation activities are not only associated with different behaviours but they are also likely to be facilitated by different processing styles. There is evidence that creativity activities involve a certain degree of divergent thinking and are therefore facilitated by a heuristic processing style (Eisenck, 2003; Runco, 1991, 1999, 2003). On the other hand, implementation activities involve being able to judge situations and eliminate less favourable possibilities, being attentive to errors, being perseverant, and avoiding procrastinate by engaging in unfocused activities. It has been suggested that such tasks require a convergent, systematic thinking style (Chaiken, 1980; Chaiken & Maheswaran, 1994; Chen, Shechter, & Chaiken, 1996; Trumbo, 1999). Consequently, a systematic processing style should be more conducive to effective implementation activities.

3.6 Stressors and job performance, information processing and innovation activities

The impact of stressors on job performance is a controversial topic. In the dominant literature, it is possible to identify three different approaches which outline how stressors affect performance. The first approach argues for a negative relationship between these two constructs (e.g., Abramis, 1994). Scholars within this perspective suggest that stressors can decrease job performance in a linear fashion both due to direct and indirect effects. An example of a direct effect is lacking the equipment required to perform a task. An indirect effect stems from stressors taking up part of the individual's limited regulatory capacity to perform a task. There is only a limited amount of resources available when performing a task and the presence of stressors will inexorably tax some of the resources, leaving less capacity available to deal with the task creatively.

A second approach suggests that the relationship between stressors and performance follows an inverted U shape (McGrath, 1976) in a variation of the Yerkes-Dodson Law (1908). This perspective is based on activation theory (Baron, 1986), which posits that a moderate level of arousal is required for the individual to keep focused on the task. This curvilinear effect, while intuitively appealing, is mostly found in experimental research and seldom in field research (Sonnentag & Frese, 2002).

A third and final approach, supported by a relatively recent perspective on the effect of stressors, eustress, argues that certain stressors like quantitative and qualitative demands can have a positive effect on performance (LePine et al., 2005). The mechanism through which this effect takes place is a motivational one – it is argued that the stressor will arouse individual motivation, which consequently boosts performance levels.

Research looking at the impact of stressors on individual innovation activities closely mirrors the relationship between stressors and performance. The majority of studies has focused on the effects of time pressure, with creativity as the outcome variable. Even when focusing only on how a single stressor affects one type of innovation activity, the results are mixed, providing evidence for a positive, a negative and a curvilinear relationship. For instance, in a study involving packaging operators and business advisors at a cereal factory, Baer and Oldham (2006) found that employees that reported perceiving higher time pressure for creativity were rated as less creative by their supervisors. Providing evidence for a curvilinear effect, Ohly and colleagues (2006) found in a study conducted in a high-tech company that creativity and innovation, operationalised as the extent to which novel and useful ideas are implemented at work, were higher when time pressure was one standard deviation above the mean level of time pressure. When time pressure was higher or lower than this value, both creativity and innovation decreased. Finally, Unsworth and colleagues (2005), in a study involving National Health Service (NHS) professionals, found that time pressure displayed a positive effect on creativity.

The studies that focused on the type of creativity under scrutiny in this research project, externally driven creativity, tend to report a negative relationship between stressors and creativity. In an experimental study in which students were asked to generate ideas for different problems, Madjar and Oldham (2006) found that perceived time pressure negatively predicted fluency and overall creativity. In another experimental study involving students, Johns and Morse (1997) verified that participants in the condition without time limit had significantly higher means on traditional fluency and flexibility divergent production scores than participants in the time limited condition. These results are corroborated by other experimental studies looking at the impact of time pressure on creative fluency or flexibility (Johns, Morse, & Morse, 2001; Morse, Morse, & Johns, 2001). Similar results were found in field settings. In a sample of product managers, Andrews and Smith (1996) found that time pressure had a negative impact on marketing programme creativity.

Although the majority of the studies looking at time pressure and externally driven creativity identified a negative impact of time pressure, it is important to note that there are a few exceptions. An example is the study conducted by Andrews and Farris (1972) involving a sample of scientists and engineers from a NASA research division. The authors found that time pressure had a curvilinear effect on innovation, operationalised as the extent to which the employee's work had "increased knowledge in his field through lines of research or development which were useful and new" (p.188).

The reason studies looking at externally driven creativity tend to find a negative impact of stressors, whereas research looking at internally driven creativity fails to identify such a pattern and reports instead equally compelling evidence for a curvilinear of positive effect, might be related to the different nature of the job. For instance, the NHS staff work is likely to be less cognitive than R&D work and therefore will rely less on information processing activities, which are critically affected by the presence of stressors. Furthermore, in occupations where being creative is not part of the job role (for instance, a NHS nurse), creativity is often appraised as the extent to which an individual is able to think about new ways of performing their job in a more effective manner. The presence of stressors can actually prompt individuals to engage in such activities (Fay & Sonnentag, 2002). For instance, a nurse under time pressure is more likely to think of and implement changes in her working routine that will enable him or her to deal with patients in a more efficient manner than a nurse under no time pressure. On the other hand, if the job role implies being creative, creativity will be ultimately appraised in regard to the overall originality of the final product the individual is in charge of contributing towards. If the individual is under time pressure, cognitive resources necessary to respond to such a cognitively demanding task are being overloaded, and then he or she is forced to rely on old routines rather than an optimised solution. In this context, as it is the case in this project, stressors should hinder innovative performance. This distinct impact of stressors on different innovation elements relates to the discussion introduced in chapter two on how each of the creativity types suggested by Unsworth (2001) is likely to be influenced differently by the same variables.

Researchers have systematically reported that stressors negatively affect information capabilities by narrowing individuals' breadth of attention, leading them to focus their attention on sources of information that are considered a priority and ignoring peripheral tasks (Gladstein & Reilly, 1985). Stressors tax limited resources and require a redistribution of resources that might overload attention. Several empirical studies provide support for this assertion. For instance, stressors were found to reduce working memory capacity (Hamilton, 1982), which is associated with speed-accuracy trade-offs (Wickens, 1996). Furthermore, narrowed attention and reduced working memory affect decision-making, leading to simpler decision strategies, recognitions rather analytical strategies and less complete mental simulations (Klein, 1996).

Compelling evidence for the impact of stressors on creative cognitive processing was provided by Amabile and colleagues (2002). The authors requested team members working on projects in which creativity was necessary to complete daily electronic questionnaires over a period of 30 weeks. Participants were asked to report the levels of perceived time pressure, intrinsic motivation, and to provide narrative reports of events occurring on those projects. Measures of their creative cognitive processing were extracted based on these narrative reports. Creative outcomes of each participant in terms of contribution to the project were obtained from his or her peers on a monthly basis. The results showed that time pressure on a given day negatively predicted creative cognitive processing on that day, one day later, two days later and over longer time periods. This relationship was not meditated by intrinsic motivation, suggesting that the impact of stressors on creative cognitive processing is likely to be a direct one.

Furthermore, average creative cognitive processing for the prior 30 days was a significant predictor of peer ratings of creativity.

Considering that the area of performance this project focuses on is highly dependent on cognitive resources, the most appropriate of the three approaches accounting for the effect of stressors on performance described earlier to inform this research is the first one, which argued that the depletion of cognitive resources caused by stressors will result in decreased levels of performance. Further, stressors are also likely to influence an individual's decision about engaging in creative actions. According to Ford (1996), creative and routine actions are competing behavioural options for an individual. It is likely that when facing stressors individuals will be more prone to stick to routine behaviours that are less cognitively costly than creative behaviours.

Similar to creativity activities, implementation activities also rely on cognitive resources and information processes. For instance, central to the implementation process is planning the execution of ideas. Planning, as described by Mumford and colleagues (2001), relies heavily on engagement in information processing activities including knowledge scanning, information search and forecasting. Although most of the evidence looking at stressors and innovative performance derives from studies that focused only on creativity as an outcome, it is argued that the implementation activities R&D team members engage in are also very strongly dependent on information processing (this claim is justified in the following chapter) and they will thus be affected by stressors in the same manner as creativity activities.

Following this line of reasoning, the following hypotheses are drawn:

Hypothesis 1: Stressors will have a negative impact on the level of creativity activities displayed by R&D team members, i.e. there is a negative relationship between stressors and creativity activities.

Hypothesis 2: Stressors will have a negative impact on the level of implementation activities displayed by R&D team members, i.e. there is a negative relationship between stressors and implementation activities.

3.7 Mood, information processing and innovation activities

3.7.1 Mood and information processing

Over the last two decades a large number of theoretical and empirical contributions have demonstrated the pervasive influence of affective states on cognitive processes (e.g., Clore, Schwarz, & Conway, 1994; Isen, 1984; Tamir & Robinson, 2007; Schwarz, 2000; for an overview see Martin & Clore, 2001). At the individual level of analysis there is a substantial body of literature showing that affect and cognition are interdependent (Clark & Fiske, 1982; Clark & Isen, 1982). In other words, positive and negative affective states of individuals can influence their cognitive processes and their cognitive processes can in turn influence their affective states (Lazarus, 1982, 1984). Affective states were found to have an impact on encoding, storage, retrieval and judgmental processes, as well as general strategies of information processing (Blaney, 1986; Clore et al., 1994; Forgas, 1992, 1995; Isen, 1987). This means that moods can affect the outcomes of processing, such as memory, decision-making, evaluation and creativity, as well as the nature of processing itself (Isen, 1993; Isen, Shalker, Clark, & Karp, 1978).

Mounting evidence suggests that positive and negative moods elicit different processing styles. In a series of studies analysing the effect of different affective states on decision over persuasive tasks, it was discovered that, when presented with a strong and a weak argument, participants in a neutral mood were more persuaded by the stronger argument, whereas those in a positive mood were equally persuaded by strong and weak arguments (Bless, Bohner, Schwarz, & Strack, 1990; Worth & Mackie, 1987). In addition, researchers verified that individuals in positive mood were more likely to rely on heuristics such as peripheral cues that are not central to the problem (Edwards & Weary, 1993), stereotypes (Bodenhausen, 1993; Bodenhausen, Kramer, & Susser, 1994), primacy effects (Sinclair & Mark, 1992) or previous scripts (Bless et al., 1996) when making their decisions, than individuals in neutral or negative moods. Based on these findings, theorists concluded that positive moods are associated with heuristic processing strategies, whereas negative moods are associated with a systematic elaboration of the information. In other words, individuals in a positive mood are more likely to take shortcuts and rely on heuristics, whereas individuals in a negative mood are more likely to focus on the specific information provided (Bless, 2001).

In addition, several studies also suggest that positive moods are associated with cognitive flexibility. For instance, one study reported that individuals in a positive mood were able to identify more similarities between objects, promoting the use of broader systems of categorisation, but were equally able to identify a higher number of common features (Murray et al., 1990), also providing evidence for higher levels of cognitive flexibility.

3.7.2 Mood and innovation activities: The case for positive mood

Hitherto the study of the impact of mood on innovation activities has been approached mostly from a cognitive perspective. As was the case with stressors, the vast majority of research has focused on creativity activities. Researchers have attempted to explain the impact of mood on creativity on basis of the effects of mood on information processing. Although there are some contradictory findings, most of the studies tend to reveal a positive effect of positive mood and virtually all the reviews on this topic subscribe to this view (e.g., Hirt, 1999; Isen, 1999; Russ, 1993). Next, the literature linking mood to innovation activities is reviewed and special heed is paid to the mechanisms that underlie the relationship between these constructs.

One of the major contributions towards the understanding of the impact of mood on creativity is derived from the work by Isen and colleagues (Isen, 1999, 2002; Isen & Daubman, 1984; Isen, Daubman, & Nowicki, 1987; Isen, Johnson, Mertz, & Robinson, 1985). Across a number of different studies, the authors noticed that positive mood facilitated performance on tasks that were partially related to creativity, including word categorisation and word association. In one of these studies, people who had a positive mood induced, tended to categorise stimuli more inclusively than people in the control conditions did, both in a rating task (which requires individuals to rate the extent to which an item belongs to a certain category) and in a sorting task (which required individuals to distribute different items across categories). In the rating task, participants in a positive mood were more likely to consider non-typical exemplars of a category as being part of that category than participants in the control group did. In the sorting task, individuals in a positive mood tended to group more stimuli together than control participants did (Isen & Daubman, 1984).

Another study showed that individuals in a positive mood gave more unusual first associates to neutral words than individuals in control conditions did (Isen, 1985). Isen and colleagues interpreted these results as evidence for greater integration or perception of interrelatedness of stimuli among people in a positive mood. Since the ability to see relatedness in diverse stimuli that normally seem unrelated is central to the definitions of creativity (Mednick, 1962), Isen claimed that both atypical categorisation and word association could be thought of as indicators of processes central to creativity, as they require seeing aspects of objects that are real and useful but not usually central to people. They concluded that positive mood should be a facilitator of creativity. In order to test this proposition directly, Isen and colleagues (1987) conducted a series of four experimental studies analysing the effect of mood on problem-solving innovation. As expected, the authors verified that participants in a positive mood were more likely solve Duncker's candle and matches exercise (1945), which involves being able to break the set and see additional features of the match of boxes (experiment 1), and performed better in a word association task (experiment 3). Furthermore, they concluded that this effect was not due to arousal (experiment 2 and 4), and it occurred when using either a humour manipulation (a clip) or a small gift, showing that problem-solving is facilitated by positive mood in general rather than only humour. In a follow-up study using a sample of physicians, these results were replicated and further extended. It was found that participants in whom a positive mood had been induced scored higher on a creative-solving task than the control group (Estrada, Isen, & Young, 1994).

In light of their results, Isen and colleagues (1987) concluded that people in a positive mood have a stronger ability to see diverse aspects of objects or see objects more completely, which includes the potential for combination with other objects in the problem under consideration, and this is what leads to higher creativity. The authors explained these effects based on cognitive spreading activation theories. Positive mood cues and facilitates access to positive material in memory (due to congruence mechanisms), and given that usually positive material is more extensive and diverse than other material (Anderson & Bower, 1973; Boucher & Osgood, 1969), a person in a positive mood has access to a larger and more diverse set of cognitive material than they themselves or another person in a neutral or negative mood do. The activation of more materials leads to a more complex cognitive context. A complex cognitive context may influence cognitive organisation by increasing the number of ways in which ideas or objects can be integrated or related to one another. According to the authors, this may occur because of an increase in the aspects of ideas that are noticed. Another suggestion for how the complex cognitive context may influence organisation relates to the easy accessibility of many ideas simultaneously, which likely results in defocused attention. Thus, the presence of a complex cognitive context may cause many features of items and problems to become salient, so that more functions of the objects and more possibilities for solution can be seen, which in turn results in a higher creativity. These claims are also in line with Fredrickson's (1998; 2001) broaden-and-build theory, which suggests that experiences of positive emotions broaden people's momentary thought-action repertoires that hold the potential to foster creativity.

In a subsequent theoretical review of the evidence relating mood to cognition, Ashby and colleagues (1999) forwarded a neuropsychological explanation for the positive impact of mood on creativity. The authors suggested that creative problem-solving is improved in part because the increased dopamine release caused by positive affect improves cognitive flexibility and facilitates change between different perspectives.

The link between mood and creativity finds further corroboration in the work of other researchers who have assessed creativity in a range of different ways. In two experimental studies that required students to engage in verbal creativity tasks, Abele-Brehm (1992) found that participants who had had a positive mood induced showed higher fluency than participants in a neutral or negative mood, independently of the interest of the task. Hirt and colleagues (1996) asked participants who had been induced with a positive, neutral or negative mood to generate similarities and differences between TV shows and gave them different instructions about when to stop (performance-based, satisfaction-based or no instruction). They found that participants in positive mood were more creative than other participants, regardless of the rule. Mitchell and Madigan (1984) reported that participants who had a positive mood induced performed better on a heuristic problem-solving task. In another study looking at the impact of positive mood and visual access on negotiation process and outcomes, it was found that positive mood promoted creative integration in negotiation behaviour (Carnevale & Isen, 1986). Furthermore, the same results were found when mood was not manipulated. Vosburg (1998) measured participants' mood at the time of arrival and verified that high positive mood led to higher performance in real life divergent thinking tasks. Finally, these effects seem to be evident from early ages. Greene and Noice (1988) demonstrated that children induced with a positive mood by means of a compliment or a present were better at solving Duncker's (1945) candle task than children in a neutral mood.

3.7.3 Mood and innovation activities: The case for negative mood

Although the overwhelming majority of empirical research provides evidence for a positive relationship between positive mood and creativity, it is important to notice that some studies do not find a relationship at all (e.g., Clapham, 2000), while other studies even report a negative effect of positive mood. Indeed, it has been reported that positive mood could be detrimental to creative performance. Jausovec (1989) found that participants who had a positive mood induced performed worse on Duncker's radiation task, which requires creative insight, than individuals in a neutral or negative mood. Kaufmann and Vosburg (1997) verified that positive mood of participants measured at the time of arrival (experiment 1) and induced positive mood (experiment 2) led to worse results on tasks involving insight problems than neutral or negative mood. Other studies showed that participants who had a positive mood induced had lower results on a creative mental synthesis task (Anderson, Arlett, & Tarrant, 1995), were less flexible and original on a divergent thinking test (Katz, 1996) and, although they were more fluent in the first minute of an idea production task, their performance was worse than individuals in a negative or neutral mood by the fourth minute (Kaufmann & Vosburg, 2002). In light of these contradictory results, Kaufmann (2003) argued that the conclusion that positive mood facilitates creative problem-solving was conceptually and theoretically ill-founded.

The picture gets even more complex. Although scarce, there is also some experimental evidence suggesting that negative mood can have a positive effect on creative performance. In an experimental task involving problem-solving, Kaufmann and Vosburg (1997) found that people who had had a negative mood induced performed better than participants in positive or neutral moods (experiment 2). The authors explained these results by stating that positive mood informed individuals that the level of creativity was satisfactory and they therefore ceased to invest effort in the task, whereas negative mood indicated that the their creative performance was not satisfactory and should thus be improved.

Unfortunately, results of experimental studies about the effect of mood are inconsistent, with many studies suggesting a positive effect of positive mood on creativity and a smaller number suggesting a negative effect or no effect. To the knowledge of the author, no moderators have been identified to date. This means it is not clear under what conditions a positive or negative effect is more likely to occur. This makes unambiguous predictions about the effect of mood on innovation activities very difficult. Furthermore, most of the results analysed so far come from laboratory studies, raising the question of generalisability to the field. Next the field studies looking at the relationship between mood and innovation activities are reviewed.

3.7.4 Mood and innovation activities: Evidence from the field

Despite evidence for the impact of mood on creativity, there has been limited progress in understanding the role of mood as an antecedent of creativity in the workplace (Amabile et al., 2005). Only a hand-full of studies have so far looked at what this relationship looks like in real work settings. A brief review of these studies is presented next.

One of the first field studies that captured the impact of mood on creativity was conducted by Madjar, Oldham and Pratt (2002). Using sample from the knitwear industry, the authors found that positive mood was positively related to creativity.

Furthermore, their results showed that positive mood mediated the impact of work and non-work support on employees' creative performance as rated by supervisors.

There is also field evidence relating negative mood to creativity. Indeed, a view that has been supported both by the popular and also by the scientific literature, is that creativity is elicited by mood disorders (Carreno & Goodnick, 1998; Ramey & Weisberg, 2004). Examples of the lives of creative geniuses such as Virginia Wolf or Vincent Van Gogh lend face value to this perspective. Offering some additional support for this reasoning, clinical pathologic studies have found some evidence for the connection between creativity and clinical illnesses such as bipolar disorder or schizophrenia (Anderegg & Gartner, 2001; Bowden, 1994; Fodor, 1999; Fodor & Laird, 2004; Ghadirian, Gregoire, & Kosmidis, 2000; Jamison, 1993, 1996; Richards, 1994; Schuldberg, 1999, 2000a, 2000b; Walker, Koestner, & Hum, 1995; Weisberg, 1994). Also, Mraz and Runco (1994) found that an indicator of negative mood, frequency of suicidal thoughts, was positively related to problem-finding ability. However, this relationship seems to be restricted mostly to the domain of artistic creativity (Feist, 1998). In addition, extreme cases of mood alteration are of limited value to understanding how mood affects creativity in organisational settings.

There are however a number of more relevant studies attempting to explore the relationship between negative mood and creativity within a work context. Adopting a different framework to explain the effects of mood, George and Zhou (2002) argued and demonstrated that negative mood can be conducive to creativity. According to information theories of emotion such as the 'mood-as-information' perspective, individuals use their current mood as a source of information about the situation they are involved in and the measures that should be undertaken. A positive mood signals to the organism that the environment is safe and no action is required. In contrast, a negative mood signals that the environment is threatening and action is necessary. The authors suggested that, because negative mood is interpreted as indicative that the current situation is problematic and more effort is necessary, it could foster creativity under certain conditions. The authors found support for their claim in a field study involving workers in charge of developing creative designs and manufacturing techniques. Their results showed that when employees were clear about the emotions they were experiencing and felt that creativity would be rewarded; negative mood was positively related to creativity.

3.7.5 Recent developments in mood and innovation research

Based on the mixed evidence for the beneficial effects of positive and negative mood, some researchers have proposed that a combination of these two affective states might be more effective in explaining creativity. Fong (2006) forwarded the idea that ambivalence regarding one's own feelings may leave you predisposed to seeing relationships between seemingly unrelated objects, which in turn is conducive to creativity. Also, on the grounds of mood-as-information theory, Fong argued that an ambivalent mood will signal that the environment is unusual and atypical, and people will be likely to respond to the signal that they are in an unusual environment by using their creative thinking ability. Emotionally ambivalent people are being informed that previously unrelated stimuli in the environment can be associated and it hence may be necessary or adaptive to process stimuli in a flexible way. The author found support for this perspective in two experimental studies in which individuals experiencing emotional ambivalence were more sensitive to associations and performed better in the Remote Associate Task (RAT; Mednick, 1962).

In a recent study, George and Zhou (2007) further explored the possibility of a synergistic combination of positive and negative mood. The authors argued that a combination of the dual-tuning effects elicited by positive and negative moods experienced over time would be the best condition to elicit creativity. Again, using mood-as-information theory, authors argued that positive and negative moods can be beneficial for creativity, but in different ways. A positive mood signals all is well and thus prompts a looser, less systematic and less effortful information processing style, which is associated with integrative top-down strategies, simplifying heuristics, schemas and scripts, and more expansive divergent thinking, which is conducive to creativity. People in a positive mood are more likely to be confident about engaging in divergent thinking and hence be creative. On the other hand, negative moods signal a problematic state of affairs and thus promote a systematic approach to the problem, leading to a bottom-up, detail-oriented and analytic approach, more focused on understanding the data and less influenced by simplifying heuristics, which can be beneficial to creativity in the sense that it can make people more aware of potential shortfalls of an existing solution, lead people to focus on the current state of affairs rather than on pre-existing assumptions, and can motivate people to exert high levels of effort to improve matters. In other words, the authors stated that, in a context that supports creativity, negative and positive moods should interact to predict creativity because each mood provides a complementary contribution. Negative moods can promote problem identification, can generate a sense of dissatisfaction with the status quo that may promote opportunity identification, and can push people to exert greater effort in the development of ideas and thus arrive at high quality solutions. On the other hand, positive moods promote a sense of confidence and divergent thinking, which are equally important for creativity. The authors illustrate their point by giving the example of an employee who starts the day in a negative mood but is already in a positive mood by lunch time. They suggest that a negative morning mood can prompt the employee to re-examine the feasibility of some doubtful key assumptions in a proposal and anticipate some previously unforeseen potential logistic difficulties in implementing the plan, whereas the positive mood after lunch can facilitate the generation of a new alternative plan to overcoming the identified problems. This position is somewhat supported by a previous study conducted by Adaman and Blaney (1995), in which they used music to induce an elated, depressed or neutral mood and verified that participants in elated and depressed moods scored higher than individuals in neutral moods. George and Zhou (2007) tested their assumptions in a large oil-field services company. They found that when supervisors provided a supportive context for creativity and positive mood was high, negative mood had a strong positive relation to creativity, with creativity being the highest when the context was supportive, and positive and negative mood were both high. The authors concluded, in line with their hypotheses, that both positive and negative mood interact to influence creativity in a context that supports creativity.

Amabile and colleagues (2005) conducted one of most comprehensive analyses of how the unfolding of moods over the day can affect creative thinking. Their central assumption was grounded in Simonton's evolutionary theory of creative thinking (1999). Simonton suggested that creativity could be explained by a process of variation and a process of selective retention, in which the former primarily contributed to the idea novelty and the latter to the idea usefulness. As such the first process, variation, is of extreme relevance to the novelty of the idea. Variation is guided among other factors by the existence of knowledge elements available for combination into new variations. A central tenet of Simonton's theory is that the probability of novelty varies with the number of cognitive elements available for association: the more variation amongst the cognitive elements, the more creative the idea will be. The authors argued for the importance of affect by reasoning that, since creativity depends in large part on novelty and novelty is largely a function of cognitive variation, anything within the range of normal cognition that increases variation is likely to increase the probability of creativity - affect is one source of such variation. In order to test several assumptions relating to the relationship between affect and creativity Amabile and colleagues conducted a diary study involving 222 employees in seven organisations. Participants were asked to fill in a daily measure of affect and report narratives of the day events that were afterwards coded for creativity and affect. Furthermore, monthly measures of creativity were collected from each employee's peers. Using this data, the authors tested different hypotheses about the relationship between affect and creativity, which related to the impact of valence, intensity, ambivalence and lability.

In contrast with the results found by George and Zhou (2007), alternation between positive and negative moods (lability hypothesis) displayed no positive effect on creativity. One possible explanation for such results is that the condition necessary for this alternation to result in creativity, contextual support, was not present. Another possibility is that the operationalisation of lability in Amabile and colleagues' (2005) study might not capture the alternation between positive and negative moods but instead capture the change of intensity in positive mood. A final and more attractive explanation has to do with the outcome measures under consideration. Whereas Amabile and colleagues'. (2005) study focused only on pure generation of ideas (creative cognitive processing), George and Zhou (2007) captured the overall individual innovative behaviour, implicitly also including implementation activities in which the benefits of negative mood were harvested. This component was not present in Amabile and colleagues' study (2005) and perhaps that is why no beneficial effects of negative mood were found. Based on these results, it seems reasonable to suggest that positive mood is facilitative of creativity activities whereas negative mood promotes implementation activities. This idea will be resumed when developing the hypotheses.

The results of Amabile and colleagues' (2005) study also do not provide support for the role of emotional ambivalence as argued by Fong (2006). There was no significant association between affective ambivalence and daily creative thought, or between monthly affective ambivalence and monthly peer rated creativity. Perhaps the divergent results in this situation can also be explained by a different operationalisation of emotional ambivalence. Whereas in Fong's experiments participants experienced positive and negative mood at exactly the same moment, since ambivalence was induced by having people recall a situation they felt ambivalent about or by watching a movie that was happy and sad at the same time, Amabile and colleagues (2005) equated ambivalence with the extent to which in individuals had reported both positive and negative affective states on a given day, something which may constitute a better reflection of mood alternation rather than mood ambivalence.

The central conclusion of Amabile and colleagues' (2005) study supports the dominant perspective, sustaining that positive mood is positively associated with creativity. The authors found that positive affect had a positive linear relationship with creativity, assessed based on self-reports of creative thought and on monthly ratings of creativity conducted by peers.

Especially relevant for informing the effects of mood on both creativity and implementation activities of R&D team members is the notion that positive and negative moods lead to different information processing styles. As discussed earlier, creativity activities usually benefit from a more independent heuristic processing, which is elicited by positive mood. In contrast, implementation activities require more systematic and focused processing of information in order to choose the best plan of action and be able to anticipate errors. This type of processing is elicited by negative mood. Indeed, one possible explanation for the contradictory effects of mood could be that mood has a different impact on the different activities involved in the innovation process.

Based on this rationale, it is logical to hypothesise that positive mood will facilitate creativity, while negative mood will facilitate implementation activities. As described earlier, according to the mood-as-information framework, negative moods signal that something in the environment is not right and that change is required. This might propel individuals to implement their ideas. Considering that the systematic heuristic style associated with negative mood is usually not conducive to creativity, it is hypothesised that negative mood will have a negative impact on creativity. Given the complex patterns of results concerning creativity and the almost complete absence of studies about implementation activities, no hypotheses about the impact of positive mood on implementation activities are drawn at this stage.

Based on this reasoning the following hypotheses are suggested:

Hypothesis 3: Positive mood will have a positive impact on the level of creativity activities displayed by R&D team members: individuals in a high positive mood will display higher levels of creativity activities than individuals in a low positive mood.

Hypothesis 4: Negative mood will have a negative impact on the level of creativity activities displayed by R&D team members: individuals in a high negative mood will display lower levels of creativity activities than individuals in a low negative mood.

Hypothesis 5: Negative mood will have a positive impact on the level of implementation activities displayed by R&D team members: individuals in a high negative mood will display higher levels of implementation activities than individuals in a low negative mood.

3.8 Interplay between stressors and mood: Interaction models

Ivancevich and Mattesson (1980) suggested that personality differences in terms of affect were likely to have a moderating effect on the relationship between stressors and physiological, cognitive and behavioural outcomes. However, as noted earlier, the nature of this interaction has not been empirically tested yet. Even more critical is the fact that the dynamic of this interaction changes dramatically depending on which theory or model is used to inform it. The moderation model is presented (figure 3.2) below and the interplay between stressors and mood is explored next through the application of three competitive frameworks.

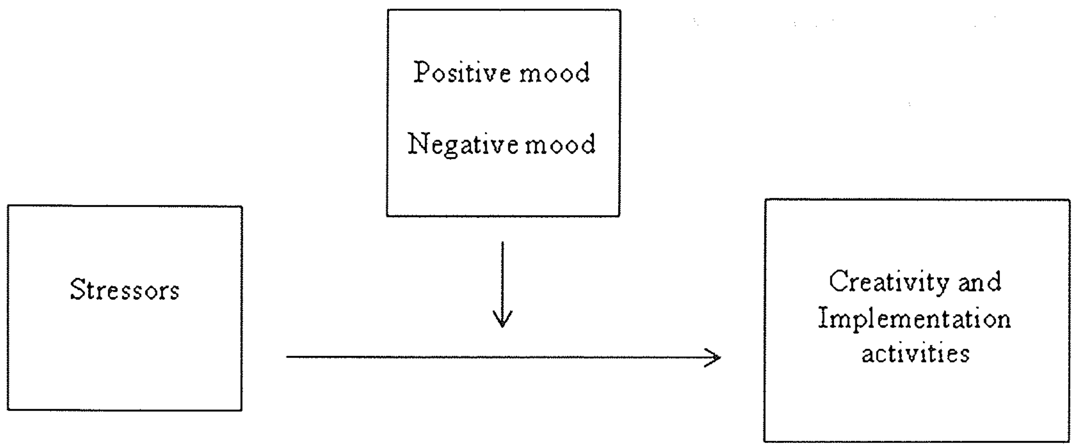


Figure 3.2:.Moderation model depicting the interaction between stressors and positive and negative mood to predict creativity and implementation activities.

The three theoretical perspectives on the interplay between stressor and mood are: 1) the Cognitive Spreading Activation theory; 2) the Mood Repair theory; and 3) the Mood-as-information theory. These different perspectives arrive at somewhat different predictions about the nature of interplay between stressors and mood. The next section develops each of the three frameworks and the predictions of each are summarised graphically at the end of the chapter (figures 3.3 and 3.4).

3.8.1 Cognitive spreading activation

The first framework applied to explain the interaction between stressors and positive mood derives from cognitive spreading activation theory, which was alluded to earlier. According to the activation model of memory, incoming portions of information are stored in an associative network, organised according to a set of relationships (Anderson & Bower, 1973; Boucher & Osgood, 1969). When a stimulus activates a node, the activation will spread through the network via cognitive spreading activation. Moods activate associate networks that are congruent with themselves, so when people are in a good mood, materials that are associated with a positive mood will be activated.

Since people generally have more positive events networks than negative events (Matlin & Stang, 1979), positive moods will elicit a wider activation, leading to a larger range of available responses to a problem, including how to cope with the stressor at hand.

This enhanced cognitive processing might counteract the processing impairment induced by stressors by providing alternative mechanism to cope with the stressor and buffering their negative impact on both creativity and implementation activities. Based on this framework, one would expect that, when facing stressors, individuals in a high positive mood are less affected than those in a low positive mood concerning their output on both creativity and implementation activities.

Hypothesis 6.1: Positive mood will buffer the negative impact of stressors on the level of creativity activities displayed by R&D team members; the level of creativity activities of individuals in a high positive mood will suffer less from increased levels of stressors than that of individuals in a low positive mood. In other words, the negative stressor-creativity slope will be steeper for individuals in a low positive mood as compared to individuals in high positive mood.

Hypothesis 6.2: Positive mood will buffer the negative impact of stressors on the level of implementation activities displayed by R&D team members; the level of implementation activities of individuals in a positive mood will suffer less from increased levels of stressors than that of individuals in a low positive mood. In other words, the negative stressor-implementation slope will be steeper for individuals in a low positive mood as compared to individuals in a high positive mood.

There is no evidence to suggest that negative moods inhibit cognitive activation as compared to neutral moods, so there no is no reason to expect an interaction effect between stressors and negative affect based on this framework.

3.8.2 Mood repair perspective

This second framework has not been used to explain the direct relationship between mood and creativity up until this point, but it can prove useful in explaining the interplay between stressors and mood. Mood scholars have suggested that there is a cognitive penalty for strong moods, either positive or negative. For instance, Frijda (1986) stated that positive and negative emotions are characterised by "control precedence", meaning that the strong emotions that are felt consume available cognitive resources because they call for direct attention. Weiss and Cropanzano (1996) extended this idea by stating that "people in an emotional state they tend to be controlled by that state, they tend to feel preoccupied by the emotion, and there is a persistence to behaviours designed to deal with the emotion" (p.54). There is cumulative evidence showing that individuals experiencing a positive mood frequently exhibit mood maintenance tendencies. For instance, Isen and Simmonds (1978) verified that individuals in a high positive mood were more likely to provide help to others than individuals in a neutral mood when the task involved reading uplifting information, but the opposite was true if the task involved reading mood-depreciating information. In another experimental study manipulating moods, Wegener and Petty (1994) found that participants in a positive mood, as compared to participants in a neutral and negative mood, chose to watch happier but not more interesting movies, leading the authors to conclude that people in a positive mood put more effort into monitoring the affective consequences of their actions than people in neutral or negative moods. These findings led to the development of the hedonic contingency model, having as central tenet the assumption that individuals have learned to seek out positive activities when in a high positive mood in order to maintain or elevate that mood (Wegener & Petty 1994; 2001). This is done in an automatic manner (Handley, Lassiter, Nickell, & Herchenroeder, 2004).

Based on the hedonic contingency model one can conclude then that individuals on the high polar ends of either positive and negative mood are concerned with and engage in activities to maintain or change their mood respectively, whereas mood is not salient for those individuals at the lower ends of these dimensions and they therefore do not have to channel their efforts into managing their mood.

A study conducted by Fishbach and Labroo (2007) on the effect of mood on self-control provides the grounds for a possible explanation on how mood interacts with stressors within a mood management framework. In a series of six experimental studies, the authors verified that positive mood only enhanced performance in a number of different outcomes (amongst which moderately difficult creative tasks) when the goal made accessible to participants was related to self-improvement. When the goal was related with mood management, positive mood was actual detrimental to performance. The authors explained this finding by suggesting that positive mood boosts adherence to goals, both long-term self-improvement and short-term mood management goals. If a mood management goal is present, people in a positive mood will abstain from self-control tasks because these tasks are incompatible with a mood management goal, leading to impaired performance. People in neutral moods (which is comparable to a low positive mood in terms of intensity) are not affected by the mood management goals because they are less likely to adhere to goals in general (and less sensitive to mood-related stimuli in particular as argued here) and therefore can continue channelling their efforts toward self-control activities which lead to increased performance. In sum, the authors concluded that when a mood management goal is accessible, a positive mood discourages a further choice of actions that undermines this goal.

Relating the above findings to the present study, it follows that a factor threatening the maintenance of a positive mood can prime a mood management goal, especially for those individuals for whom mood is already salient (individuals in a high positive or negative mood). The presence of stressors can be interpreted as a threat to the maintenance of a high positive mood. As such, individuals in high positive (or negative) moods are more likely to be primed with a mood management goal by the presence of stressors than individuals in a low positive (or negative) mood. Furthermore, as the former are more prone to adhere to goals, they will also be more likely to engage in mood management activities than individuals in a low positive mood. Accordingly, individuals in a high positive mood will abstain from self-control tasks because these tasks are incompatible with a mood management goal. Coping with stressors involves engaging in a set of actions that requires self-control and a failure to do so will lead to impaired performance. One can conclude then that individuals in a low positive mood will be less likely to engage in mood repair activities, firstly, because mood is not a salient factor for them, and secondly because they have a lower tendency to adhere to goals (and stressors are likely to prime a mood management goal). Consequently, individuals in a low positive mood should be better able to concentrate on the self-control activities required to cope with stressors and exhibit higher levels of performance than individuals in a high mood, for both creativity and implementation activities. An analogous explanation can account for the effect of negative mood on innovation activities. Again, individuals high in negative mood will have to direct their efforts toward changing their mood into a positive one, and in the presence of stressors such need is exacerbated, leaving yet less resources to cope with stressors. Individuals in a low negative mood will not be as compelled to engage in mood management activities, so they will be less affected by the presence of stressors.

Moreover, mood repair activities are cognitively consuming. Based on this fact it can be argued that high positive and negative moods additionally tax the limited cognitive resources already strained by stressors and have an additive effect on the depletion of these resources, resulting in an impaired performance in terms of both creativity and implementation innovation activities. Finally, and related to the previous point, individuals in a high positive (or negative) mood should be less motivated to invest cognitive effort than individuals in a low positive (or negative) mood given that strenuous cognitive processing interferes with the goal of maintaining positive mood states,.

Based on this perspective, it is expected that individuals in a high positive and negative mood will be more negatively affected by increasing stressors than those in a low positive or negative mood. These effects should remain the same for creativity and implementation activities, given that these are equally dependent on cognitive resources. In other words, the negative relationship between stressors and innovation activities will be stronger when moods are higher rather than lower. For both high and low levels of mood (either positive or negative), innovative behaviours will decrease as stressors increase, but for low levels of mood this deficit should be less accentuated.

Hypothesis 7.1: Positive mood will accentuate the negative impact of stressors on the level of creativity activities displayed by R&D team members: the level of creativity activities of individuals in a high positive mood will suffer more from increased levels of stressors than that of individuals in a low positive mood. In other words, the negative stressor-creativity slope will be steeper for individuals in a high positive mood as compared to individuals in a low positive mood.

Hypothesis 7.2: Positive mood will accentuate the negative impact of stressors on the level of implementation activities displayed by R&D team members: the level of implementation activities of individuals in a high positive mood will suffer more from increased levels of stressors than that of individuals in a low positive mood. In other words, the negative stressor-implementation slope will be steeper for individuals in a high positive mood as compared to individuals in a low positive mood.

Hypothesis 7.3: Negative mood will accentuate the negative impact of stressors on the level of creativity activities displayed by R&D team members: the level of creativity activities of individuals in a high negative mood will suffer more from increased levels of stressors than that of individuals in a low negative mood. In other words, the negative stressor-creativity slope will be steeper for individuals in a high negative mood as compared to individuals in a low negative mood.

Hypothesis 7.4: Negative mood will accentuate the negative impact of stressors on the level of implementation activities displayed by R&D team members: the level of implementation activities of individuals in a high negative mood will suffer more from increased levels of stressors than that of individuals in a low negative mood. In other words, the negative stressor-implementation slope will be steeper for individuals in a high negative mood as compared to individuals in a low negative mood

3.8.3 Mood-as-information

The last framework used to explain the interplay between stressors and mood is derived from the mood-as-information perspective, which was also mentioned previously while exploring the direct impact of mood. To recap, according to the mood-as-information theory, moods can provide individuals with information about their present situation. Positive moods signal that the world is currently safe and satisfactory, and there is no need to engage in cognitive effort, whereas negative moods signal a problematic situation about which it is necessary to take action (Schwarz & Clore, 1983, 1988). According to Schwarz (1990), individuals' cognitive processes are tuned to meet these perceived situational demands as the information provided by moods triggers different processing strategies. Individuals in negative moods will be more likely to engage in detail-oriented systematic processing strategies because these are particularly adept at coping with problematic situations, whereas individuals in positive mood see no reasons to engage in strenuous processing strategies. As such, positive moods promote the exploration of new associations and engagement in heuristic as opposed to effortful processing, whereas negative moods lead to careful, conservative and effortful processing. Individuals in negative moods typically process information in a more systematic manner than individuals in positive moods, whereas individuals in positive moods typically process more flexibly and creatively than those in negative moods.

Schwarz (2001) argues that the effortless processing style elicited by positive moods is not maintained in situations in which contextual task demands are made salient, and consequently individuals in positive moods are able to engage in effortful processing when task demands are explicit or instructions require detail-oriented processing. However, evidence for this claim derives from experimental studies in which mood and task demands are experienced independently by the individual (Bless et al., 1990; Bless et al., 1996). The individual is less likely to use his or her mood-as-information regarding the situation, since the task itself constitutes a strong immediate clue. On the other hand, a work environment situation is characterised by higher levels of ambiguity and individuals having more autonomy with regard to their actions. Consequently, in real settings the "environment is safe" information provided by positive mood even in the presence of stressors (which is misleading), is more likely to be used.

Further evidence for the differential information processing elicited by moods derives from a study conducted by King and colleagues (2007). Based on cognitive-experiential self theory, the authors differentiated between the experiential system, which is fast and automatic, and the rational system, which is slow and intentional. The experiential system operates holistically and it is associationistic. The rational system, on the other hand, is characterised as an analytic processing style involving effort and logic. The authors measured or manipulated positive affect in three different studies and confirmed that positive mood interacted with experientiality to predict beliefs in paranormal activities. Individuals high in positive affect were more likely to believe in paranormals activities than individuals in neutral affect. This was interpreted as an indicator that positive affect elicits an experiential processing, which, due to its less analytical properties, makes paranormal occurrences more believable.

Considering that the heuristic processing style elicited by positive mood is usually conducive to creativity, it is reasonable to hypothesise that high positive mood will compensate for the cognitive depletion caused by stressors. Consequently, when facing stressors, the creative output of individuals in a high positive mood should be less affected by stressors than the output of individuals in a low positive mood (see figure 3.3). However, the same is not the case for implementation activities. The heuristic processing style elicited by a high positive mood would not be beneficial in counteracting the impact of stressors on implementation activities, as these would only be facilitated by a systematic processing style. Furthermore, the information that the environment is safe maximises the negative impact of stressors on implementation activities by impeding awareness that engagement is some types of activities is necessary in order to cope with the stressors. Based on this line of thought, it is predicted that, when facing stressors, the implementation activities of those individuals in a high positive mood will be more affected that the ones of those in a low positive mood.

Considering the role of negative mood, it is suggested that the pattern of interaction is inverted. Negative moods inform the organism that the environment is threatening and encourage a systematic processing style, favouring the choice of safer and more routine options rather than riskier and more unusual ones. If individuals are in a high negative mood, the presence of stressors will be interpreted as a much more threatening factor and the performance in creativity activities will consequently decrease. Low negative moods do not have the same impact on information processing and the creativity activities of individuals in a low negative mood should thus be less affected by the presence of stressors than those of individuals in a high negative mood.

On the other hand, stressors affect implementation activities by depleting cognitive resources, affecting the individual's capacity to make adequate decisions, be alert to errors and retain focus. The more systematic processing style elicited by negative moods can compensate for this depletion. Based on this line of reasoning, one would expect the implementation activities of individuals in a high negative mood will be less affected than the implementation activities of individuals in a low negative mood when facing stressors.

In sum, based on this framework, high positive mood should buffer the impact of stressors on creativity activities but maximise the negative impact of stressors upon implementation activities, whereas high negative mood should buffer the negative impact of stressors on implementation activities and accentuate the negative impact of stressors on creativity activities.

Hypothesis 8.1: Positive mood will buffer the negative impact of stressors on the level of creativity activities displayed by R&D team members: the level of creativity activities of individuals in a high positive mood will suffer less from increased levels of stressors than that of individuals in a low positive mood. In other words, the negative stressor-creativity slope will be steeper for individuals in a low positive mood as compared to individuals in a high positive mood.

Hypothesis 8.2: Positive mood will accentuate the negative impact of stressors on the level of implementation activities displayed by R&D team members: the level of implementation activities of individuals in a high positive mood will suffer more from increased levels of stressors than that of individuals in a low positive mood. In other words, the negative stressor-implementation slope will be steeper for individuals in a high positive mood as compared to individuals in a low positive mood.

Hypothesis 8.3: Negative mood will accentuate the negative impact of stressors on the level of creativity activities displayed by R&D team members: the level of creativity activities of individuals in a high negative mood will suffer more from increased levels of stressors than that of individuals in a low negative mood. In other words, the negative stressor-creativity slope will be steeper for individuals in a high negative mood as compared to individuals in a low negative mood

Hypothesis 8.4: Negative mood will buffer the negative impact of stressors on the level of implementation activities displayed by R&D team members: the level of implementation activities of individuals in a high negative mood will suffer less from increased levels of stressors than that of individuals in a low negative mood. In other words, the negative stressor-implementation slope will be steeper for individuals in a low negative mood as compared to individuals in a high negative mood.

The following figures graphically summarise the hypotheses about how the interactions between stressors and positive mood (figure 3.3) and between stressors and negative mood (figure 3.4) predict creativity and implementation activities according to each of the three frameworks.

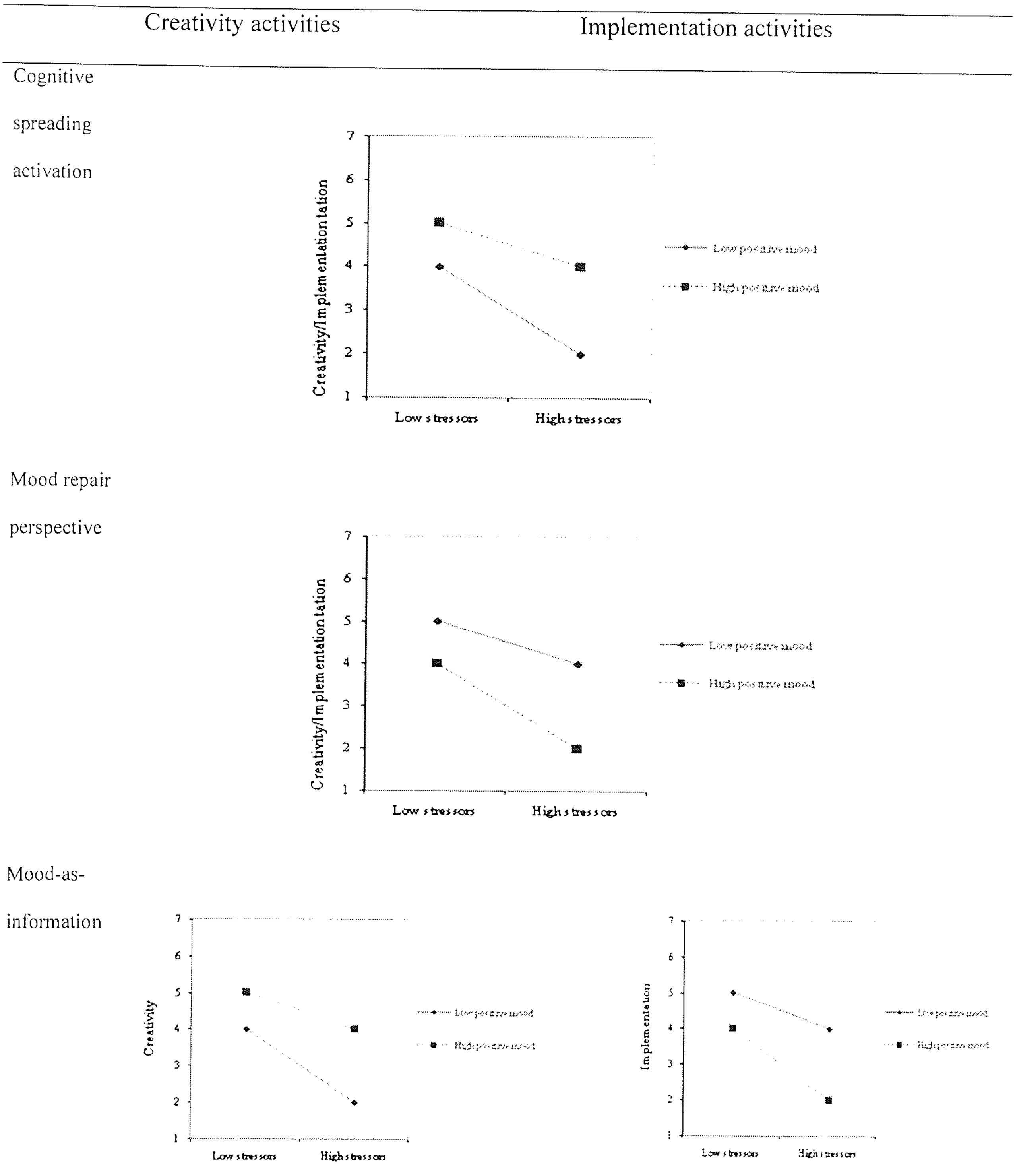


Figure 3.3: Summary of the expected patterns of interaction between stressors and positive mood to predict creativity and implementation activities according to each of the three theoretical frameworks.

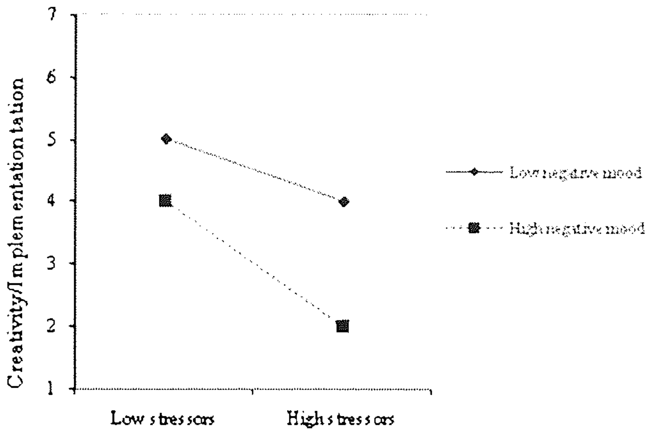
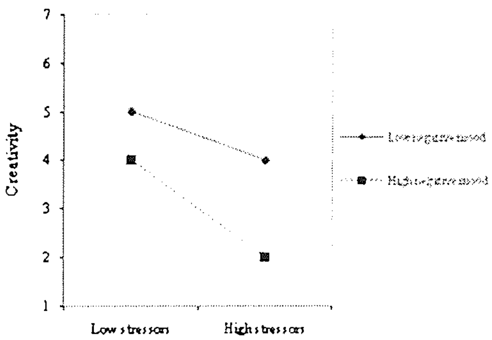
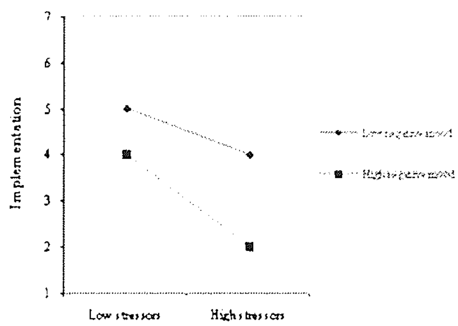
	Creativity activities	Implementation activities
Mood repair perspective		
Mood-as-information		

Figure 3.4: Summary of the expected patterns of interaction between stressors and negative mood to predict creativity and implementation activities according to each of the two theoretical frameworks.

3.9 Interplay between stressors and mood: The mediation model

An alternative explanation is to assume that the relationship between stressors and mood is described by a mediating rather than by a moderating model. According to Amabile's componential model of creativity, contextual factors can influence creativity by affecting individual level variables that are relevant for the engagement in creativity activities. Amabile made reference to the impact of stressors such as time pressure on intrinsic motivation but it is equally rational to argue that stressors can affect individual moods. Evidence shows that stressors tend to lead to an increase in negative affect but show little or no impact on positive affect.

Accordingly, it is possible that the presence of stressors will elicit a negative mood. Based on information processing perspective, negative mood should hinder creativity activities but facilitate implementation activities, as describer earlier in the discussion surrounding the main effects of mood. It is then expected that stressors will decrease creativity by inducing a negative mood. The model bellow illustrates such a relationship (figure 3.5).

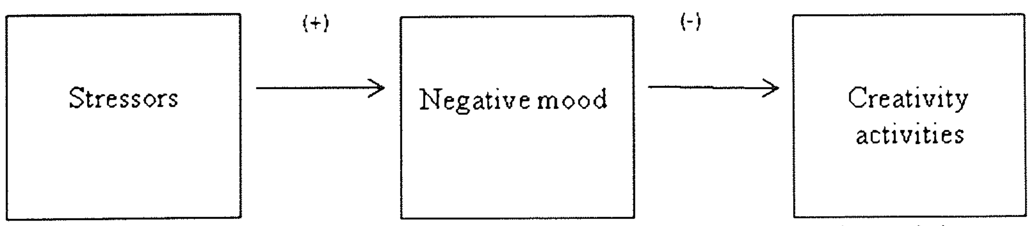


Figure 3.5: Mediation model between stressors, negative mood and creativity activities.

Hypothesis 8: Negative mood will mediate the impact of stressors on creativity

By the same token, it is feasible that stressors facilitate implementation by leading to a negative mood which in turn supports implementation activities. However such indirect effect of stressors is likely to be minimal compared to the direct effect of stressors on implementation activities via depletion of resources.

These competitive sets of hypotheses will be tested in the following chapters of this thesis.

Chapter 4

Scale development:

Creativity and implementation of innovation measures

This chapter reports the development of measures for assessing creativity and implementation activities within the context of an ongoing R&D project. The relevant dimensions of creativity and implementation are derived based on a review of the innovation literature and discussions with R&D professionals. The three studies conducted for scale development and validation are described.

4.1 Introduction

As was briefly discussed in chapter two, the burgeoning research on organisational creativity and innovation over the last two decades led to the convergence of two research streams that had evolved separately and were mostly independent - creativity and innovation. Creativity research was essentially confined to laboratory settings, grounded in a cognitive framework, and focused on individual processes (e.g., Shalley, 1991), whereas innovation scholars elected organisation as their field of study and were predominantly concerned with analysing the innovativeness of the final product of an innovation process, often an organisational (e.g., Damanpour, 1991) and sometimes a team level outcome (e.g., Drach-Zahavy & Somech, 2001; West & Anderson, 1996). Amabile's (1988) componential model of creativity and innovation in organisations promoted the convergence of the two streams by laying the groundwork for the study of employee creativity.

The conceptual proximity of these two terms has often led to some fuzziness in terms of conceptualisation, operationalisation and assessment. However, as alluded to earlier, creativity and innovation should not be understood as synonyms. Instead, innovation should be perceived as a broader construct encapsulating both the generation of ideas (creativity) and their execution (idea implementation or implementation of innovation) (West, 2002). Theorists agree that both activities are equally important for innovation and this notion is present in many of the different definitions of innovation. For instance, in West and Farr's frequently cited definition, "...the intentional introduction and application within a role, group or organisation of ideas, processes, products or procedures, new to the relevant unit of adoption, designed to significantly benefit the individual, the group, the organisation or the wider society" (West & Farr, 1990, p.9), both the ideas of newness (creativity) and implementation are present.

It is relevant at this stage to recap the adopted notion introduced in chapter two that creativity and implementation are activities rather than stages or phases. Although several innovation models include a series of stages following a sequential pattern, researchers often concede that these sequential patterns are merely illustrative and that innovation is in reality a fuzzy, untidy, non-linear process (King, 1992; West, 1990). Considering the fuzziness of the innovation process and the consequent need for creativity and implementation activities throughout the duration of the process, it is considered more adequate to follow Kanter's (1988) terminology and refer to these concepts as activities of the innovation process rather than try to fit them into a particular timeframe.

Despite their obvious relevance, creativity and implementation activities have not been studied equally. Creativity researchers have focused essentially on assessing the generation of ideas at the individual level (although, as will be discussed later, the measures used are not entirely free from an implementation dimension), whereas at a broader level innovation researchers have generally evaluated the innovativeness based only on the final product of the overall innovation process of teams or organisations. In summary, in work settings, researchers have focused on the generation of ideas (mostly by individuals) or on the final product of the innovation process, usually conceptualised as a team or organisational output.

4.2 Rationale for considering creativity and implementation activities separately

One can conclude from the previous analysis that a fundamental action of the innovation process, the implementation activities carried out by individuals and teams that enable original ideas to be transformed into final products, has not been given the attention it warrants. In the few studies that have directly approached implementation of innovation, the focus was not on describing implementation behaviour or determining its antecedents, but on identifying the organisational conditions that would promote the implementation of innovative projects, such as the strength of an organisation's climate for the implementation of a specific innovation, availability of financial resources, or management support for technology implementation (Klein, Conn, & Sorra, 2001; Klein & Sorra, 1996). It is argued here that to better understand the innovation process within an ongoing R&D project it is necessary to capture both creativity and implementation activities undertaken by team members individually and by the team as whole, rather than just the innovative character of the final product.

There are two main reasons that justify the development of a separate analysis of creativity and implementation of innovation. Firstly, creativity and implementation activities have a different nature and call for different abilities. Action-theories such as the rubicon model of action phases (Gollwitzer & Bayer, 1999) support the notion of a distinctive character of creativity and implementation activities. The rubicon model describes four different sequential action phases (Heckhausen, 1986). The first phase is the predecisional phase, in which potential action goals entailed in a person's wishes are considered. When a decision to pursue one of the goals takes place, a transition to the postdecisional (or preactional) phase occurs. The main concern at this point is to implement the chosen goal. This phase ends when actions toward achieving the goal are initiated, entering the actional stage. Finally, the postactional phase occurs when these actions have resulted in a particular outcome (Gollwitzer, Heckhausen, & Steller, 1990). Deliberation takes place in the predecisional phase, which anticipates the "cross of the rubicon". After this transition, the postdecisional phase takes place, characterised by the planning of actions. This is followed by the actional phase, in which execution is the dominant action. Finally, the postactional phase takes place, characterised by the evaluation of the results.

Drawing an analogy between creativity and implementation activities and the phases referred in the rubicon model, creativity can be associated with the deliberative phase that anticipates action, in which several possible courses for the project are developed, whereas implementation can be linked to the postdecisional and actional phases that take place after the rubicon cross. Particularly relevant is the fact that attempting to solve the tasks that are characteristic of each of these phases elicits a distinct mindset (Heckhausen & Gollwitzer, 1987). In the predecisional phase it is necessary to select different goal options. Therefore a deliberative mindset that tunes cognitive functioning toward the potential positive as well as the likelihood of reaching that goal emerges. On the other hand, in the postdecisional phase, it is necessary to promote goal attainment. Consequently an implementation mindset that gears cognitive functioning towards issues such as when, where, and how to act on the chosen options emerges. Creativity and implementation seem then to be associated with different mindsets. It has been suggested that, since it involves the delivery of unusual solutions, creativity benefits from a more heurist processing style and is thus promoted through divergent thinking, which enables the departure from more mainstream ideas (Eisenck, 2003; Runco, 1991, 1999, 2003). On the other hand, the type of activities needed during implementation – for instance perseverance and attention to errors – appears to be promoted by a more systematic processing style and convergent thinking, as this facilitates focusing efforts on one idea and move it toward its final end (Chaiken, 1980; Chaiken & Maheswaran, 1994; Chen et al., 1996; Trumbo, 1999).

The second argument for analysing creativity and implementation separately relates to the antecedents of these two activities. Given their different nature, it is very likely that creativity and implementation have also different antecedents. Although some factors might influence creativity and implementation activities in a similar fashion, others are likely to display a differential impact. This idea builds into Rank and colleagues (2004) refection on future directions for innovation research. The authors claimed that potential differential antecedents of specific creativity or innovation components had received very little attention and argued this to be one of the major avenues for future research on innovation. This notion is also present in West's (2002) model of team creativity and innovation. The author proposed that external demands such as uncertainty, time constraints, customer demands or competition would inhibit the generation of ideas but would facilitate its implementation. Furthermore, there is also empirical evidence supporting the notion that different components of the innovation process do not share the same optimal predictors. For instance, in a field study involving shop floor employees, Axtell and colleagues (2000) found that individual personal and job characteristics were better predictors of the suggestion of ideas, a measure of creativity, than group and organisational characteristics, whereas the group and organisational characteristics were more strongly correlated with implementation of ideas. Although the conceptualisation of implementation in Axtel and colleagues'. (2000) study was focused on the final product as it addressed the extent to which ideas had or not been implemented, whereas this study defines implementation in terms of the activities individuals and teams have to engage in to attain this final product, their results reinforce the notion that the different components of the innovation process should not be equated together but instead should be given differentiated attention.

In sum, the two main arguments for the separate analyses of creativity and implementation relate to the different nature of these constructs and to the likelihood of them being associated with different antecedents.

4.3 Measurement of innovation activities: Review of existent instruments

A review of the instruments developed in the literature shows that although there are several scales available for assessing creativity or innovative behaviour (Axtell et al., 2000; George & Zhou, 2001; Holman, Totterdell, Axtell, Stride, & Port, 2005; Janssen, 2001; Oldham & Cummings, 1996; O'Reilly III, Williams, & Barsade, 1998; Scott & Bruce, 1994; Tierney et al., 1999), the existing instruments are not adequate for this research project for either or both of the reasons explained below.

Firstly, although most of the authors have conceptually referred to the construct they measured as creativity, the measures applied are not purely assessing creativity, as some of the items do not tap into the generation of ideas but instead capture actions developed toward the implementation of innovation. Examples of this are "Develops adequate plans and schedules for the implementation of new ideas" (George & Zhou, 2001), "Found new uses for existing methods or equipments" (Tierney, Farmer, & Graen, 1999), and "How adaptive and practical is this person's work?" (Oldham & Cummings, 1996).

Scott and Bruce (1994) and Janssen (2001) do acknowledge the integration of implementation activities and refer to their constructs as innovative behaviour. Although it is noteworthy that the dual nature of the innovation process is acknowledged in these proposals, the fact that creativity and implementation activities are not treated independently and comprehensively impedes a stronger understanding of both creativity and implementation of innovation.

The instruments painstakingly developed by O'Reilly III and colleagues (1998) and Holman and colleagues (2005) did conceptualise and assess creativity and implementation separately. However, O'Reilly's instrument is more effective in capturing climate for creativity and implementation than creativity and implementation activities, as illustrated by the items "Mistakes are accepted as a normal part of trying something new" and "Our team has sufficient autonomy to implement new ideas without clearance from above". The reason the instrument developed by Holman and colleagues (2005) was not considered an ideal solution to assess the constructs under analysis in this project follows.

The second reason impeding the application of the existent scales in the present research project pertains to the creativity domain under scrutiny. As described in chapter two, Unsworth (2001) suggested that creativity is not an unitary construct but a heterogeneous one that can be systematised in a two-by-two matrix, based on the nature of the problem (open or closed) and on the driver for engagement (internal or external). The existent scales are in general more appropriate for circumstances in which the driver is internal rather than external, meaning creativity is not part of the role description but instead an extra-role behaviour that employees might engage in or not. Examples of such items in the instruments reviewed are "Suggests new ways of performing work tasks" (George & Zhou, 2001), "Generating organizational solutions for problems" (Janssen, 2001), [changes proposed on] "New targets or objectives" and "Methods to achieve work targets" (Axtell et al., 2000). Consequently, several instruments also include items assessing the capability to acquire support for this extra role idea generated, for example "Promotes and champions ideas to others" (George & Zhou, 2001), "Mobilizing support for innovative ideas" (Janssen, 2001), "Tried to get approval for improvements you suggested" (Holman, 2005) and "Investigates and secures funds needed to implement new ideas" (Scott & Bruce, 1994).

As this project focuses on the factors influencing the generation of ideas and implementation activities developed in the context of a R&D project that calls for innovation – externally driven creativity – items assessing extra-role creativity are not adequate. In this line of reasoning, it was considered necessary to develop and validate two scales capturing the relevant dimensions of creativity and implementation when these are part of the role description.

As it was decided to organise this research around a cognitive information processing framework in virtue of a) information processing being the common element across different creativity and innovation theories and b) the cognitive nature of R&D work, this cognitive underlying framework was also followed in the development of the scales. Accordingly, the dimensions reflect activities that are of a more cognitive rather than behavioural nature.

Next, the theoretical framework for the development of the creativity and implementation of innovation instruments is developed.

4. 4 Theoretical rationale underlying creativity and implementation activities scales

4.4.1 Creativity activities

In order to identify the relevant dimensions for analysing creativity activities within a context in which creativity is expected, this proposal draws on Guilford's (1950) pioneering psychometric theory. Guilford was responsible for the development of creativity research by pointing out that creativity was a relatively neglected field and by leading initial theoretical and empirical approaches to its study. He considered the concept of divergent production (or divergent thinking), one of the five operations of the intellect included in the Structure of the Intellect model (Guilford, 1967), crucial to creativity. Divergent thinking involves a thorough search for information and the consequent generation of several novel answers to problems. It is usually indexed by the fluency, flexibility, originality and elaboration of the mental operations. This type of process is opposite to convergent thinking, in which only a single correct answer exists. Later Guilford (1975) further extended his theory and described a number of components involved in divergent thinking, such as sensitivity to problems, which refers to the ability to identify and recognise problems; fluency, relating to the number of ideas generated when solving a given problem; flexibility, which accounts for the number of different categories provided when answering a given problem; originality, which refers to the extent that the solutions provided are new; and elaboration, defined as the extent to which an idea is more or less complex. In order to promote the development of creativity research, Guilford engaged in the development of psychometric tests to assess creativity, an example being the SOI battery. One of the tests developed is the unusual uses test, in which the participant is asked to generate as many different uses as possible for an object such as a brick or a coat hanger. Torrance (1974) was responsible for the adaptation and further expansion of the creativity tests initially developed by Guilford. Matching the empirical measurements to the theoretical underpinnings of divergent thinking, the answers provided were normally assessed in terms of their fluency, flexibility, originality and elaboration.

Although the psychometric approach has been strongly criticised for reducing creativity to a limited set of abilities (Gruber & Wallace, 2002; Plucker & Renzulli, 2002), it seems that this criticism is fair only to the extent that the tests developed within this approach allowed for a very limited range of behaviours, raising the question about the generalisability of the results to settings outside the laboratory to real (work) situations. However, the use of this framework for deriving relevant dimensions of creativity activities in innovatively demanding work settings is found to be appropriate for two reasons. Firstly, it enables the development of a pure measure of creativity, exempt from contamination of other activities involved in the innovative process. Secondly, the main criticism of being reductive is overcome by the vast array of potential activities that occur in a research and development project and which can be captured by the items tapping into these dimensions.

However, Guilford's theory of creativity does not account for all requirements of a conceptualisation of creativity within organisational settings. As suggested in several organisationally based definitions of innovation, the ideas generated should be "designed to significantly benefit the individual, the group, the organisation or the wider society" (West & Farr, 1999, p.9), meaning that the ideas should be within the context they are developed. The notion that to be creative an idea has to be both original and useful has been supported by the majority of organisational creativity researchers (e.g., Amabile, 1988; West, 2002; Woodman et al., 1993; Zhou & George, 2001). Considering innovatively demanding environments such as the ones inhabited by R&D teams, this criterion is thought to be fundamental, as the generation of a bulk of ideas that is of no use for the project in hand can hinder the successful accomplishment of the project within the expected time frame and consequently be highly detrimental to its overall innovative performance. The usefulness of an idea is directly dependent on its feasibility, the extent to which it can be executed.

In this line of reasoning, the generation of items to assess creativity was anchored in five sub-factors: *fluency*, *flexibility*, *originality*, *elaboration* and *feasibility*.

4.4.2 Implementation activities

Implementation activities are essential in the innovation process. Without implementation of ideas, creativity is an unfruitful process depleted of any value for organisations. In lack of a substantial theory of individual or team implementation in innovatively demanding work settings, this proposal draws on previous models of innovation and creativity and discussions held with R&D professionals in order to identify the dimensions representative of effective project implementation.

4.4.2.1 Decision-making

R&D teams constantly need to make decisions over the course of a project. So although decision-making is common to all teams (Ilgen, Major, Hollenbeck, & Sego, 1995), in R&D the importance of decision-making becomes even more salient because projects are typically characterised by uncertainty and exploration. It is common that at the beginning of a project several possible avenues are suggested and team members are forced to filter these different ideas and decide which one represents the best option. Further, as the project develops and obstacles emerge, team members need to continuously make decisions about how to overcome the difficulties met. Moreover, these teams are in most cases formed by highly skilled professionals who are given sufficient autonomy (and are expected) to make these decisions, which makes the relevance of this dimension even more salient.

Further support for decision-making being an important dimension of implementation derives from previous models of innovation and creativity which also included this facet, although at a different level of analysis. Zaltman, Duncan and Holbeck (1973) considered decision-making, described as the evaluation by organisational decision makers of the potential of an innovation and subsequent decision to develop it or not, one of the five main actions of their two-stage model of innovation. Amabile (1983), based on seminal stage-based models of creativity suggested by Wallas (1926) and Hogarth (1980), included idea validation, described as checking the ideas generated in the previous stage against factual knowledge or other criteria, as the fourth stage of her model of individual creativity. Both these theoretical contributions were developed having in mind a unit of analysis different from the one considered in this project. Zaltman and colleagues' model (1973) focuses on organisational level innovations with emphasis on describing the activities that occur before and after the decision of adopting an innovation by the organisation. Amabile's

(1983) model focuses on individual creativity as sequential cognitive process in which the individual ultimately decides about the most adequate solution to a given problem. In this project the unit of analysis is a research project in which being innovative is an underlying requirement. It goes beyond Amabile's (1983) model by accounting for the implementation activities posterior to the generation of ideas. It differs from Zaltman and colleagues' (1973) model in the sense that decision-making does not concern the evaluation by a top management team about the viability of implementing a given innovation but rather is an ongoing activity that increases after the initial generation of ideas. However, it is equally essential as the project develops and obstacles emerge.

Given the stronger process orientation of implementation activities, effectiveness of decision-making is evaluated not in terms of its impact on the final product or 'right or wrong' criteria based on hindsight information. Instead it is conceptualised as the determination and readiness of individual team members in choosing the ideas that appear to be most beneficial, in contrast to hesitation and delay in making decisions. It is nonetheless possible that when the implementation of the selected idea provides immediate feedback, which is assimilated by team members and managers within the one week window considered in the survey timeframe, these positive or negative results are reflected in their evaluations.

4.4.2.2 Avoiding procrastination

The discussions held with R&D professionals suggested that an indicator of poor implementation of ideas in innovative projects is procrastination. Procrastination is usually defined as an individual trait or a behavioural disposition to postpone or delay executing a task (Milgram, Mey-Tal, & Levison, 1998). It involves the avoidance of implementation of an intention. This intention concerns a behaviour experienced as emotionally unattractive but cognitively important (van Eerde, 2003). Although most of the research on procrastination has focused on identifying traits with which it is associated, recent proposals have also outlined the role of situational factors on the tendency to postpone or delay actions (Steel, 2007). Certain tasks are more prone to procrastination than others. Tasks that involve a degree of anxiety and in which there is a high level of autonomy are more likely to be procrastinated (van Eerde, 2003). R&D projects are generally characterised by task uncertainty given the non-routine nature of the projects and by medium to high levels of autonomy, resulting in a context prone to procrastination. In this line of reasoning, *avoiding procrastination* emerges as one of the dimensions encapsulated by the construct implementation of innovation.

Although *decision-making* also taps into procrastination because it captures the extent to which individuals are swift or not in making their decisions, this dimension focuses simply on the readiness for decision-making, whereas the *avoiding procrastination* dimension refers to the idea of moving the project forward once decisions are made.

4.4.2.3 Overcoming obstacles

The innovation process has an uncertain nature (Kanter, 1988) and consequently the implementation of creative projects is more likely to be challenged by unforeseen circumstances and unexpected obstacles than more standardized projects. R&D teams have often to cope with lack of resources, failure of technology or unexpected findings. As Quinn (1979) described, progress in a new innovation tends to come in spurts among unforeseen delays and setbacks. The unpredictability of innovative projects has also been considered in previous models of innovation. For instance, Schroeder and colleagues' (1989) descriptive model of innovation based on a series of six observations presents "unpredictable setbacks and surprises are inevitable" as the third observation. The ability to overcome the different types of obstacles is of major importance for the continuation of a R&D project and *overcoming obstacles* is therefore considered the third dimension of implementation.

4.4.2.4 Focus and persistence

Given the difficulties arising out of the unpredictability of the project, the fact that R&D projects are qualitatively demanding, and the controversy usually associated with any innovation process (Kanter, 1988), the capability of maintaining a clear focus and persevere in the face of adversity is crucial for effective implementation. *Focus and persistence* is therefore the last dimension of implementation.

As was referred to earlier, these four dimensions have a strong cognitive basis: *decision-making* involves comparison of advantages and disadvantages of different options; *avoiding procrastination*, though closest to having a behavioural nature, is still largely dependent on cognitive decisions to act; overcoming obstacles involves rethinking plans in order to cope with potential difficulties; and, finally, *focus and persistence* links into cognitive resilience.

It is recognised that these dimensions to not exhaust all the activities required for effective implementation, but based on a review of the innovation models and discussions with R&D professionals, it was concluded that they encapsulate the most relevant facets of an effective R&D project development.

A systematisation of the creativity and implementation dimensions described above is presented in figure 4.1.

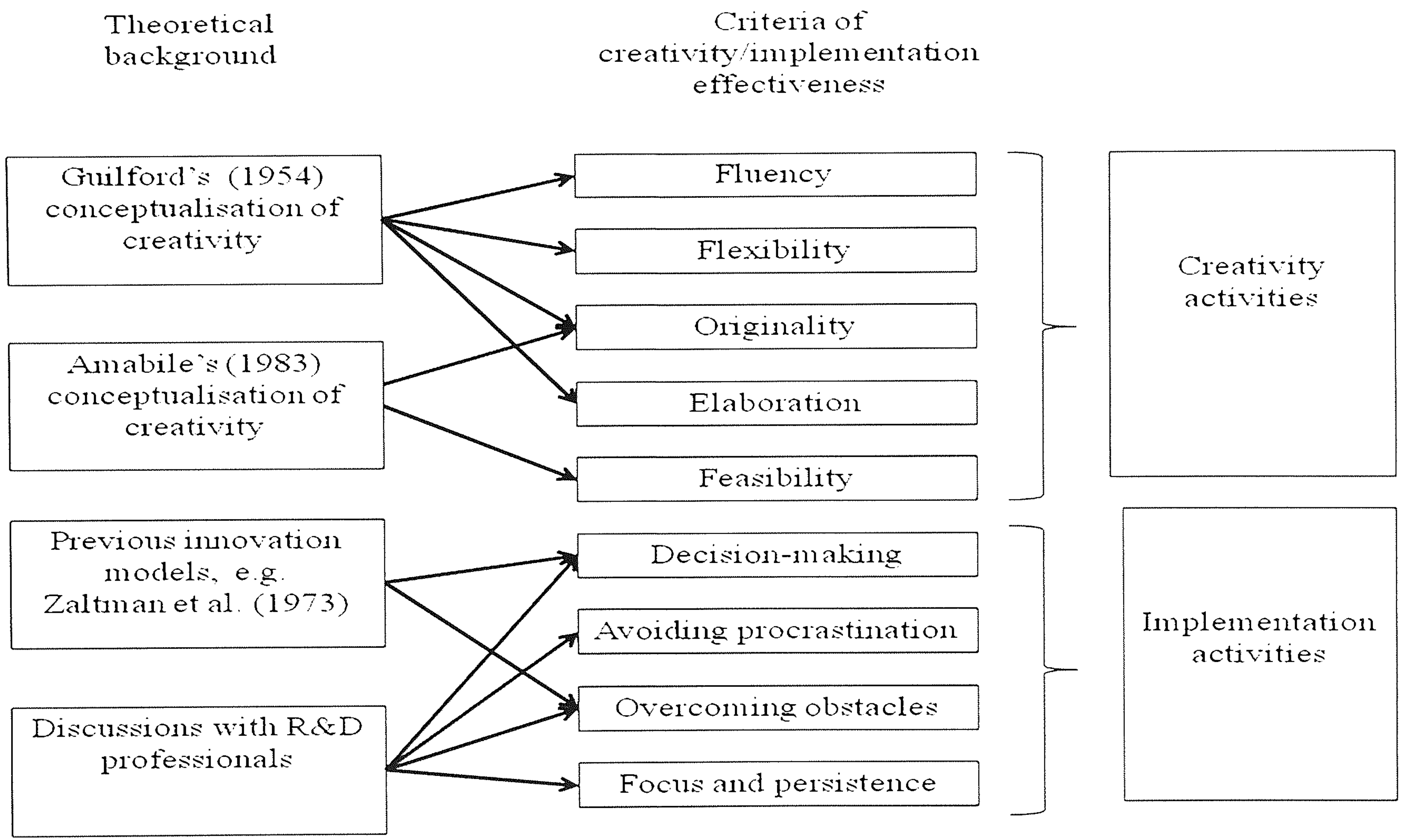


Figure 4.1: A theoretical model of creativity and implementation activities in R&D project teams

Based on this theoretical analysis, the development of the creativity and implementation measures was undertaken. The methodology employed is described in the next section.

4.5 Methodology

4.5.1 Overview

The development of a measure usually follows three stages. The first stage consists of item development, the second focuses on scale development, and the final stage involves scale evaluation (Schwab, 1980). These steps were followed in the development of the creativity and implementation scales. First, a review of the literature guided a selection of items that were scrutinised by peer creativity researchers. Secondly, exploratory factor analysis (EFA) was performed in two pilot studies (study 1, n = 144 and study 2, n = 146). Finally, confirmatory factor analysis (CFA) was performed with two different reference groups, team leaders and team members, in the sample collected for the final study (study 3).

The objective of the two pilot studies was twofold. Firstly, it was important to identify the items that were more efficient in representing the theorised underlying factors. Secondly, it was necessary to reduce the number of items per factor in order to make the application of the questionnaire more feasible. The selection of items was guided both by the results of factor analysis and subsequent analysis of the items, as well as discussion with peers and two R&D samples that filled in these scales prior to the second pilot and the final application. As it is inappropriate to use the same sample for scale development and assessing the construct validity (Campbell, 1976), the first two studies were primarily used for scale development whereas the third study was used to assess construct validity.

4.5.2 Generation of items

The generation of items followed a deductive approach, also called "logical partitioning" or "classification from above" (Hinkin, 1995). Based on a thorough review of the literature, the theoretical definitions of the constructs under examination were developed, as described in the previous sections. The items were then developed to tap into these theoretical definitions. Both adequate domain sampling and parsimony are essential for content and construct validity (Cronbach & Meehl, 1955) and these concerns were present throughout the development of the items. A total of 28 items was generated, distributed by the sub-factors in the following manner: *fluency* (2); *flexibility* (2); *originality* (3); *elaboration* (2); *feasibility* (2); *decision-making* (6); *avoiding procrastination* (6); *focus and persistence* (3); *overcoming obstacles* (2). Two *originality* items, one *feasibility* item and one *avoiding procrastination* item were based on two previously developed scales of *creativity* (Tierney et al., 1999) and *procrastination* (Tuckman, 1991). All items are presented in this order in table 4.1.

In alignment with other measures of creativity (e.g., George & Zhou, 2002), a seven-point response scale ranging from 1 = *Strongly disagree* to 7 = *Strongly agree* was employed. The seven points were considered adequate to generate sufficient variance across respondents.

It is usually recommended that an equal number of negatively and positively worded items is included to avoid response biases (Nunnally, 1978). Accordingly, 11 items across the implementation sub-factors were negatively worded.

To evaluate the extent to which these items assessed the domains of interest (face validity and content validity), a definition of each sub-factor and the associated items were given to two creativity researchers for scrutiny. According to the feedback provided, a number of items that were not perceived to tap into the respective underlying construct were revised. In the next step, three doctoral students conducting research on the topic of creativity and innovation (subject method experts) were given theoretical definitions of the constructs and asked to match the items to the different construct definitions. The items that were erroneously allocated were again revised. Instead of deleting items, it was preferred at this stage to revise them so they would more clearly tap into the respective construct and keep them for the first pilot study. Content validity was reassessed with professional samples after the first and second pilot studies, as will be later described.

4.5.3 Study 1

The objective of the first pilot study was to allow for an initial examination of the psychometric properties of the scales and an analysis of how well the items confirmed the expectations about the structure of the measures. For the sake of legibility, all tables are placed at the end of this chapter.

4.5.3.1 Procedure

The selected items were piloted in a heterogeneous sample of students and professionals.

Students who had participated in syndicate group work involving the development of a two-week project requiring some level of creativity were asked to fill in the scale having in mind their last week of work together (n= 113). The questionnaires were distributed and collected at the time of the submission of the group project. All questionnaires distributed were collected (response rate 100%).

The second part of the sample was collected amongst R&D professionals of a biotechnology institute who agreed to fill in and provide feedback on the scales. Of the 35 questionnaires distributed, 31 (27 team members and 4 team leaders) were collected (response rate 88.6%). Informal short discussions about the meaning and the extent to which the items represented and captured their innovative work were held with these participants on a one-to-one basis.

The limited number of individuals in each sub-sample did not allow for the execution of separate factor analysis for each group, which led to the less optimal solution of having students and professionals analysed jointly. As this constituted solely the first step of the scale validation and another sample would still be collected this was considered an acceptable procedure.

Given that the number of items piloted was 28, the total sample of 144 participants satisfies the absolute minimum ratio of five individuals per each variable suggested by

Gorsuch (1983). It has been reported that in most cases a sample size of 150 cases is sufficient to obtain an accurate solution in EFA, provided that item intercorrelations are reasonably strong (Guadagnoli & Velicer, 1988).

Exploratory factor analysis involves a sequence of decisions regarding factor extraction method, factor rotation and number of factors to be extracted (Fabrigar, Wegener, MacCallum, & Strahan, 1999). The justification for the options chosen in these analyses is briefly described next.

Principal components analysis, which is likely the most frequent extraction method (Thompson, 2004), seeks to identify the group of factors which can account for all the common and unique variance in a set of variables. It assumes that the scores on measured variables have perfect reliability and attempts to reproduce the variance or information in the sample data, rather than the population. A second commonly applied method, principal axes factor analysis, aims to identify the least number of factors which can account for the common variance in a set of variables. Although these methods usually lead to similar conclusions (Wilkinson, Blank, & Gruber, 1996), given the expected correlation between factors, the principal axis factor analysis was elected.

Factor rotation consists of moving the factors axes measuring the locations of the measured variables in the factors space so the nature of the underlying constructs becomes more interpretable (Thompson, 2004). Rotation can follow an orthogonal or an oblique pattern. In the former, the 90° degree angle between factors is maintained so they remain uncorrelated. A typical orthogonal rotation method is the varimax rotation, which focuses on maximising the differences between the squared pattern coefficients on a factor. Oblique rotation on the other hand allows factors to be correlated. Direct oblimin rotation is the most commonly used method for a non-orthogonal solution. Given the expected correlations between the anticipated factors, this rotation method was preferred.

A final decision concerns the number of factors to be extracted. It is usually recommended to use a combination of several methods such as eigenvalues greater than 1.0 (Guttman, 1954), graphic representation on a scree test (Cattel, 1966) or parallel analysis (Horn, 1965). The extraction decision was based on eigenvalues greater than 1.0 (Guttman, 1954) and examination of the scree plot as these are the most commonly used and accessible methods. Variable loadings above the threshold of .35 were considered for each factor.

4.5.3.2 Analysis and results

The factor analysis solution did not support the hypothesised nine factors; instead, the results supported a five factor solution, suggesting that the differences between the five creativity and the four implementation sub-factors were too fine-grained to be perceived in real work settings. Instead, as shown in table 4.1, creativity variables tended to load on two factors whereas the implementation variables tended to load on three different factors. The explained variance is described below. Three factors were left unnamed as the items loading on them belonged to different hypothesised constructs, making impossible a clear understanding of the dominant construct.

Factor 1, *creativity 1*, explained 34.50% of the variance; factor 2 was responsible for 14.52% of the variance; factor 3 accounted for 4.67% of the variance; factor 4, *creativity 2* explained 3.67% of the variance; and finally factor 5 explained 2.56% of the variance.

The analysis of the EFA results and the subsequent refinement of the creativity and implementation scales for the second pilot are described next.

An analysis of the creativity items suggests that these tended to load on two separate factors. The underlying distinctions between the items are probably too fine-grained for people to disentangle these differences in their usual work. The first factor (creativity 1) roughly encapsulated the items related to *flexibility* and *fluency* whereas the fourth factor (creativity 2) roughly held the items initially associated with *originality* and *feasibility*. This is however not absolutely clear, as items supposedly associated with *feasibility* loaded on the first factor as well. Given the uncertainty of the creativity factor loadings, all items with exception of *cr8* – the lowest loading of both factors – were kept for the second pilot study.

The implementation items followed a somewhat more complex pattern. Items *imp1* and *imp2* which belonged to the hypothesised decision-making factor, loaded together as expected. Item *imp5* failed to load with the previous items, loading instead with the *avoiding procrastination* items. A subsequent analysis of this item suggests that this was due to the term "delayed". As such this item was reworded as "The team had difficulties making tough decisions that would have helped the project to get going." Item *imp4* loaded on the second factor of creativity and was therefore removed. A subsequent analysis of this item, "The team selected the most creative ideas", shed light on the reason for this, as the word "creative" leads to an association with the creativity items. Items *imp3* and *imp6* were also removed since they loaded with the group of items associated with *overcoming obstacles* and not the other *decision-making* items.

Avoiding procrastination items all loaded on the same factor, with exception of *imp12*, which was therefore not included in the next stage.

The items developed to capture the *focus and persistence* sub-factor were the most problematic. *Imp13* loaded with the *avoiding procrastination* items, whereas *imp14* loaded negatively on the same factor. These items were removed. Another item reflecting this facet of implementation was generated for the second study, "The team had a clear focus on how to progress" (*imp18* from now onwards). The last item of this suggested factor, *imp15*, presented double loadings in creativity 1 and *overcoming obstacles*. Given the face validity of this item, it was kept but reworded to "Even when things got confusing, we did not lose sight of our project's vision".

Finally, items *imp16* and *imp17*, which belonged to the hypothesised *overcoming obstacles* factor, loaded together as expected. After discussing this facet of implementation with scholars and R&D professionals, another item was included to extend its content validity by accounting for anticipating problems as well. The item generated for the second stage of the pilot was "The team anticipated eventual problems" (*imp19* from now onwards).

Based on discussions with scholars and members that comprised the professional pilot sample, the following items were reworded to more directly tap into the matching construct: *imp8*, "The team wasted some time" was revised to "The team wasted some time while implementing plans"; *imp17*, "The team developed creative solutions for unexpected problems" was revised to "The team developed solutions for unexpected problems while implementing plans"; and *imp16* "The team successfully overcame the obstacles that emerged" was revised to "The team overcame the obstacles that emerged".

A selection of ten creativity items and thirteen implementation items was piloted in the second study.

4.5.4 Study 2

The objective of the second study was to analyse the extent to which the revising of the items that was conducted on the basis of the results of the first study resulted in an improvement of the factor structure and to verify if further alterations were required.

4.5.4.1 Procedure

A set of twenty-three items, presented in Table 4.2, selected from the first study was tested in the second study.

Data was collected via a web-based survey. Web based surveys hold recognised advantages. They are less expensive, more accurate and faster than traditional paper and pencil surveys (Buchanan & Smith, 1999; Krantz & Dalal, 2000; Sproull, 1985). Given that it was the author's priority to survey as many individuals as possible in a short amount of time this method was considered the most suitable. An online survey was developed by the author and the link to it was sent to a convenience sample including a large number of professionals in different fields (approximate sample size of 200). It was indicated that participants should only fill in the questionnaire if they were involved or had been recently involved in a team project involving innovative work. If that requirement was fulfilled, they were asked to fill in the scales having in mind the last week they had work with the team in such project. Participants were also asked to forward the link to colleagues that could potentially fulfil the requirement, as such it is not possible to calculate a response rate. In total, 146 individuals filled in the survey.

In a second step, after the application of the on-line survey, a pilot study involving one R&D team was conducted. The team leader and eleven team members of a R&D team responsible for the development of software filled in a pilot questionnaire including the creativity and implementation scales. In similar fashion to the first study, the questionnaires were delivered at the beginning of a working week and collected at the beginning of the following week. All distributed questionnaires were collected and short discussions with the team members were held in order to collect their feedback about the extent to which the items were clear and applicable to their job. The feedback obtained in this pilot study informed the process of trimming down the number of the items included in each scale for the sake of parsimony. Examples of inputs from these professionals were for instance the non applicability of the item *cr7* "The team generated ideas revolutionary for the field" and the lack of clarity of the item *cr9* "The team presented highly elaborated ideas".

The same analysis procedure as described in the first study was followed.

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4.5.4.2 Analysis and results

The factor analysis solution presented a smaller number of factors, four instead of five, likely a consequence of the smaller and more consistent set of items. As shown in table 4.2, all creativity items tended to load on the same factor, whereas the implementation items tended to load on three different factors, consistent with the previous study. The analysis of the EFA results and the subsequent refinement of the creativity and implementation scales follow.

All creativity items presented unique loadings on the same factor, suggesting a clear and homogenous construct. As the four hypothesised components of creativity developed based on Guilford's (1950; 1967; 1975) proposal plus the *feasibility* factor are not reflected in the factor structure, *fluency*, *flexibility*, *originality*, *elaboration* and *feasibility* were no longer conceptualised as different sub-factors but simply as dimensions of creativity.

The EFA results provided no empirical reason for elimination of items, as all variables loaded uniquely on their underlying construct. As it was necessary to strip down the number of items for the final questionnaire, the elimination of three items was guided by the feedback collected from R&D professionals that piloted the study and scholars interested in the study of creativity and innovation. Items *cr7* and *cr9* were eliminated on the grounds that they were not relevant in real work settings most of the time. Item *cr5* was deleted given that it did not tap into the *flexibility* dimension it should be capturing.

Overall, the implementation variables loaded on the expected factors. The items developed to tap into *focus and persistence* and *overcoming obstacles* once again loaded together. A possible explanation for this relies on the strong link between these two dimensions, as *focus and obstacles* implies that one has to persevere at the task, rather than giving up or following less interesting but easier alternatives. As so it was decided that these dimensions should constitute a unique sub-factor, named *focus and obstacles*. For parsimony sake, item *imp11* was deleted as it presented the lowest loading of all variables.

A selection of seven items tapping into creativity and 12 items representing three different implementation factors, *decision-making* (3), *avoiding procrastination* (4), and *focus and obstacles* (5) was selected for the final test of the scales.

Analysis of the scree plot confirms the selection of four factors, as shown in figure 4.2. The slope decreases sharply between the fourth and fifth factor, suggesting that the four initial factors accounted for the major part of the variance. Factor 1, *creativity*, explained 27.42% of the variance; factor 2, *avoiding procrastination*, was responsible for 18.22% of the variance; factor 3, *focus and obstacles*, accounted for 10.12% of the variance; and finally factor 4, *decision-making*, explained 4.56% of the variance.

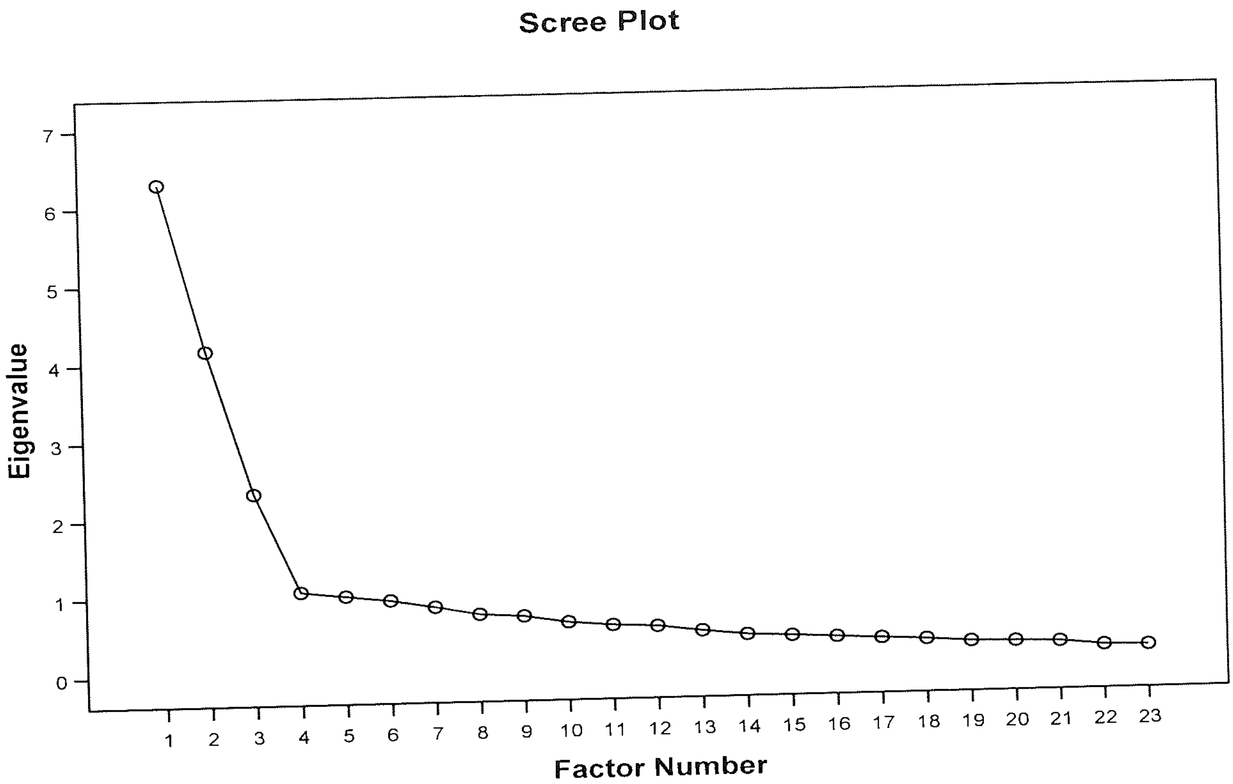

Figure 4.2. Scree plot factors analysis second study

Assessment of reliability constitutes another step in the evaluation of the adequacy of a measure. The two basic concerns about reliability are the consistency of items within a measure and stability of the measure over time (Hinkin, 1995). Stability over time can be assessed for instance with test-retest reliability. The most common measure of reliability is Cronbach's Alpha. All subscales exhibited a Cronbach α above .70: *creativity* α =.858; *decision-making* α =.743; *avoiding procrastination* α =.782; and *focus and obstacles* α =.835.

The results of these two studies imply that the suggested model of creativity and innovation activities which postulated four and five activity factors respectively (cf. figure 4.1), could not be successfully operationalised and measured in the field. Instead, the results suggest a simplification. Data suggest that creativity is best described by one factor, and the implementation activities comprising three factors, *decision-making*, *avoiding procrastination* and *focus and obstacles.*

4.5.5 Study 3

Exploratory factor analysis is useful as an initial test of the theoretical assumptions about the constructs under investigation, since these do not have to be declared and consequently the analysis is not influenced by them. When the theory has already been developed CFA is more useful, as it allows the theory to be directly tested and the degree to which the data fits the model can be quantified in several ways (Thompson, 2004). After having revised the scales based on the EFA results of the two pilots, CFA was used in the third study to directly test the underlying theory and examine construct validity.

4.5.5.1 Procedure

The final stage of scale development coincided with the collection of data for the overall research project. The sample was drawn from a database of 61 companies that had applied and had been granted government funding for the development of a R&D centre. A total of 21 companies participated in the study. The questionnaires including the creativity and implementation scales were sent by mail and distributed by a contact person in each organisation at the beginning of a working week. They were collected personally by the author at the beginning of the following week. The final sample consisted of 150 team members belonging to 57 R&D teams and 51 team leaders. This sample is slightly larger than the one used in the test of hypotheses (chapters five and seven) due to the fact that in the latter analysis data from individuals who had been the only respondent in their teams (by virtue of being the only person working in the project over the week under analysis) had to be deleted whereas these were kept for the present analysis, since there this is no impediment for using such data for scale validation.

The scales were applied both at the individual and team levels. The items initially developed at the team level were reformulated at the individual level by shifting the referent, for example "The team suggested many ideas" to "I suggested many ideas" in the team members' questionnaire and "He/she (name of the R&D team member) suggested many ideas" in the team leaders' questionnaire. Team leaders were asked to evaluate each team member and the team as a whole, whereas team members were solely asked to evaluate their own work. The time reference was consistently one working week.

In order to test for factor invariance across different respondent groups, two sets of confirmatory factor analyses were run separately, the first for the team members sample, in which several competitive models were tested, and the second for the leaders' sample in which the two models found to have the best fit in the first sample were tested again.

For the leaders' group there were two options regarding the referent used for CFA, the individual ratings attributed to each team member or the overall ratings attributed to the team. Given the higher number of cases at the individual level, CFA was based on their ratings of individual members.

More detailed information regarding methodology and sample characteristics is presented in chapter five.

4.5.5.2 Analysis and results

Theorists of scale development suggest that an important step after conducting exploratory factor analysis is testing the hypothesized model with a confirmatory factor analysis using a different sample (Hinkin, 1995). It is however difficult to find a consensus in the literature concerning the most adequate fit indices to be used (Byrne, 2001). Model evaluation is one of the most unsettled issues associated with structural modelling and many different statistics have been proposed as measures of the adequacy of a model (Arbuckle, 2005). Around thirty goodness-of-fit indices are now available (MacKenzie, Podsakoff, & Fetter, 1991). A common indicator is the χ^2 statistical significance test. If the model has an adequate fit, χ^2 should not be significant and so the model is not rejected. However, this indicator is highly affected by sample size and large sample sizes tend to always present significant levels. Another indicator relates to the size of χ^2. The smaller the χ^2, the better the model is considered to be, and it is generally accepted that a χ^2 two or three times larger than the degrees of freedom is acceptable (Carmines & McIver, 1981) but that the closer the χ^2 is to the degrees of freedom, the better the model. χ^2 is also very useful in evaluating the comparative fit of nested models (Thompson, 2004).

In order to overcome some of the problems associated with the χ^2 index, researchers have developed a series of goodness-of fit statistics, which can be classified as incremental or comparative indexes. These indexes are based on a comparison of the hypothesised model against a baseline model. One of the most commonly applied indices used to be the normed fit index (NFI; Bentler & Bonett, 1980). However, researchers have consistently reported that the NFI tends to underestimate fit in small samples. In an attempt to overcome this problem Bentler (1990) revised the NFI to take sample size into account, resulting in the now popular comparative fit index (CFI; Bentler, 1990). The incremental fit index IFI (IFI; Bollen, 1989) was also developed to address the issues of parsimony and sample size which were associated with the NFI. Its computation is basically the same as the NFI, except that degrees of freedom are taken into account. The Tucker Lewis index (TLI, Tucker & Lewis, 1973), also referred to as non-normed fit index (NNFI), was also developed to overcome one of the weaknesses of the NFI. Whereas in the NFI there is no penalty for adding parameters, the TLI has such a penalty. These indexes vary from 0 to 1 and usually values above .90 are considered to represent an acceptable fit (Byrne, 2001). Finally, the root-mean-square error of approximation (RMSEA, Steiger & Lind, 1980) estimates how well the model parameters are able to reproduce the population covariances. Values below .1 are usually considered an indicator of an acceptable fit. Considering the above analysis, the CFI, IFI and TLI and RMSEA are the indexes used to evaluate the fit of the suggested creativity and implementation model.

Before testing the model, the issue concerning negatively worded items was addressed. Despite negatively worded items being useful in avoiding response biases, such items also complicate the interpretation of factor results. If negatively worded items are distributed within one dimension, meaning all items measuring a single factor are negatively worded, a construct irrelevant factor is formed, which shares little or no trait variance with the construct that is supposed to represent. On the other hand, if these items are spread across dimensions, an additional negative wording method factor emerges, which accounts for a substantial part of the variance (Williams, Ford, & Nguyen, 2002). The latter is the case in the present study, given that both decision-making and avoiding procrastination comprise negatively worded items, which may induce some additional shared covariance between these items beyond that attributable to the fact that each of the items reflects a factor that is correlated with the factor associated with the other indicators. Williams and colleagues (2002) suggested that if it is not properly accounted for, the methodologically induced variance can hinder the estimation and interpretation of the parameters in the model such as factor loadings and factor correlations. The same authors described a way of accounting for this variance by allowing the negatively worded items to load on a second factor, the so called reverse coding method factor. This factor should be assumed to be uncorrelated with the substantive latent variables so the model can be identified. This procedure was followed and all the tested models allow the negatively worded items to load on an extra factor orthogonal to substantive latent variables.

The models were tested using CFA with AMOS version 6.0 (Arbuckle, 2005). The four factor structure including all the items selected according to the results from the previous studies (except for one decision-making item which was deleted after checking for scale reliability, see below) were subjected to a CFA in which several competitive nested models were tested against each other. Generally the purpose of the CFA is to compare the goodness-of-fit of rival models. Typically the comparisons are held between a null model, where all items load on separate factors; a single common factor model; and a multi-trait model in which the number of factors matches the number of constructs included in the measure (Jorekog & Sorebom, 1993). The following models were tested: one-factor model including all the items assuming therefore that participants do not differentiate between creativity and implementation; a two first-order factors model, assuming participants do differentiate between creativity and implementation but not between the sub-factors of implementation; a four first-order factors model, assuming that participants distinguish between the four sub-factors equally without assuming an integration of the implementation sub-factors; and finally the hypothesised model, one first order factor for creativity and one second order-factor for implementation comprising three first-order factors. This last model is not nested and therefore the χ^2 difference test was not performed. In order to compare between the best of the nested models (model 4) and the non nested model (model 5) the Akaike information criterion was used. This index can be used to select among competing non-nested models, whereby the model with the smaller AIC fits the data better. The results are presented in table 4.3.

The CFA shows that a structure with only one factor does not fit the data adequately (model 2), neither does a structure with only two factors (model 3). The results show that although the hypothesised model (model 5) presents an acceptable fit, a structure in which the four first order sub-factors are allowed to correlate without any second order factors fits the data better (model 4). In order to verify if the factor structure is invariant across different respondent groups the two models with better fit were reproduced and tested using the ratings attributed by team leaders to each team member. Table 4.4 shows that both the four factor model (4) and the hypothesised model (5) present an acceptable fit, with the CFI, and IFI indices above .90 and RMSEA indices below .1, indicating that model (4) and model (5) fit the two groups reasonably well.

However, similar to what was found in the CFA conducted with the team members' self ratings, the four-factor model (model 4) provides a better fit than the hypothesised model (model 5), with the AIC of model five being smaller than the AIC of model four in both groups.

Given that the confirmatory factor analysis offered support for a four factor structure, the reliability of each of the four subscales was analysed. Considering the self-ratings of the team members, all subscales exhibited a Cronbach's alpha above .70: creativity α =.894; *decision-making* α =.719 (but increased to .775 with the deletion of the third item assessing this sub-factor, *imp5*); *avoiding procrastination* α =.756; and focus and obstacles α =.801

When looking at the ratings of the team leaders, the reliabilities are also all above .70: *creativity* α =.901; *decision-making* α =.783 (but increased to .834 with the deletion of the third item assessing this sub-factor, *imp5*); *avoiding procrastination* α =.906; and *focus and obstacles* α =.886. Given that the *decision-making* scale reliability improved substantial with deletion of one item, *imp5* was removed from further analysis. The list of final items is available in appendix 1.

Taking these results into account, further analysis will consider the four sub-scales *creativity, decision-making, avoiding procrastination* and *focus and obstacles* separately rather than aggregating the last three sub-scales under the umbrella of implementation.

It is important to recognise that the indexes found are not ideal. For instance, although the sample is not very large ($n = 150$) the chi-square test is still significant (an indicator of poor fit) and the TLI index in the leaders' group is below .9. However, given that all the other indexes were satisfactory, the final structure is theoretically sounded, and that different R&D professionals referred to the instrument as an effective tool in capturing their activities within the realm of a project, it was decided that the scales developed were sufficiently good to be applied in the testing of the hypotheses of this dissertation.

4.6 Discussion

The objective of this chapter was firstly to present the theoretical background for the development of measures to assess the outcomes under analysis in this study, creativity and implementation activities within the scope of a R&D project, and secondly to develop, empirically test and validate those theoretically driven measures. The development of measures was found necessary given that the existing scales did not satisfactorily match the constructs the author wished to analyse in the present dissertation for either of the following reasons: a) the measures assessed creativity and implementation activities jointly instead of independently or b) the measures referred to internally driven rather than externally driven creativity, which is more relevant when considering R&D teams.

Based on a literature review of the existent innovation models and discussions with R&D professionals, five creativity sub-factors (*fluency*, *flexibility*, *originality*, *elaboration* and *feasibility*) and four implementation sub-factors (*decision-making*, *avoiding procrastination*, *focus and persistence*, and *overcoming obstacles*) were identified. After development of items matching those factors, three studies were conducted in order to test and improve the instruments. In contrast with the theoretical model (figure 4.1), exploratory FA suggested the existence of only four rather than nine sub-factors, perhaps because in real work settings people are not able to establish such fine grained distinctions. Indeed, the EFA results of the first two studies did not provide evidence for a distinction between any of the five creativity sub-factors. The results also suggested that *focus and persistence* and *overcoming obstacles* should be conceptualised as one rather than two sub-factors. Since these results could be explained within the theoretical framework adopted without violating its central assumptions, the conceptualisation of the creativity and implementation activities was changed in order to better fit the factor structure found. Creativity was conceptualised as one factor including all the different dimensions (with no sub-factors) and implementation was described as integrating three sub-factors instead of four, with *focus and persistence* and *overcoming obstacles* being subsumed under *focus and obstacles*.

The CFA conducted in the third study suggested that instead of having *decision-making*, *avoiding procrastination*, and *focus and obstacles* as sub-factors of implementation, they should not be associated with a second order factor but instead should be conceptualised at the same level as the creativity factor. Although these results are taken into account in the sense that all further analysis are conducted for each factor rather than for the implementation scale as a whole, theoretically it is still argued that these three factors conceptually share more in common with each other than with the creativity factor and they should be referred to as implementation activities.

Although the three studies conducted reflect the painstaking care taken in the development of these measures, it is also important to note some limitations. The development of scales is an extenuating and very demanding process that requires many refinements across several successive studies. In a doctoral project in which the main objective is not the development of a scale but to test a theoretical model for which such instruments are necessary, critical resources are scarce and therefore some compromises had to be made. Namely, the sample size for each study (between 144 and 150) was smaller than what ideally would be required for scale development, which might have led to instable factor structures. It is possible that with a much larger sample the hypothesised initial structure would be supported by EFA. Also related to sample issues, in the first study both professionals and students were grouped together given that neither group on its own would suffice for conducting an EFA. As this was simply the first study, the mixed sample was considered to be a minor problem.

Another weakness of the development process relates to the different referents the scales are meant to assess. The objective was to develop measures that could be employed in reference to both individuals and teams. As such, the ideal procedure would have been to conduct the whole validation process for the two referents separately. Although unlikely, one can speculate that the factor structure is not the same for the two referents, and EFA and CFA of both referents would have allowed to directly test the extent to which the factor structure is stable or not. Due to time and sample constraints it was decided to instead use the team referent in the first two studies and the individual referent in the third study. Although this is not the ideal procedure, the fact that the CFA conducted with an individual referent shows acceptable indexes for the factor structure suggested by EFA conducted with a team referent brings some confidence in the fact that these measures are appropriate to assess both individuals and teams.

4.7 Conclusion

This chapter described the development of measures of creativity and implementation. Firstly, arguments were provided for the separate analysis of these constructs, based on their different nature and potentially different antecedent factors. Next, the relevant dimensions of each construct were developed based on previous innovation literature and discussion with R&D professionals. Finally, the process of development and refinement of the measures through the three studies conducted was described. Results showed that a four first order factor structure fits the data better than the hypothesised model in which the sub-factors loaded on second order factors. In line with these results it was decided to use the sub-scales independently in subsequent analysis.

Table 4.1

Scale development, Study 1: Principal Axis Factor Analysis of Self Report Data Study 1; Principal Axis Factor Analysis, Pattern Matrix, Oblique rotation

	Expected factor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Cr1- The team suggested many ideas	Fluency	**.98**	-.12	-.05	-.04	-.02
Cr2- The team actively suggested new possibilities for the project	Fluency	**.78**	.11	-.13	.17	-.07
Cr3- The team suggested new ideas concerning varied aspects of the project	Flexibility	**.75**	.02	-.03	.04	.05
Cr4- The team suggested very diverse ideas	Flexibility	**.63**	.05	-.21	.18	.10
Cr5- The team suggested very interesting ideas	Originality	**.73**	-.08	-.02	.27	.02
Cr6- The team demonstrated originality in their work	Originality	**.52**	.10	.00	**.47**	-.01
Cr7- The team generated ideas revolutionary to the field	Originality	.05	.06	-.01	**.71**	-.02
Cr8- The team developed well structured ideas	Elaboration	**.45**	.11	.15	.22	.30
Cr9- The team presented highly elaborated ideas	Elaboration	.17	-.04	.14	**.65**	.12
Cr10- The team suggested feasible ideas to the project	Feasibility	**.49**	.10	.08	.09	.21
Cr11- The team generated novel, but operable work-related ideas	Feasibility	.28	-.10	.08	**.61**	.04
Imp1- The team wasted too much time generating ideas	Decision-making	-.15	.04	**.68**	.12	-.06
Imp2- The team spent a lot of time deciding which ideas were worth pursuing	Decision - making	-.04	-.05	**.89**	-.02	-.07

Table 4.1

(continued)

	Expected factor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Imp3- The team selected the most appropriate ideas	Decision - making	.30	.02	-.09	.08	**.51**
Imp4- The team selected the most creative ideas	Decision - making	.09	.01	-.04	**.61**	**.37**
Imp5- The team delayed making tough decisions	Decision - making	.10	**.47**	.21	.09	.20
Imp6- The team correctly weighted the risks and consequences of each decision	Decision - making	-.07	.06	-.12	.16	**.75**
Imp7- The team could have developed the project at a faster pace	Avoiding procrastinati on	.02	**.82**	-.05	.09	-.22
Imp8- The team wasted some time	Avoiding procrastinati on	.02	**.87**	.03	.01	-.14
Imp9- The team procrastinated in the execution of plans	Avoiding procrastinati on	-.12	**.82**	-.07	-.10	.18
Imp10- The team got stuck in neutral even though they knew how important it was to get started	Avoiding procrastinati on	-.12	**.71**	.04	-.02	.22
Imp11- The team reached the end of the week with a backlog of work still to be completed	Avoiding procrastinati on	-.05	**.56**	.04	-.01	.21

Table 4.1

(continued)

	Expected factor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Imp12- Once a decision had been made, the team put ideas into practice very quickly	Avoiding procrastination	.22	.24	.12	-.03	.34
Imp13- The team engaged in the implementation of ideas that were afterwards dropped	Focus and Persistence	.21	**.37**	.24	-.26	.04
Imp14- The team rejected new ideas that would necessitate starting again in another direction	Focus and Persistence	-.15	**-.34**	-.13	.00	-.06
Imp15- The team always kept the same vision about the project to be developed	Focus and Persistence	.37	.07	.09	-.28	**.39**
Imp16- The team successfully overcame the obstacles that emerged	Overcoming obstacles	.10	.09	-.05	.19	**.63**
Imp17- The team developed creative solutions for unexpected problems	Overcoming obstacles	.15	.08	-.11	**.46**	**.34**

N=144

Table 4.2

Scale development, Study 2: Principal Axis Factor Analysis of Self Report Data Study 2; Principal Axis Factor Analysis, Pattern Matrix, Oblique rotation

	Expected factor	Factor 1	Factor 2	Factor 3	Factor 4
Cr1- The team suggested many ideas	Fluency	**.78**	.12	.11	-.04
Cr2- The team actively suggested new possibilities for the project	Fluency	**.79**	-.03	.12	-.02
Cr3- The team suggested new ideas concerning varied aspects of the project	Flexibility	**.81**	-.01	.02	-.01
Cr4- The team suggested very diverse ideas	Flexibility	**.76**	.08	.08	-.17
Cr5- The team suggested very interesting ideas	Originality	**.84**	-.03	-.04	.10
Cr6- The team demonstrated originality in their work	Originality	**.78**	-.04	-.06	.02
Cr7- The team generated ideas revolutionary to the field	Originality	**.56**	-.04	-.08	-.08
Cr9- The team presented highly elaborated ideas	Elaboration	**.38**	.11	-.22	-.22
Cr10- The team suggested feasible ideas to the project	Feasibility	**.36**	-.03	-.34	.14
Cr11- The team generated novel, but operable work-related ideas	Feasibility	**.52**	-.00	-.18	.21
Imp1- The team wasted too much time generating ideas	Decision-making	-.07	.18	-.16	**.59**
Imp2- The team spent a lot of time deciding which ideas were worth pursuing	Decision-making	-.00	.10	.28	**.76**
Imp5- The team had difficulties making tough decisions that would have helped the project to get going	Decision-making	-.13	.20	-.20	**.49**
Imp7- The team could have developed the project at a faster pace	Avoiding Procrastination	-.03	**.47**	.06	.18

Table 4.2

(continued)

	Expected factor	Factor 1	Factor 2	Factor 3	Factor 4
Imp8- The team wasted some time while implementing plans	Avoiding Procrastination	.02	**.82**	.12	.00
Imp9- The team procrastinated in the execution of plans	Avoiding Procrastination	.05	**.80**	-.07	-.12
Imp10- The team got stuck in neutral even though we knew how important it was to get started	Avoiding Procrastination	-.01	**.61**	-.20	.11
Imp11- The team reached the end of the week with a backlog of work still to be completed	Avoiding Procrastination	.04	**.42**	-.02	.30
Imp15- Even when things got confusing, we didn't lose sight of our project's vision	Focus and persistence	.04	-.07	**-.67**	-.08
Imp 18 – The team had a clear focus on how to progress	Focus and persistence	-.02	.13	**-.75**	.05
Imp16- The team overcame the obstacles that emerged	Overcoming obstacles	.04	-.02	**-.86**	.02
Imp17- The team developed solutions for unexpected problems while implementing plans	Overcoming obstacles	.06	.02	**-.67**	-.06
Imp 19 – The team anticipated eventual problems	Overcoming obstacles	-.06	.04	**-.60**	.02

N=146

Table 4.3

Fit Indices of Confirmatory Factor Analysis for the Creativity and Implementation Scales Team Member Self-Ratings

	χ^2	Df	χ^2/df	$\Delta\chi^2$/(df)	CFI	RMSEA	TLI	IFI	AIC
1) Null model	1340.72***	153	8.76		.00	.23	-.14	.00	1412.72
2) 1 Factor	372.88***	129	2.89	967.84(24)***	.79	.11	.72	.78	492.88
3) 2 First-order factors correlated	326.72***	128	2.55	46.16(1)***	.83	.10	.77	.84	448.72
4) 4 First-order factors correlated	**199.65*** **	**123**	**1.62**	**127.07(5)*** **	**.93**	**.07**	**.91**	**.94**	**331.65**
5) 1 second-order factor correlated with one first order factor, 3 first order factors	203.76***	124	1.64		.93	.07	.91	.93	333.76

N=150. CFI, Normed Noncentrality Comparative Fit Index; RMSEA, Root Mean Square Error of Approximation; TLI, Tucker-Lewis coefficient; IFI, Incremental Fit Index; AIC, Akaike information criterion;

Table 4.4

Fit Indices of Confirmatory Factor Analysis for the Creativity and Implementation Scales - Team Leader Ratings

	χ^2	df	χ^2/df	$\Delta\chi^2$/(df)	CFI	RMSEA	TLI	IFI	AIC
4) 4 First-order factors correlated	**274.82*** **	**123**	**2.23**	**NA**	**.91**	**.09**	**.87**	**.91**	**406.83**
5) 1 second-order factor correlated with one first order factor, 3 first order factors	287.24***	124	2.32	NA	.90	.09	.87	.90	417.24

N=150. NFI, Bentler-Bonnett Normed Fit Index; NNFI, Bentler-Bonnett Non-Normed Fit Index; CFI, Normed Noncentrality Comparative Fit Index.

Chapter 5

Methodology: Field study

The objective of this chapter is firstly to explain the rationale for the methodology adopted in the central study of this project and secondly to describe the research design and sample characteristics.

5.1 Research paradigm

The planning of a research project always mirrors the underlying research paradigm. A paradigm can be defined as the representation of the rules, beliefs, values and techniques accepted by any mature scientific field in any given time (Kuhn, 1970). Different conceptualisations of the world, of knowledge, and how knowledge is transmitted are associated with different research paradigms which in turn influence the methods adopted by a researcher. The present research is embedded within a positivist paradigm.

Positivism generally claims the superiority of science over other forms of knowledge and it is driven by an instrumental rationality striving to gain intellectual mastery over nature and society (Delanty, 2002). The two major assumptions of positivism are realism, the idea that realities exist outside of our mind, and objectivism, the idea that objects have meaning independently of any consciousness of them. As the social world exists independently of the individual's appreciation of it, the posture of the knower must be of *value freedom* to discover the true (Crotty, 1998). Positivism also incorporates *empiricism*, the idea that knowledge is restricted to immediate experience and what can be logically derived from that.

According to the positivistic perspective, knowledge can only be obtained through observation, and science is built by means of observation and verification. Consequently, only by using the natural science method it is possible to acquire unambiguous and accurate knowledge about the social world and to uncover general *causal laws* that have the power of explanation (Delanty, 2002).

Accordingly with the positivistic assumptions outlined above, this research is underlined by the notion that it is possible to identify general laws about factors that facilitate or hinder creativity. Also, as it is characteristic of the positivism, the methodology in this research project follows a deductive approach. The hypotheses are derived from a previously developed theoretical framework, they are tested through observation and verification, and the results are analysed and transformed in general laws that feedback to the theory.

5.2 Research methodology

As introduced earlier, the research paradigm exerts great influence over the methodology adopted. Traditionally, a positivistic paradigm is associated with quantitative methods, whereas qualitative methods are underpinned by an interpretivist paradigm. This has led, in the past, to the dichotomisation of qualitative and quantitative methods. More recently, certain theorists argued that a method should not be exclusively associated with one paradigm but researchers should instead use hybrid designs, combining different methods in their research independently of their underlying paradigm, and, by means of triangulation, compensate for the weaknesses associated with each method (Jick, 1983).

A third alternative is offered by a recent theoretical framework (Edmondson & McManus, 2007). Rather than choosing the first position and strictly subscribing to the methods from one paradigm, or adopting the second position and assuming a methodologically eclectic perspective that combines both quantitative and qualitative methods regardless of those being necessary or not, this framework suggests that researchers should ensure their methodological decisions promote a good methodological fit. This means that there should be an internal consistency between the four elements of a field research project: the research question, prior work in the field, the research design, and the contribution to the literature. According to this framework, a key issue to understanding the extent to which one methodology is more or less adequate in addressing a specific research question is the state of prior theory and research in the field of interest. Theories fall along a continuum, from mature to nascent. Mature theories are characterised by well-developed constructs and models that have been studied over time with increasing precision, resulting in a vast body of accumulative knowledge. On the other hand, nascent theories propose tentative answers to novel questions, often merely suggesting new connections among phenomena. Somewhere along the continuum are intermediate theories, which present a provisional explanation of phenomena, often introducing a new construct and proposing relationships between it and well established constructs (Edmondson & McManus, 2007).

When doing research in mature fields, researchers are interested in the test of specific hypotheses, and this is better served by the use of quantitative methods.

Application of qualitative methods in these cases tends to lead to a misfit problem dubbed by Edmondson and McManus (2007) as "reinventing the wheel", in which the study findings are too obvious or already well-known. In such settings, the use of qualitative methods to complement quantitative methods is also considered by the authors to be redundant and bereft of any added value. In nascent fields, because little is known, it is necessary to acquire first rich and evocative data, and these are obtained via qualitative methods such as interviews and observations. The use of an hybrid method would not bring any advantages, as statistical tests are at this stage likely to be misleading, contradicting the existence of emergence constructs suggested by qualitative methods, and a quantitative method on its own would not be more than a "fishing expedition" (Edmondson & McManus, 2007). Finally, intermediate research, because it draws from prior work to propose new constructs and/or provisional theoretical literature, can benefit from the use of both qualitative and quantitative data to increase confidence that the researcher's explanations of the phenomena are more plausible than alternative explanations (Edmondson & McManus, 2007).

The state of the field in the present research can be considered closer to the mature end of the continuum. All central constructs – stressors, mood, and innovation – are well established (Amabile, 1988; Sonnentag & Frese, 2002; Watson, Clarck et al., 1988) and the objectives of the research are to test specific hypotheses and to develop a supported theory that may add specificity, new mechanisms, or new boundaries to existing ones. Although the two outcome measures were developed specifically for this study, these do not constitute new constructs but are rather a translation of existing constructs within the innovation literature to the domain of an ongoing R&D project. Accordingly, this research places little emphasis on qualitative methods. Although the informal discussions held with R&D professionals when developing the creativity and implementation scales, and after each pilot study, have a strong qualitative character, the bulk of the project and the test of hypotheses rely solely on quantitative methods. The method selected is the field survey. In addition, and also within a quantitative framework, an experimental study was conducted (see chapter nine), but this chapter reports exclusively on the field study.

A field survey generally involves the collection of data, predominantly by questionnaires or structured interviews at a point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables, which are afterwards examined to identify patterns of association (Bryman & Bell, 2003). The use of questionnaires became very popular in organisational psychology, essential due to the simplicity of its application. This method is suitable for the present project as it enables obtaining data from a considerable large sample which will afterwards allow the testing of the hypotheses suggested and the generalisation of the results. One of the main advantages of this method is that it enables the collection of a large amount of information in a relatively short period.

5.3 Study design

The field study followed a cross-sectional design. Although a longitudinal study would have been preferable, the majority of companies agreed to participate as long as their employees would be required to complete the questionnaires only once, so a second collection wave was deemed impossible. Albeit a longitudinal design would have been advantageous in terms of, for instance, clarifying causal relationships, the cross-sectional design still enables testing the hypotheses under analysis in this project and consequently this was not considered to be a critical weakness of the study.

In order to avoid common method variance, predictor variables were collected from team members, whereas the leader (or direct supervisor, as the terminology varied across organisations) provided data regarding the outcome variables. As in order to complete the innovation activities questions respondents had to be very familiar with the work developed by each team member over the period of a week, it was not considered adequate to ask a person external to the team (such as an independent line manager) for such ratings, as someone who was not present during the project's daily activities would not have the required proximity to develop such knowledge.

Two different questionnaires were developed, one intended for the team leaders and another one to be completed by the team members. The instruments were piloted in two separate occasions and the final study took place after the revisions were conducted. Table 5.1 illustrates the steps followed until the application of the final questionnaire.

Table 5.1:

Field study design

	Piloting T1	Piloting T2	Main study
Sample	27 R&D team members, 4 team leaders	11 R&D team members, 1 team leader	123 team members, 41 R&D project teams
Team members' questionnaire	X	X	X
Team leaders' questionnaire	X	X	X

5.4 Piloting

As reported in chapter four, the first pilot sample included 27 team members and 4 team leaders from a Portuguese national biotechnology institute dedicated to support research and development. Succinctly, the questionnaires were distributed at the beginning of a working week and the researcher collected them at the start of the following working week. At this point the researcher held informal meetings with the participants, both on an individual and group basis, according to their availability. Participants were asked to comment specifically on the innovation activities items and generally upon other measures included in the questionnaires. They were asked about the extent to which they had felt the items were meaningful in their work. Based on their comments, the instruments were reviewed and prepared for the second pilot. (Note that this sample was also included in the factor analysis of the first study conducted for scale development, as described in chapter four.)

The team that participated in the second pilot was part of a private Portuguese software development company. It involved 11 team members and one team leader. The procedure followed was similar to the one described above. Again, after the collection of questionnaires, informal meetings were held with participants; based on these, the instruments were further revised and prepared for the final study.

5.5 Access negotiation

Simultaneously with the piloting of the questionnaires, the investigator started seeking organisational access in order to initiate data collection. The difficulties associated with the specificity of the sample required led to a long period of intensive quest. After several failed attempts, the investigator established contact with a Portuguese governmental centre that provides funding for companies in the R&D sector. The centre agreed to support the project and provided the investigator with a database of companies that had successfully applied for government funding for the development of an R&D centre. The sample was drawn from this database which included 61 companies. All companies were sent a brief description of the research project and an invitation to participate in the study. These companies were contacted via phone a week later. Seventeen companies informed the investigator that their research centres were not yet organised and therefore they could not participate in the study. Ten companies argued they could not participate due to lack of time. No answer was received from eight companies. Four companies said they would participate but subsequently failed to send the required information. One company was sent the questionnaires but failed to schedule a meeting for collection. A total of 21 companies participated in the study, 34.4% of the original database.

5.6 Study procedure

Each company that agreed to participate was asked to appoint a contact person responsible for providing the investigator with the necessary support throughout the project. This contact person was asked to identify the R&D project team(s) that was eligible to participate in the study, this participation being conditional on (a) the project having an innovative nature (b) at least two team members working on the project during the week of collection, and (c) the leader having sufficient contact with the team members to enable him or her to complete the innovation activities questions.

The contact person also provided details of all team members participating in the team project during the week of the study. Members who had been in the team before, but were no longer involved as skills were no longer required (R&D teams tend to follow a cross-functional structure), were not asked to fill in the questionnaires, and neither were members who, although still involved, during the particular week in question had not contributed to the project.

As the questionnaires referred to a one-week period and had to be filled in in a very short time frame, it was agreed individually with each contact person when it would be more convenient for their teams to participate. Overall, the collection of data lasted approximately 12 weeks.

On the Friday before the questionnaires were distributed, the team leader and team members, who had also already been informed by the contact person, were sent an email by the investigator informing them of the general purposes of research – understanding how work in teams influences innovation, saying that their participation would be voluntary and anonymous, and enhancing the value of their contribution. The email also invited participants to contact the investigator if they had any questions.

The questionnaires were sent by mail and distributed by the contact person in each organisation at the beginning of a working week. Individual envelopes with the name of each participant written were posted to the contact person, who was in charge of distributing them. In order to ensure that participants were clear about which project they should be referring to when completing the questions (it is common in R&D for people to work concomitantly on different projects), each questionnaire had written on its cover the name of the project team and the week to which that research referred. Each questionnaire also contained a secret code that linked it to the name of the participant who had filled it in. Only the investigator was aware of these associations. Inside there was also a blank envelope in which participants were asked to insert their questionnaires once they were completed. Although on most occasions the researcher collected the questionnaires from each team member, on a small number of occasions team members gathered all envelopes together and asked a team representative who would be present at the time of the collection to hand them in. Anticipating this, it was considered critical to ensure that these questionnaires would not contain any information that would allow other individuals to uncover the identity of the respondent. Along with the questionnaires was also sent a box of chocolates per team as a token of gratitude.

At the end of the working week the investigator sent another email thanking the R&D team members for their participation and informing them of the exact day of the following week when they should expect the investigator to visit in order to collect the questionnaires.

5.7 Sample characteristics

5.7.1 Sample size

Given the small number of eligible participants per team, and the responsibility imposed on the participants by the visit of the investigator to collect the questionnaires on the scheduled date, virtually all questionnaires were returned. The few misses were due to the fact that participants who had been appointed as team members were no longer involved in the project, or due to absence of the participant during the week on sickness leave. In either case these participants would not fulfill the criteria for participating, as they were not active members during the week under scrutiny. Responses of 150 team members belonging to 57 R&D teams, and of 51 project leaders, were collected. Sixteen teams were excluded from the analysis as they consisted solely of one project leader and one team member, resulting in a final sample of 41 R&D teams, including 123 team members and 36 project leaders from 18 organisations.

5.7.2 Demographics

5.7.2.1 Project teams

The R&D projects were representative of several different areas, such as biotechnology, software development and food industry. There was a larger variation concerning the expected duration of the project, partially a reflection of the different types of industry involved – project length varied from four weeks to nine years, with an average of 1.7 years. The majority of the projects consisted of new product or process development (75.6%); 12.2% were related to technical services, and 7.3% were applied research.

5.7.2.2 Team members

A total of 123 project members was included in the final sample of this study. As it is typical of the R&D industry, the sample was very young: team members' average age was 30.8 years. Also reflecting the gender distribution in R&D, 87.8% of the participants were male. Average professional tenure was 5.97 years. Concerning education level, 3.3% held a PhD, 8.1% a masters degree, 77.2 % a bachelors degree (usually a five year degree in Portugal), and 4.1% had completed high school.

The average age of the thirty-six project leaders was 32.6 years, 80.5% were male and average professional tenure was 7.00 years. Doctoral degrees were held by 4.9% of the project leaders, 17.1% had a masters degree and 78% had a bachelors degree.

5.8 Instruments

5.8.1 Team members' questionnaire

Attached to each questionnaire was an introductory page that explained the objective of the study, assured respondents of the confidentiality of their responses, and informed them of the voluntary nature of their participation. This introductory page also informed participants about the estimated time required to complete the questionnaire and contained an example of how to fill in the questionnaire.

Team members' questionnaires included demographics, measures of the constructs under analysis in this study, and other additional measures that are not central to this particular research question.

5.8.2 Team leaders' questionnaire

Although the leaders had already agreed to participate in the study, attached to their questionnaires was also a covering letter that explained the objective of the study, assured them that their ratings were confidential, and informed them of the voluntary nature of their participation.

Team leaders' questionnaires included questions about individual and team demographics and the innovation activities measures. Leaders were asked to rate the team as a whole, and each team member in particular, regarding their creative and implementation activities over the current working week. The name of each team member had already been included in the questionnaires by the investigator.

5.8.3 Translation of items

The questionnaire was developed in English but applied in Portugal. When applying an instrument in a country with a different language it is necessary to ensure that the items do not lose their meaning. In order to minimise this risk the recommendations issued by Brislin(1986) were followed. The instrument was translated to Portuguese by a bilingual speaker and afterwards retranslated to English by another translator. Two English native speakers that were also familiar with organisational behaviour theories compared the two versions for possible discrepancies (Brislin, 1986). Any misalignments were corrected. This version was afterwards subjected to two pilot studies in which the understating of the items was discussed with the R&D professionals.

5.8.4 Time frame

The majority of the measures collected (stressors, mood, innovation activities) asked participants to consider only the week under analysis when responding. By asking both team members and team leaders to have in mind only the last week when reporting about stressors and mood (in the case of team members) or employee innovative activities (in the case of team leaders), this study avoids previous methodological weaknesses regarding mismatches in the time-frame for the mood and creativity assessments. For instance, George and Zhou (2002) asked employees to report upon their levels of negative and positive affect experienced over the course of a particular week but asked supervisors to rate the general creativity of employees rather than the creativity displayed over the same week, which makes the logical connection between supervisor ratings and employee mood seem problematic.

5.9 Measures

Issues of validity and reliability were paramount in the choice of the measures used to ascertain the construct included this study. All constructs (aside from innovation activities) were therefore measured using existing pre-validated measures and multiple scale items. Details on each measure are provided below; the complete list of items is provided in the appendix 1.

5.9.1 Stressors

5.9.1.1 Individual stressors

Quantitative job demands were measured using a six item scale adapted from Janssen (2000). Examples are "I had to work fast", "I had to work under time pressure". The rating scale was from 1 = *Never* to 4 = *Always*.

Qualitative overload or qualitative demands was assessed using the five items included in the Stress Diagnostic Survey (Ivancevich & Matteson, 1980) that address this construct. Examples are "The demands of work quality made upon me were unreasonable" or "My tasks seemed to be getting more and more complex". The scale ranged from 1 = *Never* to 7 = *Always*.

Role ambiguity was measured using five items previously applied by Peterson and colleagues (1995) in a cross cultural study. Examples are "I knew exactly what my responsibilities were" and 'I knew exactly what was expected of me" (both reverse coded). The rating scale was from 1 = *Totally disagree* to 5 = *Totally agree*.

5.9.1.2 Team stressors

Team Stressors. Using a reference shift model (Chan, 1998), all stressor measures were also collected using a team referent instead of an individual referent, for example "We had to work fast" and "We had to work under time pressure".

5.9.2 Mood

Positive and negative mood were assessed using the PANAS scale (Watson, Clarck et al., 1988), which is underpinned by a bidimensional conceptualisation of positive and negative affect (see chapter three for more details). The scale includes ten positive mood items (e.g., attentive, interested, excited) and ten negative mood items (e.g., irritable, ashamed, afraid). Participants were asked to rate the extent to which they had felt like it was described by each item over the last week on a scale from 1 = *Not at all* to 5 = *Very much*. Although it might be criticised that participant's retrospective ratings of their moods can be affected by memory biases, it has been empirically demonstrated that mood ratings provided by participants for the whole previous week are very similar to the average of their daily mood ratings, lending some support for the validity of this measurement (Parkinson, Briner, Reynolds, & Totterdell, 1995).

5.9.3 Innovation activities

5.9.3.1 Individual innovation activities

In order to clearly disentangle creativity and implementation activities, new scales were developed (see chapter four). Items capturing creativity and implementation relevant activities in the context of an R&D project were generated based on a literature review. These items were tested and refined in three separate studies. Exploratory and confirmatory factor analysis during scale development showed that four factors encapsulated the different facets of innovation activities: *creativity*, *decision-making*, *avoiding procrastination* and *focus and obstacles*.

The creativity activities scales consisted of seven items. Examples are "Suggested many ideas", "Suggested feasible ideas for the project" (1 = *Not true at all* , 7 = *Absolutely true*).

Decision-making was evaluated using two items, "Wasted too much time generating ideas" and "Spent a lot of time deciding which ideas were worth pursuing" (both reverse coded).

The avoiding procrastination measure consisted of four items; examples are "Procrastinated in the execution of plans" and "Got stuck in neutral even though he/she knew how important it was to get started" (both reverse scored).

Focus and obstacles was assessed using five items. Examples are "Had a clear focus on how to progress", and "Overcame the obstacles that emerged".

All innovation activities items were measured on a seven -point likert scale ranging from 1 = *Not true at all* to 7 = *Absolutely true.*

5.9.3.2 Team innovation activities

Again following a reference shift model, innovation activities items were collected also in relation to a team referent. These measures are included in appendix 1.

5.9.4 Control variables

In order to reduce the probability that other variables likely to affect innovation activities would confound the relationships examined in this research, a number of variables were included in the analyses as controls. These controls were both at individual and team levels as individuals were nested in teams their output was also likely to be confounded by team-level factors that affect their work. Individual level controls were age, gender and education. Age and gender have been identified as predictors of creativity and therefore they were included in the regression models as controls (Baer, 1997, 1998; Simonton, 1988). Gender was coded as 1=*female*, 2 =*male*. Previous research showing that education has positive effects on creativity (Zhou, 2003) justifies its inclusion as a control variable. Education was measured on a scale that ranged from 1 = High school to 4 = Doctoral degree.

At the team level, team size, project length, project stage and creativity requirements over the week were identified as potential confounding factors and included in the analysis. Team size was found to have an influence on innovative behaviours (Curral, Forrester, Dawson, & West, 2001) and this was assessed by asking project leaders how many individuals were considered team members within a certain project. The development and organisation of a project is influenced by the length allocated to it, and team dynamics are likely to differ if the team is expected to devote four weeks, rather than four years, to a given project. It seems logical to expect that in short projects all activities are concentrated in small periods and therefore both creativity and implementation activities will be very intense, whereas in longer projects actions will be usually more delayed and creativity and implementation activities, although always present, will be less intense and more diluted over time. Projects' length was assessed by asking project managers how much time had been allocated to the execution of the project. As observed by Gersick (1988; 1989), teams change their functioning style across project stages, and a major transition in teams' approach toward their work takes place at the midpoint of their allotted time. Because this different functioning is likely to have repercussions in terms of creativity and implementation outputs, the stage of the project was included as a control variable. Stage was coded 0 or 1, depending on whether teams had yet used fifty percent of the time allocated to the project. Finally, although all projects required creativity, it is natural that the extent of this requirement varied across projects and within projects, and even more natural that this also varies across weeks (Unsworth, Wall., & Carter, 2005). In order to control for these differences a one-item measure was developed based on Unsworth's (2005) work. Project leaders were asked to what extent they agreed with the statement "Over last week, this project required the team to be creative" (scale ranging from 1 = *Totally disagree* to 7 = *Totally agree*).

Given the relatively large number of organisations involved (18) and the relatively small number of teams, it was considered statistically ineffective to control for organisational belongingness as this would require the inclusion of 17 dummy variables in the regression equations, which would lead to a significant loss of power. As the projects were in general equally distributed across organisations, and there was no main effect of organisation on either creativity or implementation activities, this solution was deemed acceptable. Similarly, the type of R&D also did not have a significant effect on any of the outcomes and therefore was also not included as a control variable.

The next chapter presents the reader with the testing of the hypotheses outlined in chapter four.

Chapter 6

Analyses and results:

Testing individual level hypotheses

This chapter presents the results of the statistical analyses performed on the data collected by means of the questionnaire survey described in chapter five. Firstly, the psychometric properties of the data set are analysed. The factor analysis results, scale reliability tests and correlational results are introduced. Multilevel analyses are then conducted in order to test the hypotheses drawn in chapter three. This chapter concludes with a discussion of the results, theoretical contributions and practical implications.

6.1 Factor analysis results

This study includes three stressor variables that share a similar theoretical background; although they were assessed using well validated scales it is still important to ensure that these are indeed different constructs. The distinctiveness of the stressor constructs included in this study was tested using exploratory factor analysis (EFA) techniques. Similar to the EFA strategy adopted when developing the creativity and implementation scales (see chapter four), principal axis factoring and direct oblimin rotation were employed as methods of extraction and rotation, respectively. Table 6.1 presents the results of the EFA including the items capturing quantitative demands, qualitative demands, and role ambiguity. As expected, the results show a clear three-factor structure, providing evidence for the distinctiveness of the three stressors.

6.2 Means, standard deviations, zero-order correlations, and reliabilities

Means, standard deviations, zero-order correlations, and reliabilities of the observable study variables are presented in table 6.2. Cronbach's alpha coefficients for all scales were above .78, showing good scale reliability (in terms of internal consistency).

6.3 Test of hypotheses

The relationships between individual stressors, mood and individual innovation activities were considered within a hierarchical linear model (Bryk & Raudenbush, 1992). The use of ordinary regression analysis would possibly have led to unreliable results because individuals in the same group share common influences, so that the assumption of independent observations would be violated (Bryk & Raudenbush, 1992). The hierarchical linear model takes into account between-group variability as well as within-group variability in the variables of interest. Multilevel data analysis was performed using the HLM6 computer package (Raudenbush, Bryk, Cheong, & Congdon, 2004).

In order to test the individual level hypotheses the strategy outlined by Hofmann (1997) was followed. The first task of a hierarchical analysis is to show that significant between-group differences exist for the dependent variables of interest (Hofmann, 1997). Four null hierarchical models (having no explanatory variables) with creativity, decision-making, avoiding procrastination and focus and obstacles as dependent variables were tested. The results provided evidence of significant between-group variance in creativity, χ^2 (38, N=39) 169.63; p = .00); decision-making χ^2 (38, N=39) = 201.71; p = .00); avoiding procrastination χ^2 (38, N=39) = 192.98; p = .00); and focus and obstacles χ^2 (38, N=39) = 78.27; p = .00), justifying conducting further analysis using a hierarchical linear model. Using the interclass correlation coefficient provided by Hofmann, Griffin, and Gavin (2000) it was found that for creativity, decision-making, avoiding procrastination and focus and obstacles, respectively 44.2%, 35.6%, 38.6% and 71% of the variance resided within groups, whereas 55.8%, 64.4%, 61.4% and 29% of the variance resided between groups.

6.3.1 Testing of main effects – procedure adopted

In order to test the hypotheses referring to main effects an intercepts as outcomes model was employed.

For analysing the main effect of each stressor and positive and negative mood on each of the four innovation activities, each predictor was entered as level-1 slope in separate models, while controlling for age, gender and education. At the group level, project length, team size, stage of the project and requirements for creativity over the week were controlled as level-2 intercepts. Due to limitations associated with the HLM program it was not possible to include all predictors in a single equation. When the level-2 sample size is relatively low, as is the case in this sample, only a limited number of level-1 variables can be handled. The same situation occurred when trying to test the interaction models. Given the impossibility of including all the variables in one equation, the following alternative procedure was adopted: several analyses were performed, always including all the individual and team control variables, and testing each stressor and each mood variable in separate analyses.

Below is presented an example of a model testing for main effects, in this case of quantitative demands.

Level-1:

Y (Individual Creativity) = $\beta_0 + \beta_1$ X gender + β_2 X age + β_3 X education + β_4 X quantitative demands + e,

Level-2:

$\beta_0 = \gamma_{00} + \gamma_{01}$ X week creativity requirements + γ_{02} X project length + γ_{03} x Stage + γ_{04} X team size+ $v_{0,}$

$\beta_1 = \gamma_{10,}$

$\beta_2 = \gamma_{20} + v_{2,}$

$\beta_3 = \gamma_{30} + v_{3,}$

$\beta_4 = \gamma_{40} + v_{4,}$

where Y refers to the individual outcome of interest (in this case creativity), β_0 refers to intercept, β_1 refers to slope gender, β_2 refers to slope age, β_3 refers to slope education, β_4 refers to slope quantitative demands, e refers to the overall error term, γ_{00} refers to the intercept of level-2 predicting $\beta_{0,}$ γ_{01} refers to the slope of level-2 regression (week creativity requirements) predicting $\beta_{0,}$ γ_{02} refers to the slope of level-2 regression (project length) predicting $\beta_{0,}$ γ_{03} refers to the slope of level-2 regression (stage) predicting $\beta_{0,}$ γ_{01} refers to the slope of level-2 regression (size) predicting $\beta_{0,}$ v_0 refers to the error term of the level-1 slope β_0, γ_{10} refers to the intercept of level-2 predicting β_1, γ_{20} refers to the intercept of level-2 predicting β_2, v_2 refers to the error term of the level-1 slope β_2, γ_{30} refers to the intercept of level-2 predicting β_3, v_3 refers to the error term of the level-1 slope β_3, γ_{40} refers to the intercept of level-2 predicting β_4, v_4 refers to the error term of the level-1 slope β_4. For the main effect under analysis to exist the term γ_{40} has to be significant. All the error terms of the level-1 slopes were allowed to vary across groups except for gender. Given that the majority of the sample was male, there was not much variance across groups regarding this variable and so this parameter was kept fixed (Snijders & Bosker, 1999).

6.3.2 Testing of interaction effects – procedure adopted

The interaction hypotheses were also tested by means of an intercepts as outcomes model. In order to test the interactions, six interaction terms were initially computed, one between each of the stressors and both positive and negative mood. The correspondent interaction term as a level-1 slope was then added. As explained, each interaction was tested separately for each of the four outcome measures. The following equation is an example of how the model was tested. This represents the model testing the existence of an interaction between quantitative demands and positive mood to predict creativity.

Level-1:

Y (Individual Creativity) = $\beta_0 + \beta_1$ X gender + β_2 X age + β_3 X education + β_4 X quantitative demands + β_5 X positive mood + β_6 quantitative demands X positive mood + e, Level-2:

$\beta_0 = \gamma_{00} + \gamma_{01}$ X week creativity requirements $+ \gamma_{02}$ X project length $+ \gamma_{03}$ x Stage $+ \gamma_{04}$ X team size$+ v_{0,}$

$\beta_1 = \gamma_{10,}$

$\beta_2 = \gamma_{20} + v_{2,}$

$\beta_3 = \gamma_{30} + v_{3,}$

$\beta_4 = \gamma_{40} + v_{4,}$

$\beta_5 = \gamma_{50} + v_{5,}$

$\beta_6 = \gamma_{60} + v_{6,}$

where Y refers to the individual outcome of interest (in this case creativity), β_0 refers to intercept, β_1 refers to slope gender, β_2 refers to slope age, β_3 refers to slope education, β_4 refers to slope quantitative demands, β_5 refers to slope positive affect, β_6 refers to the slope of the interaction, *e* refers to the overall error term, γ_{00} refers to the intercept of level-2 predicting $\beta_{0,}$ γ_{01} refers to the slope of level-2 regression (week creativity requirements) predicting $\beta_{0,}$ γ_{02} refers to the slope of level-2 regression (project length) predicting $\beta_{0,}$ γ_{03} refers to the slope of level-2 regression (stage) predicting $\beta_{0,}$ γ_{01} refers to the slope of level-2 regression (size) predicting $\beta_{0,}$ v_0 refers to the error term of the level-1 slope $\beta_{0,}$ γ_{10} refers to the intercept of level-2 predicting $\beta_{1,}$ γ_{20} refers to the intercept of level-2 predicting $\beta_{2,}$ v_2 refers to the error term of the level-1 slope $\beta_{2,}$ γ_{30} refers to the intercept of level 2 predicting $\beta_{3,}$ v_3 refers to the error term of the level-1 slope β_3 γ_{40} refers to the intercept of level-2 predicting $\beta_{4,}$ v_4 refers to the error term of the level-1 slope β_4 γ_{50} refers to the intercept of level-2 predicting $\beta_{5,}$ v_5 refers to the error term of the level-1 slope β_5 γ_{60}

refers to the intercept of level-2 predicting β_6, v_6 refers to the error term of the level-1 slope β_6. For the interaction between the stressor under analysis and positive mood to exist the interaction term γ_{60} has to be significant.

6.3.3 Testing of main effects – results

Table 6.3 reports the HLM results on the impact of each of the three stressors and type of mood on the different innovation activities. (This table refers only to the predictor variables, a table including the control variables is placed in appendix 3, table 6i.)

The results show that from the three stressors only role ambiguity had a significant impact over different activities of the innovation process: it affected creativity, γ =.21. *SE* = .09, $t(38) = 2.41$; $p = .02$, and decision-making γ = -.023. *SE* = .08, $t(38) = 2.87$; $p = .01$. Also, the impact of role ambiguity on avoiding procrastination was marginally significant, γ = -.20. *SE* = .11, $t(38) = 1.79$; $p = .08$.

The impact of the quantitative demands and qualitative demands on the different innovation activities was not significant.

Concerning the effects of mood, positive mood was found to positively affect focus and obstacles, γ = .25, *SE* = .09, $t(38) = 2.63$ $p = .01$. Negative mood was found to negatively affect creativity, γ = -.23, *SE* = .10, $t(38) = 2.17$; $p = .03$, and had also a marginally significant impact on focus and obstacles, γ = .-20, *SE* = .12, $t(38) = -1.65$; p = .1.

For the sake of completion potential curvilinear effects of stressors and mood were also investigated. A quadratic term for each stressor and both positive and negative mood was computed and included in the correspondent HLM model. No curvilinear effects were found.

6.3.4 Testing of interaction effects – results

6.3.4.1 Interactions stressors – positive mood

Table 6.4 includes a summary of the interaction models tested between each stressor and positive mood. Looking at the hypothesised interactions between stressors and positive mood, it was found that positive mood interacted with qualitative demands, $\gamma_{60} = -.14$, $SE = .07$, $t(38) = -2.02$; $p = .05$ (table 6.5, figure 6.1), and role ambiguity, $\gamma_{60} = -15.$ $SE = .07$, $t(38) = -2.17$; $p = .04$ (table 6.6, figure 6.2) to predict creativity. Positive mood interacted with quantitative demands to predict decision-making $\gamma_{60} = -.17$, $SE = .08$, $t(38) = 2.07$; $p = .045$ (table 6.7, figure 6.3) and to predict avoiding procrastination $\gamma_{60} = -16.$ $SE = .07$, $t(38) = -2.12$; $p = .04$ (table 6.8, figure 6.4).

6.3.4.2 Interactions stressors – negative mood

Table 6.9 presents a summary of the interaction models tested between each stressor and negative mood. Negative mood was found to interact with quantitative demands to predict avoiding procrastination, $\gamma_{60} = .17$, $SE = .07$, $t(38) = 2.29$; $p = .03$

(table 6.10, figure 6.5); and to predict focus and obstacles, γ_{60} = -.30, *SE* = .09, *t*(38) = -3.20; *p* = .00 (table 6.11, figure 6.6). Negative mood also interacted with role ambiguity, γ_{60} = .17, *SE* = .07, *t*(38) = 2.63; *p* = .01 to predict avoiding procrastination (table 6.12, figure 6.7).

To further explore the interaction effects the interactions are displayed graphically. Following Cohen, Cohen, West, and Aiken (2003) two simple regression equations were computed using the values of one standard deviation above and below the mean, which are displayed in figures 6.1 to 6.7.

6.4 Test of mediation model

According with the mediation hypothesis, stressors lead to an increase on negative affect which in turn leads to impaired creativity.

In order for this to occur, four conditions are necessary (Baron & Kenny, 1986):

1) Stressors should have a significant positive effect on negative mood

2) Negative mood should have a significant negative impact on creativity

3) Stressors should have a significant negative impact on creativity

4) When negative mood is added to the model including the stressor and creativity, the coefficient should become non significant or at least should be reduced.

In order to test these conditions, the same logic as outlined above was followed when defining the model.

When testing condition one, all controls were included in the model, negative mood was included as outcome variable, and the effect of each stressor was tested one at a time. All stressors were found to have a significant positive impact on negative mood, for quantitative demands, $\gamma_{40} = .47$, $SE = .08$, $t(38) = 5.90$; $p = .00$; for qualitative demands $\gamma_{40} = .35$, $SE = .07$, $t(38) = 5.28$; $p = .00$, and for role ambiguity, $\gamma_{40} = .-23$, $SE = .09$, $t(38) = 2.63$; $p = .013$, satisfying the first condition.

Support for condition two has already been presented when discussing the main effects of negative mood. As it was described, negative mood was found to have a significant negative effect on creativity, $\gamma = -.23$, $SE = .10$, $t(38) = 2.17$, $p = .03$.

However, condition three is not supported, as the analyses of main effects conducted previously showed no significant effects of quantitative or qualitative demands, and role ambiguity was found to have a positive impact on creativity, which invalidates the mediation model.

6.5 Interpretation of results

Whereas no main effects were found for quantitative and qualitative demands, role ambiguity was found to have mixed effects throughout the different activities. As expected, its effect on implementation activities, such as decision-making and avoiding procrastination, was negative, suggesting that role ambiguity impairs activities that are more closely related to implementation (H 2). On the other hand, and contrary to what had been hypothesised (H 1), role ambiguity was found to have a positive effect on creativity activities. It could be the case that, within the R&D environment, having role ambiguity is equated with having more autonomy regarding how to approach the problem at hand. Therefore, rather than taxing cognitive resources role ambiguity stimulates R&D professionals to think about the issue in different terms, resulting in increased creativity. The failure to identify main effects of quantitative and qualitative demands indicates a strong likelihood that certain moderators are operating. These results suggest that the impact of stressors needs to be carefully examined, as it is very likely that a) not all stressors impact on the different innovation activities in the same way, and b) as it is the case with role ambiguity, it is likely that the same stressor might have differential effects upon the different activities.

Considering the main effects of mood, again only partial support for the suggested hypotheses was found. Contrary to what was expected, there was no positive effect of positive mood on creativity (H 3). The results showed, however, that positive mood had a facilitative effect upon another innovation activity, focus and obstacles. Although no hypothesis had been drawn for the effect of positive mood on implementation activities, these results suggest that it might be worthy to place more emphasis on analysing which activities of the innovation process are actually facilitated by positive mood.

As predicted, negative mood was found to have a negative impact on individual creativity (H 4), however, opposite to what was expected, no support was found for its positive impact on implementation activities (H 5). The results suggest instead that negative mood impairs focus and obstacles; however, this result should be interpreted with caution as this effect was only marginally significant. The mediation model was not supported.

In order to identify which of the three frameworks presented earlier best predicts the interplay between stressors and mood it is necessary to analyse the interaction patterns that resulted from the significant interactions between stressors and positive mood and stressors and negative mood. Table 6.10 supports the following analyses.

Focusing first on the interactions between stressors and positive mood, the plotted results display a similar pattern for almost all the significant interactions, suggesting that when facing stressors the innovative performance of individuals in low positive mood is less hindered than those in high positive mood, or is even facilitated by the increase of stressors.

These results also suggest that positive mood plays a different role in moderating the impact of stressors across different innovation activities. Whereas creativity is predicted by the interaction of positive mood with qualitative demands and with role ambiguity, implementation activities such as decision-making and avoiding procrastination are predicted by the interaction of mood with quantitative demands. These results are further discussed in the following section.

The results are slightly more complex when it comes to the interplay between stressors and negative mood. Quantitative demands were found to interact with negative mood to predict both avoiding procrastination and focus and obstacles; however, the pattern differs for each of the two outcomes. In terms of focus and obstacles, it seems that as quantitative demands increase, performance is facilitated by a low negative mood. On the other hand, when it comes to avoiding procrastination, as quantitative demands increase performance is facilitated by a high negative mood. Role ambiguity was also found to interact with negative mood to predict avoiding procrastination. The pattern of this interaction is similar to that which was described for the interplay between quantitative demands and negative mood to predict avoiding procrastination, although in this case none of the mood levels benefits from the presence of role ambiguity. Avoiding procrastination is negatively related with role ambiguity but this relationship is less strongly negative when individuals are in a high negative mood. These results suggest that depending on the implementation activity and on the stressor, both high and low negative mood can be facilitative.

The results reported regarding the interactions between stressors and positive mood lend some support to the mood repair hypotheses, as the patterns consistently show that higher levels of positive mood impair performance in the presence of stressors in both creativity (H 7.1) and implementation activities (H 7.2). These results are in agreement with the idea sustained by this framework that higher levels of mood are associated with repairing activities, which are cognitive taxing, leaving even less resources available to cope with stressors. However, in order to fully accept this framework as the best explanation, the pattern of interactions between stressors and negative mood would also have to show that in the presence of stressors a high negative mood is conducive to worse results than a low negative mood for both creativity activities (H 7.3) and implementation activities (H 7.4). However, there is no evidence showing that negative mood interplays with stressors to predict creativity activities, and, more critically, when it comes to implementation activities only one of the three significant interactions supports this idea (H 7.4), the interaction between quantitative demands and negative mood to predict focus and obstacles.

The remaining significant two interactions of negative mood with stressors, more specifically with quantitative demands and with role ambiguity to predict avoiding procrastination, offer instead support to the mood-as-information hypotheses, since they suggest that in the presence of stressors a high negative mood is more conducive to implementation activities. This result is in agreement with the notion supported by this framework that negative mood facilitates implementation activities in the presence of stressors because it provides the individual with the correct information that something is wrong and therefore action is required (H 8.4).

This framework is also supported by the fact that high positive mood was found to accentuate the negative impact of quantitative demands on decision-making and avoiding procrastination, as anticipated in hypothesis 8.2. This finding, however, lends support to both mood repair and mood-as-information frameworks.

However, hypothesis 8.1 was critical in order to prove mood-as-information as the best framework, and contrary to what was expected, when in the presence of stressors, individuals in high positive mood did not perform better than individuals in low positive mood in terms of creative output: the opposite was the case. Furthermore, there is no evidence to support hypothesis 8.3, which stated that high negative mood would accentuate the negative impact of stressors on the level of creativity activities.

It is also important to notice that the significant interactions found do not offer any support to the hypotheses drawn based on the cognitive spreading activation framework.

According with this framework, it was expected that positive mood would buffer the negative impact of stressors on the level of creativity activities (H 6.1), which is contradicted by the interactions found between positive mood and both qualitative demands and role ambiguity to predict creativity. The second hypothesis based on this framework suggested that positive mood would buffer the negative impact of stressors on the level of implementation activities (H 6.2), and this was contradicted by the interactions between quantitative demands and positive mood to predict both decision-making and avoiding procrastination.

Table 6.10 presents a summary of the evidence in support of and against each of the hypotheses that was drawn in accordance with the three different frameworks. For the sake of simplicity, the seven interactions found, and which are now used as evidence to support or reject each of the hypotheses, were numbered from one to seven

(1) Qualitative demands x positive mood to predict creativity (figure 6.1)

(2) Role ambiguity x positive mood to predict creativity (figure 6.2)

(3) Quantitative demands x positive mood to predict decision-making (figure 6.3)

(4) Quantitative demands x positive mood to predict avoiding procrastination (figure 6.4)

(5) Quantitative demands x negative mood to predict avoiding procrastination (figure 6.5)

(6) Quantitative demands x negative mood to predict focus and obstacles (figure 6.6)

(7) Role ambiguity x negative mood to predict avoiding procrastination (figure 6.7)

As it can be observed, the mood repair perspective is the framework that founds stronger support, with three out of the four hypotheses having some evidence to support them, and only one hypothesis having both evidence in favour and against, depending on the implementation outcome under consideration. The mood-as-information framework, although partially supported, sees its central tenets being contradicted. No support at all is found for the cognitive spreading activation framework.

6.6 Discussion

6.6.1 Study overview

The primary aim of this study was to investigate from an information processing perspective how stressors affected the performance of R&D team members on both creativity and implementation activities, and how this influence was moderated by an individual variable: mood. These variables were selected on the grounds that they have both been shown to impact on creativity, although the results have been scattered and unclear, and both affect the nature of information processing activities.

Hypotheses were drawn regarding the main effects of stressors and mood upon both creativity and implementation activities and also regarding their interplay. Based on the depletion of cognitive resources, stressors were expected to impair both creativity (H 1) and implementation activities (H 2). Based on mood-as-information framework, positive mood was expected to have a facilitative effect on creativity (H 3) whereas negative mood was hypothesised to impair creativity (H 4) and facilitate implementation activities (H 5).

Three competitive frameworks were presented in order to explain the interaction effect between stressors and mood. The cognitive spreading activation theory would lead to the prediction that individuals in high positive mood would cope better with stressors when involved in both types of innovation activities, given that the broader cognitive processing elicited by positive mood would counteract the processing impairment induced by stressors.

From a mood repair perspective it would be expected that those team members in high positive or negative mood would be more affected by stressors than those in low positive or negative mood given that the former would find their cognitive resources double taxed by coping with stressors and investing effort in keeping their mood high, and this effect would occur for both creativity and implementation activities. From a mood-as-information perspective one would predict a different pattern of interaction for creativity and implementation activities. The more heuristic processing style elicited by high positive mood would counteract the negative impact of stressors on creativity activities, since these are facilitated by such type of processing. However, such processing style is not favourable to implementation activities, which benefit more a more systematic and analytic processing. Moreover, a high positive mood would further hinder the depletion caused by stressors by providing individuals with the misleading information that the environment is safe and no action is required. As such, individuals in high positive mood would be less affected by stressors than those in low positive mood concerning creativity activities, but the opposite would occur regarding implementation activities. Following the same logic, opposite hypotheses were drawn for negative mood. It was expected that high negative mood would maximise the negative impact of stressors on creativity activities but would be a buffer when considering implementation activities. An alternative mediation model suggesting a path linking stressors, negative mood and creativity was also tested.

Not all main effects expected were found to be significant, suggesting that, in line with previous findings in the literature, the effect of these variables is complex and has to be investigated in context with other factors.

The results showed that creativity activities were affected by the interaction of two of the three stressors, qualitative demands and role ambiguity, with positive mood. Two of the three implementation activities, decision-making and avoiding procrastination, were affected by the interaction between quantitative demands and positive mood. Except for the interaction between role ambiguity and positive mood, all the interaction effects followed the same pattern - as stressors increased, the performance of team members in high positive mood on both creativity and implementation activities was more strongly impaired than the performance of those in low positive mood.

Concerning the moderator role of negative mood, the results were less clear. The results showed that quantitative demands interacted with negative mood to predict both avoiding procrastination and focus and obstacles; however, the patterns found for these two outcomes were opposite. In the case of focus and obstacles the results are in line with the interactions of stressors with positive mood, showing that a low valence is more facilitative of innovative activities when in the presence of stressors. However, when it comes to avoiding procrastination, what was found is that in the presence of stressors a high negative mood is more beneficial. A third interaction, between role ambiguity and negative mood to predict avoiding procrastination, also indicated that a high negative mood can be more facilitative.

All these results were taken into account and weighted and it was found that the framework that gathered stronger support was the mood repair perspective. A high level of positive mood indeed appears to be disadvantageous rather than facilitative, suggesting that the effort employed in managing a salient mood further impairs cognitive processing when the cognitive resources are already depleted by stressors. The cognitive spreading activation perspective is not supported, as high positive mood does not buffer the negative impact of stressors as it would be predicted by this framework. Finally, the hypotheses suggested by mood-as-information are not entirely supported either, as the same pattern can be found for both creativity and implementation activities, opposite to what would be expected. Whereas the interactions predicting implementation activities could be considered to provide partial support for this approach, since as predicted when facing increasing level of stressors, individuals in high positive mood are more negatively affected than individuals in low positive mood, the expected higher performance on creativity activities by individuals in high positive mood does not occur, invalidating the set of predictions drawn by this approach.

It is necessary to point out, however, that the support found for the mood repair perspective is partial rather than total, since the interaction patterns found do not follow exactly the one that was drawn informed by this perspective. Focusing on the interplay between stressors and positive mood, as described earlier, one would expect a decline for both individuals in high and low positive mood as stressors increased, the slope being less accentuated for the latter. However, the plots show that individuals in low positive mood actually benefit from increasing level of stressors, being performance in both creativity and implementation activities highest when stressors are high and positive mood is low. Although this scenario was not forecasted when predicting the pattern of the interaction, it is possible to speculate about its nature. Low positive mood facilitates cognitive processing by sparing cognitive resources, as it does not overtax them with mood management activities, but it is also associated with low levels of activation and energy (Watson & Tellegen, 1985). One possible explanation for the effect found is that although individuals in low positive mood hold the advantage of not having their resources misplaced in mood management activities, the lack of energy that characterises the low poles impedes their enthusiastic engagement in creativity and innovation activities. It is then possible that the activation role of stressors suggested by the Yerkes-Dodson Law (1908) gives individuals in low positive mood the prompt to act, conducing individuals in low positive mood to display higher levels of innovative performance. This explanation is, however, speculative and requires further examination.

Another result that warrants further discussion is the different pattern found for the interaction between role ambiguity and positive mood. As shown in figure 6.2, as role ambiguity increases, so does creativity for both individuals in high and low positive mood. In agreement with the pattern previously examined, this interaction also suggests that individuals in low positive mood benefit more than those in high positive mood with increasing levels of stressors; however, for the particular case of role ambiguity, those individuals in high positive mood also display higher levels of creativity as role ambiguity increases. It is possible to speculate that as R&D professionals are normally used to having high levels of autonomy and enjoy work in a setting characterised by high uncertainty, role ambiguity is not so much faced as a stressor but as an opportunity for further acquiring more autonomy and responsibility for their own work and consequently provides them with more leeway to be creativity and implement their ideas.

Finally, it is noteworthy that although the pattern of interaction found is virtually the same, creativity and implementation activities were predicted by the interaction of positive mood with a different set of stressors. Whereas creativity was affected by role ambiguity and qualitative demands, implementation activities were influenced by quantitative demands. Some frameworks differentiate the impact of stressors, for instance LePine and colleagues suggest (LePine, LePine, & Jackson, 2004; Podsakoff, LePine, & LePine, 2007) that challenge stressors such as time pressure (very similar to the present quantitative demands) or qualitative demands will facilitate performance, whereas hindrance stressors such as role ambiguity will have a detrimental impact on performance. This framework is, however, not helpful in elucidating the present findings. Firstly, the results do not show any support for the distinction between positive and negative main effects of challenge and hindrance stressors. Furthermore, considering their impact on the different outcomes, qualitative demands (a challenge stressor in LePine and colleagues' (2005) terminology) affect the same outcome as role ambiguity (an hindrance stressor), when it would be expected that both challenge stressors would be equally related to the same outcome. From a motivational perspective it is possible to draw differential relations between the three stressors and the two innovation activities that are somewhat in line with the results. For instance, one would expect a stronger positive relationship between quantitative demands (or time pressure) and implementation, given that if time is scarce

R&D professionals are forced to implement whatever ideas are available in order to finish the project; it is also reasonable to expect a positive correlation between qualitative demands and creativity and between role ambiguity and creativity. The fact that the project is difficult and unclear means that usual solutions are not applicable and therefore something new is necessary. However, these explanations are neither meaningful in the information processing framework adopted in this study, nor do they explain the interactions found with positive mood. Further research would be necessary examining both cognitive and motivational pathways.

An alternative account for the results obtained by individuals in a high positive mood when facing stressors can be derived from Bower's (1981) associative network models of emotion. This model grounds the impact of moods on the spreading activation mechanism, which was described earlier, but holds the particular assumption that moods facilitate the perception, learning and recall of stimuli that are congruent with that mood. One can derive from this that individuals in a high positive mood would be better able to assimilate and interpret information which has a positive connotation than individuals in low positive mood, but if the information has a negative connotation, as it is the case with stressors, individuals in high positive mood would be at a disadvantage in comparison with individuals in low positive mood. The less effective perception of stressors and the demands with them associated could then be the basis for the worse performance of individuals in high positive mood when facing stressors.

6.6.2 Contributions to theory

This study makes several important contributions. Firstly, by disentangling two different important activities of the innovation process, creativity and implementation activities, this study promotes a more thorough and realistic analysis of the innovation process, enabling a deeper understanding of how different predictors affect each activity. Although the results found are not conclusive, the fact that positive mood interacts with different stressors to predict creativity and innovation activities suggests that more research should be done in uncovering the underlying causes of such result and in also identifying other differential predictors.

Secondly, the inclusion of three different stressors contributes to a stronger clarification of the impact of stressors on the innovation process. Research on this topic is unfortunately still characterised by inconclusive results, possible due to the fact that not all stressors affect the innovation process the same way. Although no differential predictions were made for each stressor, the differences found suggest that the differential impact of stressors has not so much to do with the valence of its impact but is more dependent on the type of activity of the innovation process, with some stressors affecting creativity and others implementation activities (when in interaction with mood).

Finally, this is the first study to analyse the interplay between stressors and mood. Given the ubiquity of stressors in the workplace and the impact of individual mood in job performance, and the influence of both these constructs on information processing, it is surprising that this has not yet been explored. Overall, these results, showing that stressors might enhance innovative behaviour when associated with individuals' low positive mood, contributes to a growing literature suggesting that the match between contextual conditions and personal characteristic can result in favourable innovative responses (e.g., Puccio, Talbot, & Joniak, 2000; Tierney et al., 1999).

6.6.3 Limitations

This study has a few limitations that should be considered. Firstly, the sample includes R&D professionals only and it is consequently not clear if the results generalise to other types of jobs. Although focusing solely on externally driven creativity (Unsworth, 2001) is, in the author's opinion, a strength and a step forward in disentangling the factors influencing different types of creativity, it is important that further research analyses whether this relationship is replicated in other functions than R&D, that also involve innovative work, and how these variables interplay in samples in which creativity is not externally driven by the job requirements but internally driven by individuals' wish to contribute.

Another limitation of this study is its correlational design, which precludes a clear determination of the direction of causality. It is possible that employees considered to be more effective in innovation activities just described their level of stressors and mood differently from employees less effective in innovation activities. The focus on a one-week time frame is, in the authors' opinion, a strength, as it enables an analysis of the immediate impact of the predictors and emphasises the relevance of the innovation process rather than just focusing on the final outcomes of an innovation project.

6.6.4 Practical implications

Despite these limitations, this study may have some important implications for promoting innovative behaviour in R&D teams. Common wisdom usually represents people having their best ideas when they are in a positive mood (for instance, when in the shower). While this lay idea might prove true in some settings, the results found here suggest that this does apply in the workplace, considering the combined effect with stressors. One natural implication is that managers should refrain from assuming that stressors are always detrimental to innovation activities, or that positive mood is always facilitative. This does not mean at all that managers should attempt to trigger a negative mood on their followers (which is quite different from having a low positive mood), or even that they should counteract a high positive mood. More simply, it suggests that in the presence of stressors, managers should present them to team members as a challenge but that they should avoid any excessive sugarcoating or any attempt to reframe the stressor as "fantastic opportunity", triggering a high positive mood by making followers feel overenthusiastic. This recommendation is supported by the finding that, in the presence of stressors, high positive mood is not only not helpful, but that it is also detrimental in the sense that it provides misleading information and overcharges cognitive resources.

6.6.5 Future research

This study points to several avenues for interesting future research. Perhaps the most interesting would be to develop a design in which the information processing mechanisms, here presented as the mediator factor through which stressors and affect interplay to affect innovation activities, could be clearly measured. This would allow a confirmation of the suitability of the information procession framework assumed here. Furthermore, other mediators, such as behavioural and motivational ones, should also be scrutinised. Although it is the author's initial idea that the interplay between stressors and mood takes place mainly in a cognitive framework, the fact that this perspective cannot fully explain the results found suggests that other frameworks should also be considered.

This study was conducted within an R&D sample in which innovative behaviour is expected. It would be interesting to verify whether stressors and mood interplay in the same way in a context where innovative behaviour is not part of the work role.

Further research should also extend the range of stressors under scrutiny. There are still both some lack of clarity and contradictory findings regarding the impact of stressors on innovation activities; one avenue to overcome this would be the systematic analysis of a broad range of stressors, applying the same paradigm and similar samples. Furthermore, the emotion related construct here assessed, mood, is a temporary one. It would be interesting to analyse whether more long lasting emotions such as trait affect interact with stressors in the same fashion. Hopefully, future endeavours will continue to further understanding of how stressors and emotions can affect innovation activities in the workplace.

This study followed a two-dimensional approach to moods (i.e. positive and negative mood). However, moods differ in many other respects than valence. It is possible that specific moods such as anger or sadness interact with stressors in a different way, although they both have a negative valence. An investigation of different mood states would contribute to a better understanding of how moods affect individuals' responses to work stressors. Furthermore, the interplay of other affect related constructs such as emotions with stressors should also be scrutinised.

Table 6.1

EFA Quantitative demands, Qualitative Demands and Role Ambiguity

Principal Axis Factor Analysis, Pattern Matrix, Oblique rotation

Item	Construct	Factor loadings		
I had to work fast.	Quantitative demands	**.802**	-.044	-.018
I had too much work to do.	Quantitative demands	**.757**	.075	.108
I had to work extra hard to finish a task.	Quantitative demands	**.753**	.064	.088
I could do my work in comfort.	Quantitative demands	**.609**	.079	.026
I had to work under time pressure	Quantitative demands	**.831**	-.077	-.093
I had to deal with a backlog at work.	Quantitative demands	**.739**	-.025	-.015
The demands of work quality made upon me were unreasonable.	Qualitative demands	.154	-.125	**.476**
My assigned tasks were sometimes too difficult and complex.	Qualitative demands	.003	-.080	**.811**
Tasks seemed to be getting more and more complex.	Qualitative demands	-.031	-.079	**.850**
The organization expected more of me than my skills and/or abilities provide.	Qualitative demands	.151	.131	**.551**
I had insufficient training and/or experience to discharge my duties properly.	Qualitative demands	-.082	.154	**.496**
I had clear planned goals and objectives for this project.	Role ambiguity	-.063	**.789**	.016
I knew exactly what was expected of me.	Role ambiguity	.081	**.939**	-.071
I knew what my responsibilities were.	Role ambiguity	.027	**.885**	-.035
I felt certain about how much authority I had.	Role ambiguity	.027	**.503**	.068
My responsibilities were clearly defined.	Role ambiguity	-.023	**.840**	-.024

N = 114-123

Table 6.2

Means, Standard Deviations, Correlations and Scale Reliabilities of Individual Level Variables

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11
1. Gender	1.88	.33											
2. Age	30.76	6.42	-.10										
3.Education	3.01	.67	-.03	-.06									
4.Quantitative demands	2.48	.66	.04	.05	-.00	(.89)							
5.Qualitative demands	2.97	1.02	.10	-.05	.08	.40**	(.76)						
6.Role ambiguity	2.17	.743	.11	-.08	-.08	.04	.15	(.88)					
7.Positive mood	3.48	.56	-.01	-.04	.09	.15	-.11	-.26**	(.88)				
8.Negative mood	1.74	.63	.07	-.18	-.01	.49**	.41**	.27**	-.06	(.89)			
9.Creativity	3.81	1.35	-.03	-.01	-.01	.04	-.06	.14	.15	-.08	(.90)		
10.Decision-making	5.17	1.54	-.14	-.11	-.06	-.12	-.01	-.10	-.12	.09	-.52**	(.82)	

Table 6.2

(continued)

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11
11.Avoiding procrastination	5.32	1.49	.05	.20*	-.13	-.02	.04	-.20*	.09	-.14	-.24*	.51**	(.92)
12.Focus and obstacles	4.57	1.28	.02	-.14	.13	.02	-.15	.02	.32**	-.06	.59**	-.26**	.07

N = 114-123. *Note**p<.05 **p<.001. Gender coded "1" female "2" male

Table 6.3

Testing Main Effects of Stressors and Mood on Innovation Activities at the Individual Level

	Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*
Quantitative demands	-.05	.11	-.40	.62	-.08	.12	-.67	.51	.00	.09	.28	.78	-.05	.11	-.49	.63
Qualitative demands	-.16	.10	-1.56	.13	-.01	.12	-.09	.93	.03	.09	.37	.71	-.14	.09	-1.53	.13
Role ambiguity	.21	.09	2.41	.02	-.23	.08	-2.87	.01	-.20	.11	-1.79	.08	-.02	.10	-.18	.85
Positive mood	.00	.07	.03	.97	.98	.10	.97	.34	.08	.09	.90	.37	.25	.09	2.63	.01
Negative mood	-.23	.10	-2.17	.03	-.04	.09	-.46	.65	.03	.10	.30	.76	-.20	.12	-1.65	.10

N = 101 level-1 units, 39 level-2 units

Table 6.4

Summary of Interaction Tests between Stressors and Positive Mood

	Creativity	Decision-making	Avoiding procrastination	Focus and obstacles
Quantitative demands x Positive mood		Sig.	Sig.	
Qualitative demands x Positive mood	Sig.			
Role ambiguity x Positive mood	Sig.			

Table 6.5

Results of Multilevel Analysis for the Effects of Qualitative Demands and Positive Mood on Creativity

	γ	*SE*	*t*	*p*
Step 1 (control variables)				
Gender	.39	.21	1.78(93)	.08
Age	.04	.02	1.62(38)	.11
Education	.17	.21	.82(38)	.41
Creativity requirement	.35	.08	4.05(34)	.00
Project length	.00	.00	1.26(34)	.21
Stage	.07	.30	-.21(34)	.83
Team size	-.13	.08	-1.82(34)	.08
Step 2 (main effects)				
Qualitative demands	-.16	.13	-1.24(38)	.22
Positive mood	.08	.09	.78(38)	.44
Step 3 (two-way interaction)				
Qualitative demands x positive mood	-.14	.07	-2.02(38)	.05

N = 101 level-1 units, 39 level-2 units

Table 6.6

Results of Multilevel Analysis for the Effects of Role Ambiguity and Positive Mood on Creativity

	γ	*SE*	*t*	*p*
Step 1 (control variables)				
Gender	.39	.21	1.78(93)	.08
Age	.04	.02	1.62(38)	.11
Education	.17	.21	.82(38)	.41
Creativity requirement	.35	.08	4.05(34)	.00
Project length	.00	.00	1.26(34)	.21
Stage	.07	.30	-.21(34)	.83
Team size	-.13	.08	-1.82(34)	.08
Step 2 (main effects)				
Role ambiguity	.35	.12	2.91(38)	.00
Positive mood	.20	.11	1.86(38)	.07
Step 3 (two-way interaction)				
Role ambiguity x positive mood	-.15	.07	-2.17(38)	.04

N = 101 level-1 units, 39 level-2 units

Table 6.7

Results of Multilevel Analysis for the Effects of Quantitative Demands and Positive Mood on Decision-Making

	γ	*SE*	*t*	*p*
Step 1 (control variables)				
Gender	-.08	.37	-.21 (93)	.83
Age	-.04	.03	-1.54(38)	.13
Education	.16	.19	.85(38)	.40
Creativity requirement	-.20	.12	-1.73 (34)	.09
Project length	.01	.00	1.65 (34)	.11
Stage	.45	.42	1.07 (34)	.30
Team size	.10	.10	.98 (34)	.34
Step 2 (main effects)				
Quantitative demands	.12	.12	-.97(38)	.34
Positive mood	-.02	.08	-.26(38)	.79
Step 3 (two-way interaction)				
Quantitative demands x positive mood	-.17	.08	-2.07(38)	.045

N = 101 level-1 units, 39 level-2 units

Table 6.8

Results of Multilevel Analysis for the Effects of Quantitative Demands and Positive Mood on Avoiding Procrastination

	γ	*SE*	*t*	*p*
Step 1 (control variables)				
Gender	.80	.54	1.48(93)	.14
Age	-.00	.01	-.04(38)	.96
Education	-.23	.15	-1.43(38)	.16
Creativity requirement	-.25	.72	5.56(34)	.00
Project length	-.01	.01	-2.45(34)	.02
Stage	.80	.33	2.38(34)	.02
Team size	.28	.08	3.5(34)	.00
Step 2 (main effects)				
Quantitative demands	.12	.12	-.97(38)	.34
Positive mood	-.02	.08	-.26(38)	.79
Step 3 (two-way interaction)				
Quantitative demands x positive mood	-.16	.07	-2.12(38)	.04

N = 101 level-1 units, 39 level-2 units

Table 6.9

Summary of Interaction Tests between Stressors and Negative Mood

	Creativity	Decision-making	Avoiding procrastination	Focus and obstacles
Quantitative demands x Negative mood			Sig.	Sig.
Qualitative demands x Negative mood				
Role ambiguity x Negative mood			Sig	

N = 101 level-1 units, 39 level-2 units

Table 6.10

Results of Multilevel Analysis for the Effects Of Quantitative Demands and Negative Mood on Avoiding Procrastination

	γt	*SE*	*t*	*p*
Step 1 (control variables)				
Gender	.80	.54	1.48(93)	.14
Age	-.00	.01	-.04(38)	.96
Education	-.23	.15	-1.43(38)	.16
Creativity requirement	-.25	.72	5.56(34)	.00
Project length	-.01	.01	-2.45(34)	.02
Stage	.80	.33	2.38(34)	.02
Team size	.28	.08	3.5(34)	.00
Step 2 (main effects)				
Quantitative demands	.01	.11	1.46(38)	.86
Negative mood	-.02	.12	.16(38)	.87
Step 3 (interaction effects)				
Quantitative demands x negative mood	.17	.07	2.29(38)	.03

N = 101 level-1 units, 39 level-2 units

Table 6.11

Results of Multilevel Analysis for the Effects Of Quantitative Demands and Negative Mood on Focus and Obstacles

	γ	*SE*	*t*	*p*
Step 1 (control variables)				
Gender	.06	.25	.26(93)	.80
Age	-.00	.02	-.10(38)	.92
Education	.27	.17	1.58(38)	.12
Creativity requirement	.14	.04	1.93(34)	.06
Project length	-.01	.00	-.26(34)	.22
Stage	.30	.29	1.06(34)	.30
Team size	.01	.08	.13(34)	.90
Step 2 (main effects)				
Quantitative demands	.18	.11	1.65(38)	.10
Negative mood	-.36	.13	-2.77(38)	.00
Step 3 (interaction effects)				
Quantitative demands x negative mood	-.30	.09	-3.20(38)	.00

N = 101 level-1 units, 39 level-2 units

Table 6.12

Results of Multilevel Analysis for the Effects of Quantitative Demands and Negative Mood on Avoiding Procrastination

	γ	*SE*	*t*	*p*
Step 1 (control variables)				
Gender	.80	.54	1.48(93)	.14
Age	-.00	.01	-.04(38)	.96
Education	-.23	.15	-1.43(38)	.16
Creativity requirement	-.25	.72	5.56(34)	.00
Project length	-.01	.01	-2.45(34)	.02
Stage	.80	.33	2.38(34)	.02
Team size	.28	.08	3.5(34)	.00
Step 2 (main effects)				
Role ambiguity	-.28	.13	-2.14(38)	.04
Negative mood	.20	.11	1.86(38)	.07
Step 3 (interaction effects)				
Role ambiguity x negative mood	.17	.07	2.63 (38)	.01

N = 101 level-1 units, 39 level-2 units

Table 6.13

Summary of the Evidence in Support and Against Each Framework

Framework	Hypothesis number	Prediction	Evidence in favour	Evidence against
Cognitive spreading activation	H6.1	Positive mood will buffer the negative impact of stressors on the level of creativity activities		• (1) Qualitative demands x positive mood – creativity • (2) Role ambiguity x positive mood - creativity •
	H6.2	Positive mood will buffer the negative impact of stressors on the level of implementation activities		• (3) Quantitative demands x positive mood – decision-making • (4) Quantitative demands x positive mood – avoiding procrastination
Mood repair perspective	H7.1	Positive mood will accentuate the negative impact of stressors on the level of creativity activities	• (1) Qualitative demands x positive mood – creativity • (2) Role ambiguity x positive mood - creativity •	
	H7.2	Positive mood will accentuate the negative impact of stressors on the level of implementation activities	• (3) Quantitative demands x positive mood – decision-making • (4) Quantitative demands x positive mood – avoiding procrastination •	
	H7.3	Negative mood will accentuate the negative impact of stressors on the level of creativity activities		
	H7.4	Negative mood will accentuate the negative impact of stressors on the level of implementation activities	• (6) Quantitative demands x negative mood –focus and obstacles	• (5) Quantitative demands x negative mood – avoiding procrastination • (7) Role ambiguity x negative mood to predict avoiding procrastination

Table 6.13

(continued)

Framework	Hypothesis number	Prediction	Evidence in favour	Evidence against
Mood-as-information	H8.1	Positive mood will buffer the negative impact of stressors on the level of creativity activities displayed by R&D team members		• (1) Qualitative demands x positive mood – creativity • (2) Role ambiguity x positive mood - creativity •
	H8.2	Positive mood will accentuate the negative impact of stressors on the level of implementation activities	• (3) Quantitative demands x positive mood – decision-making • (4) Quantitative demands x positive mood – avoiding procrastination •	
	H8.3	Negative mood will accentuate the negative impact of stressors on the level of creativity activities		
	H8.4	Negative mood will buffer the negative impact of stressors on the level of implementation activities	• (5) Quantitative demands x negative mood – avoiding procrastination • (7) Role ambiguity x negative mood to predict avoiding procrastination	• (6) Quantitative demands x negative mood –focus and obstacles

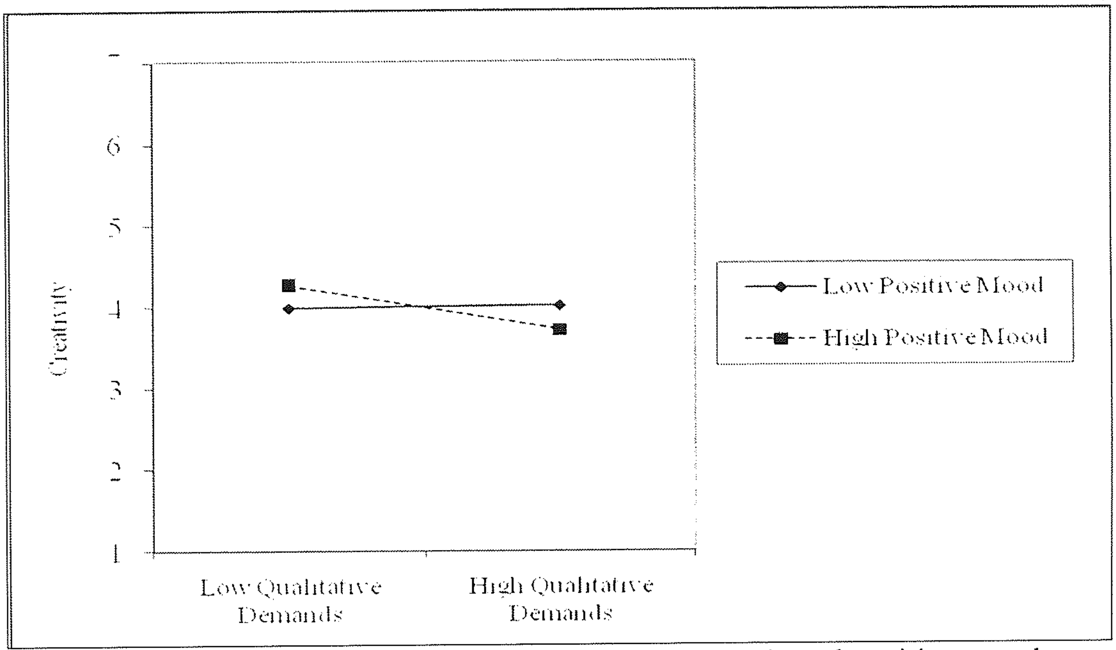

Figure 6.1.Interaction between qualitative demands and positive mood to predict creativity activities

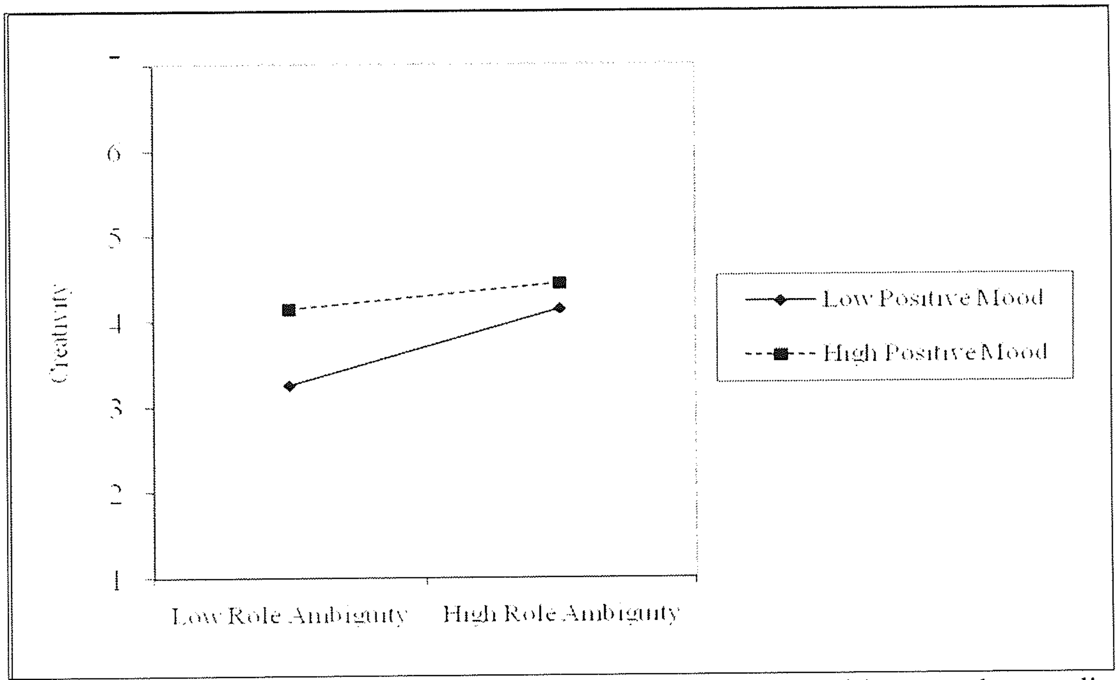

Figure 6.2. .Interaction between role ambiguity and positive mood to predict creativity activities

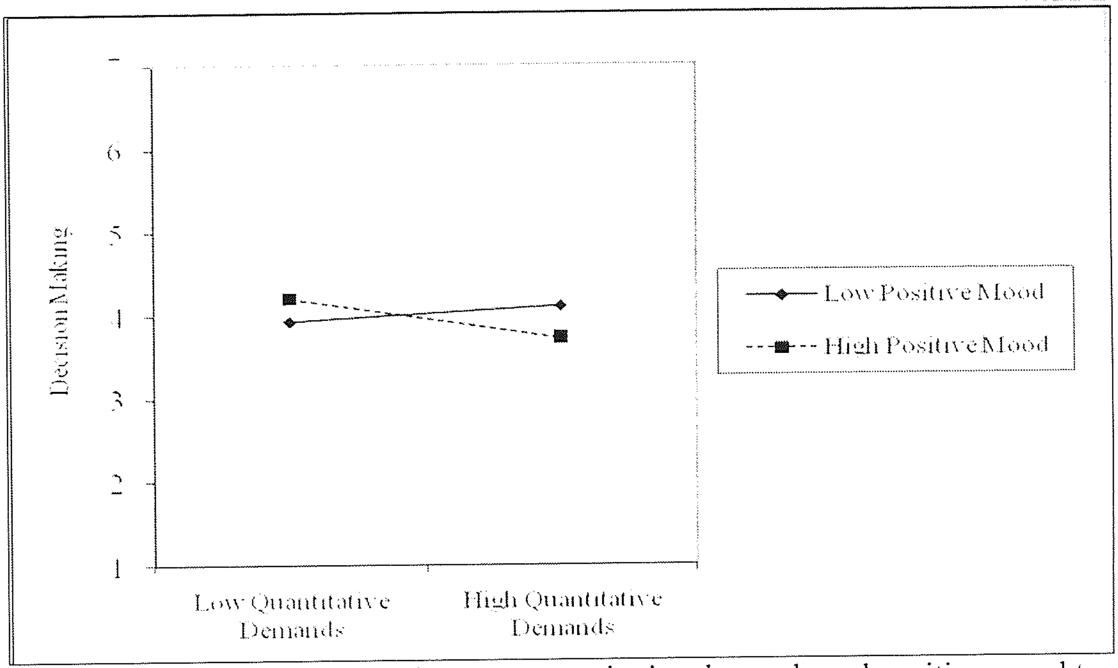

Figure 6.3. Interaction between quantitative demands and positive mood to predict decision-making

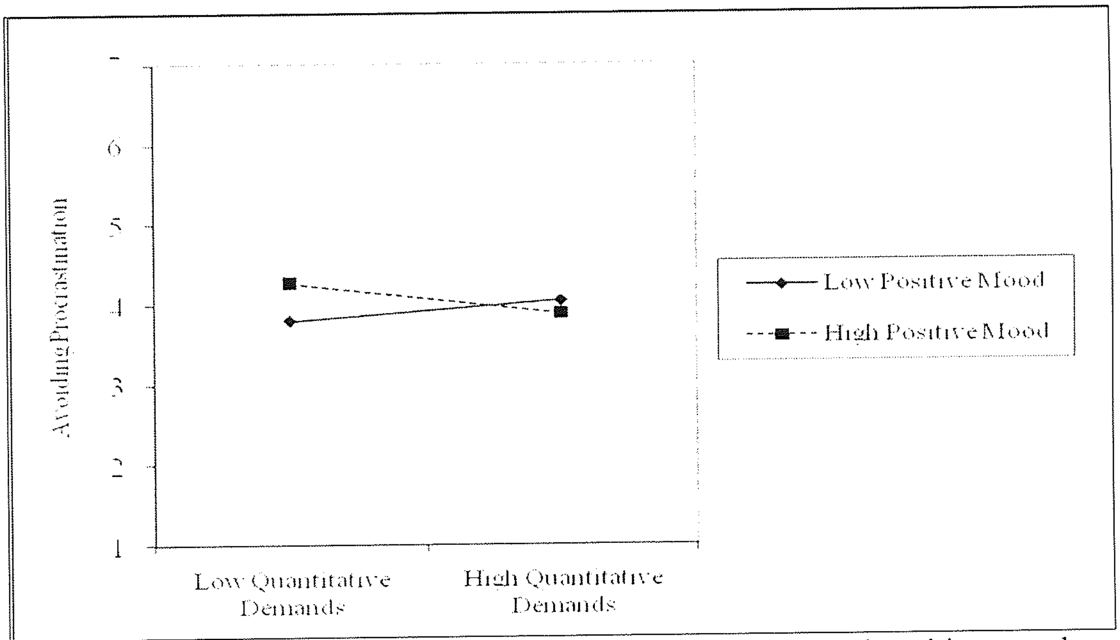

Figure 6.4. Interaction between quantitative demands and positive mood to predict avoiding procrastination

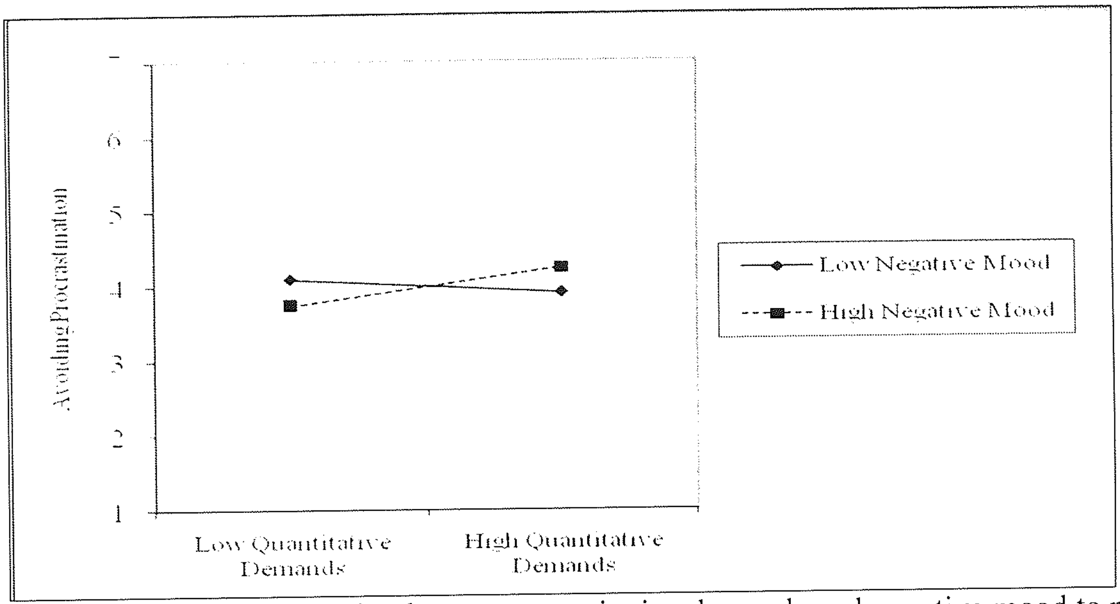

Figure 6.5 Interaction between quantitative demands and negative mood to predict avoiding procrastination

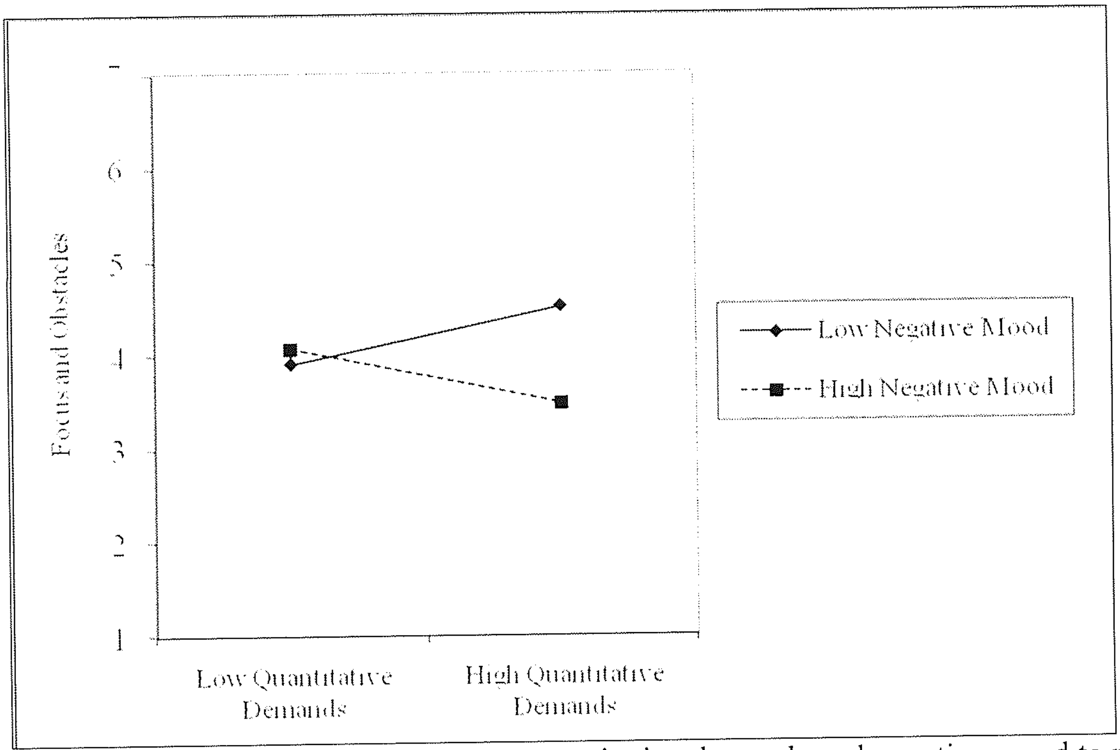

Figure 6.6 Interaction between quantitative demands and negative mood to predict focus and obstacles

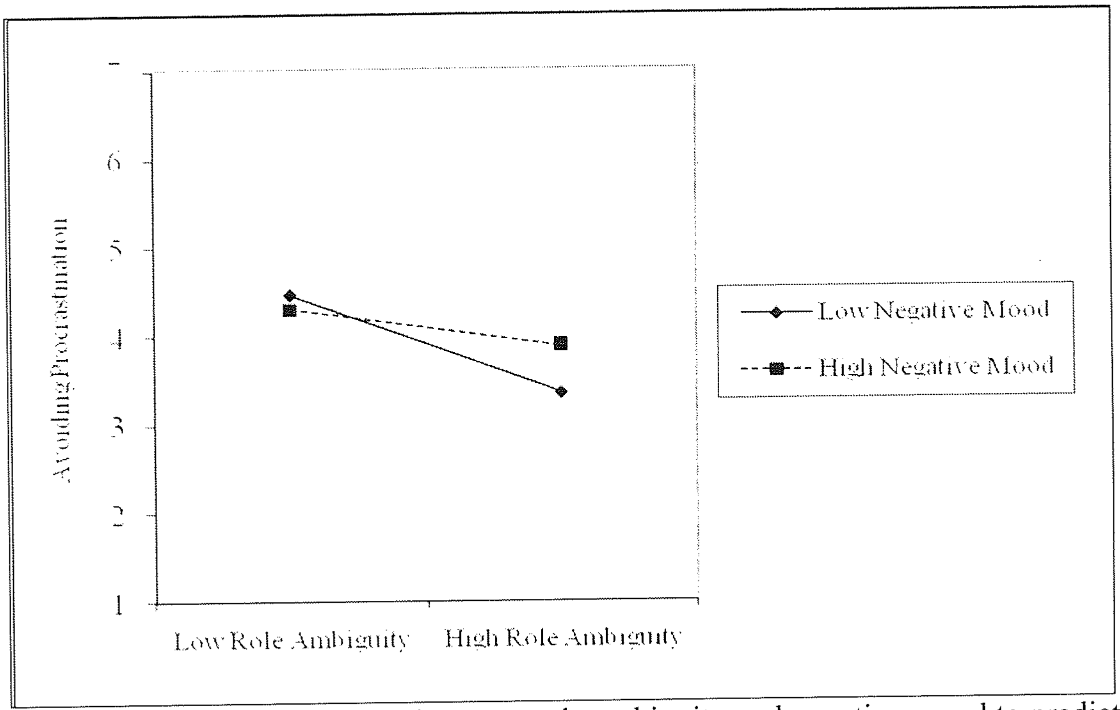

Figure 6.7. Interaction between role ambiguity and negative mood to predict avoiding procrastination

Chapter 7

The impact of stressors and mood on team innovation activities –

Extension of an information processing approach to the team level of analysis

This chapter examines how stressors and mood interplay to affect innovation activities at the team level. In similar fashion as in the chapter examining these relationships at the individual level (chapter three), a theoretical framework accounting for the impact of these variables is developed. Firstly, the nature of each construct at the team level is discussed. Next, the independent effects of team stressors and team mood on innovation activities are explored in light of previous theory and empirical evidence. Finally, the development of three competitive frameworks offering different predictions on the effect of the interplay of the two team level variables on team innovation is presented.

7.1 Introduction

In chapters three and six the impact of individual stressors and individual mood on creativity and implementation activities of individual team members was examined. The growth of team-based working in current organisational settings (Mohrman, Cohen, & Mohrman, 1995) and the pleas for more multilevel research in general and on innovative behaviour in particular, suggest that there are strong empirical and theoretical reasons to investigate how these relationships evolve at the team level of analysis.

In virtue of its thoroughness and consensual character, the definition of teams adopted here is the one forwarded by Kozlowski and Bell (2003) based on their comprehensive literature review. The authors suggested that work teams are entities composed of two or more individuals who exist to perform organisationally relevant tasks, share one or more common goals, interact socially, exhibit task interdependencies (i.e., work flow, goals, outcomes), maintain and manage boundaries, and are embedded in an organisational context that sets boundaries, constrains the team, and influences exchanges with other units in the broader entity. All the teams included in this project agree to these criteria.

7.2 Team information processing

In an era in which information is of foremost importance teams are increasingly in charge of performing tasks of a cognitive nature (e.g., Salas, Dickinson, Converse, & Tannenbaum, 1992). In line with this practical evidence, recent proposals have suggested that information processing is not only a feature of individuals but also of teams (e.g, Hinsz, Tindale, & Vollrath, 1997). Like individuals, groups can process relevant and available information in order to perform intellectual tasks (e.g., Larson & Christensen, 1993). The processing of information in teams involves the activities that occur within and among team members. At the team level, "information processing involves the degree to which information, ideas, or cognitive processes are shared, and are being shared, among the group members and how this sharing of information affects both individual and group level processes" (Hinsz et al., 1997, p. 43). Group level processing is dependent on various aspects of individual level processing, and individual level processing is also affected by group level processes. In a parallelism with individual processing, group processing can also be represented by a feedback-loop involving processing objectives which guide information processing, attention processes which filter the information, and encoding, storage and retrieval processes. These phenomena are of great relevance for the innovation activities of R&D teams given the highly demanding nature of this specific type of work in terms of assimilating and managing information. But team information processing is also prone to be affected by external factors, such as stressors, and other team emergent states, such as team mood. The next sections describe the emergence of stressors and mood as team level properties and explore the possible patterns of interaction between these variables.

7.3 Stressors as a team level property

As approached in chapter three, there is an extensive body of research showing that stressors negatively affect information processing by narrowing individual's breadth of attention, leading to a focus of attention on previous sources of information and a neglect of secondary and peripheral information (Cohen, 1980; Pennebaker, Czajka, Cropanzano, & Richards, 1990). One obvious question when studying the performance of individuals nested in teams is whether there is a similar effect of stressors upon the team processes in addition to occurrences at the individual level, leading to the conceptualisation of stressors as a shared property of the team.

Drach-Zahavy and Freund (2007) suggested that, although stressors are best examined as individual manifested cognitions (given that they are perceived and experienced by individuals), the stress phenomenon can be further understood by investigating how it is embedded in different contexts, such as the team. The authors argued that the input-process-output (IPO) framework provides solid theoretical grounds for considering stressors as a relatively shared property of the team. Within the IPO model, inputs are the conditions that exist prior to group activity. Considering that team members work in the same context, they absorb similar stimuli from their work environment, including stress stimuli. As stress appraisals are also influenced by the social context in which individuals are embedded (Hobfoll, 2001), team members not only absorb similar stressors but process them in the same manner, display similar stress responses and produce a shared stressor related phenomenon within the team. In line with this reasoning, other empirical studies have already conceptualised and operationalised stressors as a team level construct (e.g., Keller, 2001).

7.3.1 The impact of stressors on team information processing

The idea that stressors also affect the way team members work together can be found in very early examinations of group behaviour under stress. Torrance (1954) suggested that when facing stressors, linkages between team members can become confused and people may lack a clear perception of what they can expect from one another, with whom they can relate, and how they can relate to one another. Despite this early insightful analysis, research at the team level was for a long period neglected due to researchers' focus on the individual. More recently, the level of analysis has broadened again, as research started focusing on the impact of stressors on team related outcomes such as team processes, team performance and team decision-making (Driskell & Salas, 1991; Kelly & Karau, 1999; Kelly & McGrath, 1985). Although work in this area is still scarce (Drach-Zahavy & Freund, 2007; Driskell, Salas, & Johnston, 1999), the majority of the studies have applied an information processing perspective and within this framework results generally suggest a negative impact of stressors on team related outcomes (e.g., Cannon-Bowers & Salas, 1998; Karau & Kelly, 1992). For instance, Gladstein and Reilly (1985) found in an experimental study that the introduction of a stressor restricted the way in which groups processed information.

Several mechanisms have been forwarded in order to account for these findings. One possible explanation is related to a decrease in communication. Research has shown that team members tend to interact less under acute stress (Driskell & Johnston, 1998; Gladstein & Reilly, 1985). This explanation has been challenged by evidence showing that only the quality of communication (Campion, Medsker, & Higgs, 1993) and not quantity (Smith, Smith, Olian, Sims, O'Bannon & Scully, 1994) is positively related with team performance. This criticism is easily refuted if we consider that stressors are likely to affect not only the quantity of communication exchanged but the quality as well.

Exploring an alternative pathway, Driskell, Salas, Johnston (1999) suggested and empirically demonstrated that, in a team environment, the narrowing of attention induced by stressors results in a shift of attention from a broad team perspective to a narrower or individualistic focus, which results in decreased team performance. Given that information processing relies on a team focus, Driskell and colleagues (1999) suggested that this attention shift can disrupt information processing activities at the team level, such as encoding, storage and retrieval. Recently, Ellis (2006) advanced this explanation further by showing that the loss of team perspective caused by acute stress disrupts cognitive processes, such as mental models and transitive memory, which ultimately leads to the decrease of team performance.

In sum, several mechanisms have been advanced to account for the impact of stressors on team performance, including communication deficits, shift from a team to an individual focus, and disruption of team cognitive structures such as team mental models and transactive memory.

7.4 Team mood

The impact of individual emotions on work related outcomes has been solidly established, as described in chapter three (for a review see Brief & Weiss, 2002). More recently, organisational behaviour research as seen an increasing interest on collective emotion, with researchers focusing on constructs grounded in affective relations such as group cohesion and team identification. In line with the emphasis on team emotions, it has been suggested that affect is not simply an intrapersonal factor but instead has a strong social component that can influence group interactions (Bartel & Saavedra, 2000; George, 1990; Kelly & Barsade, 2001; Parkinson, 1996). George (1990) advanced the concept of group affective tone which is characterised by consistent or homogenous affective reactions within a group. George operationalised it as an aggregate of the moods of the individual members of the group and argued that if the individual moods were consistent, group affective tone could be treated as a group property. Since then researchers have tried to describe the processes involved in the development of a collective mood and to determine how this concept influences work related outcomes (e.g., Kelly & Barsade, 2001; Totterdell, Kellett, Teuchmann, & Briner, 1998).

As described in chapter three, certain conceptualisations distinguish between three types of affective constructs; dispositional affect, which is a long term stable variable; emotions, described as intense and relatively short term reactions to specific stimuli; and moods, which are weaker, more diffuse, and short-term affective reactions to general environment or stimuli. Barsade (2000) argued that moods are the most likely of the affective constructs to be translated to the group level, given their broader ranging effects, and the fact that everyday moods are the construct that most closely represents the commonplace and malleable short-term changes that can occur in groups. In line with this argumentation, this project focuses also on the emergence and effects of a collective team mood.

Mounting evidence has been provided for the existence of team moods. Investigating a sample of 26 salespeople groups George (1990) found that individual affect was consistent within groups, suggesting the emergence of a team level property. Totterdell and colleagues (1998), in a field study involving teams of nurses and accountants, verified that the moods of team members were related to each other, and this was even true when controlling for work problems shared by the team. These results were replicated by Totterdell (2000) in a sample of cricket teams. Extending these findings, Bartell and Saavedra (2000) reported that group mood could be recognised and assessed by not only members of the team but also by external evaluators. More recently, in an experimental study conducted by Sy, Cote & Saavedra (2005), it was found that when leaders were in a positive mood, team members experienced more positive and less negative mood, and groups had a more positive and a less negative affective tone, providing further evidence for mood contagion within groups.

Some of the factors so far identified as antecedents of collective mood are team interdependence, satisfaction with the team (Totterdell, 2000), stable membership, existence of norms about mood regulation, and task and social independence (Bartel & Saavedra, 2000). Several mechanisms have been suggested to account for the emergence of a collective congruent mood. Barsade (2002), driven by studies that looked at emotional contagion in dyads, developed a theory of mood convergence based on social influence processes. According to the author, the emotions felt by one team member are perceived by others via nonverbal signs. The degree to which emotional contagion takes place is dependent on attentional processes; the more attention is allocated to the other's mood expression, the greater contagion will occur. After this perception, the subconscious and conscious mechanisms that enable transfer of emotions come into play. The subconscious mechanism is very primitive and automatic, and it is based on the innate human tendency toward mimicking the behaviour of others. Individuals tend to mimick facial expressions, body language, speech patterns, and vocal tones of significant others. As a consequence of this mimicking behaviour, people receive afferent feedback from their muscular, visceral and glandular responses, and in last instance experience the emotion itself. The second mechanism suggested by Barsade (2002) as a potential explanation for emotional contagion is based on a set of effortful cognitive processes and relies on social comparison theory. Individuals compare their mood with those of others surrounding them, and then decide on what is appropriate for the situation. Emotion, is in this case, is used as social information to understand how one should be feeling, leading ultimately to the convergence of moods within members of the same group.

George (1990) explained the consistency in affective tone within groups using two complementary perspectives: Schneider's (1987) attraction-selection-attrition framework and socialization processes. Based on attraction-selection-attrition processes, the emergence of a consistent affective tone occurs because, for instance, individuals with high positive trait affectivity tend to be attracted and retained by groups in which other members exhibit similar characteristics, whereas individuals with high negative trait affectivity would be repelled by groups in which members have a high positive affect. Socialisation processes also contribute to the emergence of the collective affective tone in the sense that group members learn early on about an overall positive or negative group orientation to the work situation, that afterwards will be manifested in their characteristic affect at work.

Kelly and Barsade (2001) distinguished between implicit and explicit processes involved in the affective composition of the group. Examples of implicit processes are emotional contagion, behavioural entrainment and the vicarious experience of affect through modelling, in which the individual is not necessarily aware that emotional sharing is occurring. Explicit processes involve people actively attempting to influence the affect of other group members via intentional affective induction and affective impression management. Intentional affective induction consists of deliberate attempts by the sender to influence the mood of the receivers. Affective impression management involves engaging in surface level emotional displays in order to fit in, or gain rewards from the group.

All these potential explanations for the emergence of group mood are not exclusive. It is possible that different mechanisms lead to the emergence of a group mood in different situations, or even that different mechanisms have an additive effect.

Evidence has been provided for the influence of group mood on both team processes and work related outcomes. An experimental study by Barsade (2002) found that groups that had been induced with a positive emotional contagion experienced less conflict and more improved cooperation. Sy and colleagues (2005) verified that leaders' mood influenced the affective tone of the group, and those groups which had a leader in a positive mood exhibited more coordination and expended less effort than those groups which their leaders were in a negative mood. Barsade and colleagues (2000) examined the influence of diversity in positive affect in senior management teams and found a negative relationship between team's diversity in positive affect and the use of participatory decision-making and company financial performance. In addition, affectively diverse, low mean positive affect groups experienced the greatest task and emotional conflict and the least cooperation. George (1990) found that high positive tone was negatively associated with absenteeism, whereas high negative tone was negatively associated with prosocial behaviours at work. In a subsequent study, George (1995) also found that positive affective tone was positively associated with high customer service and reduced absenteeism.

Given that R&D team members usually have to exchange a great deal of information in virtue of the complexity of their tasks and the high task interdependence that typically characterises their projects, team members usually end up working in close proximity to each other (even if not physically at least in virtual settings, via e-mail or teleconference). These teams have consequently an ideal setting for the development of a team mood. This is specifically true in this study, since only team members that were directly involved in the R&D project under scrutiny, and therefore in communication with the others over the one week reference period of the study, were included in the sample. The extent to which team mood is likely to affect innovation activities will be further explored in a later section.

7.5 The nature of team innovation activities

It is important at this stage to discuss the conceptualisation of innovation activities as a team level construct with basis on multilevel theory. For the sake of illustration, the following discussion is focused on creativity activities, but the same argumentation should apply to implementation activities.

Multilevel research on creativity is still underdeveloped, which can be justified by the youth of the field. Yet, the failure to adopt a multilevel framework might undermine the understanding of work related creativity (Mumford & Hunter, 2004). Despite the pleadings for multilevel research, most of the studies conducted until now have focused on a single level of analysis, commonly the individual level (e.g., Zhou & George, 2001). Some exceptions are Taggar's (2002) study on the relationship between team creativity-relevant processes and individual and team creativity; Hirst, van Knippenberg and Zhou's (2008) study on the relationship between team learning behaviour, team supports for learning, goal orientation and employee creativity; and Drazin, Glynn, and Kazanjian's (1999) theoretical framework on how creativity unfolds across levels in long-duration organisational projects.

Scholars engaged in multilevel research on team (rather than individual) creativity face increased difficulties concerning theoretical, measurement and analysis issues. Kozlowski and Klein (2000) also made this point when they stated that "at first glance, the construct of unit creativity appears straightforward [...] But a further, multilevel perspective indicates much work to be done in defining, explicating, and operationalising the nature and emergence of unit-level creativity", p. 41.

Hitherto the work related to creativity literature has been dominated by individual level studies, and even when the research setting involves teams, the outcome under analyses is usually individual creativity (e.g., Amabile et al., 2005). These studies do not entail major measurement decisions as the level of data collection is obviously the individual. Team innovation research, on the other hand, is not centered on the generation of ideas but on their final execution, and the outcome to be assessed is usually associated with the final product developed by the team, which informs the methodological design (West, 2002; West & Anderson, 1996). However, when the outcome of interest is not individual creativity, or the final innovation product, but instead team creativity or team implementation activities, choices about the level of data collection, such as collecting measures for each single member or to gather one score for the whole team have to be undertaken.

By aiming to study *team creativity* this project is underlined by the assumption that, at least in the specific situation of R&D teams, creativity is a collective construct. The emergence of collective constructs takes place via social interactions between the lower level systems. In organisational settings, many collective constructs have their roots in the cognition, affect, behaviour and characteristics of individuals that emerge via social interaction and manifest at different levels (Morgeson & Hofmann, 1999). Emergence processes vary in a continuum ranging from composition to compilation (Kozlowski & Klein, 2000). For the sake of simplicity, only the two extreme forms of emergence will be discussed here.

Composition is based on assumptions of some level of isomorphism, and describes phenomena that are to some extent the same as they emerge across levels. The collective construct (designated shared unit properties) results from the convergence of similar lower level properties. Shared unit properties originate at the individual level and converge among group members as a function of attraction, selection, attrition, socialisation, or social interaction (Kozlowski & Klein, 2000).

Compilation, on the other hand, is based on assumptions of discontinuity. It refers to situations in which lower-level characteristics, behaviours and perceptions do not coalesce, but instead the higher-level phenomenon (designated as configural unit properties) is a more complex combination of the individual level contributions. The phenomenon comprises a common domain but is distinctively different across levels. Configural unit properties capture the array of different individual contributions to the whole. They also originate at the individual level, but unlike shared properties, they are not assumed to converge among members of a unit (Kozlowski & Klein, 2000).

The question about the nature of team creativity is pertinent within this project as it should inform the approach to data collection. Questions that should be addressed refer to whether team creativity emerges as a result of the convergence of the essentially identical contributions of individual members, as would be suggested by a direct consensus model (Chan, 1998), so that team creativity is a mere sum or average of individual creativity, or if team creativity results from the array or pattern of individual team members' creativity – the complex combination of one team member's contribution for one issue, another team members' contribution on a second issue, and the lack of contribution from a third member?

If one thinks of a string quartet in which each member performs their own part of the same music, and contributes equally for the overall creative performance of the quartet, one is led to assume the overall level of creativity follows a compositional emergence. The same conclusion applies if one considers the tendency for less creative individuals to start expressing themselves more freely and being more creative once given a role model (Jaussi & Dionne, 2003). It is likely that in teams that are initially dominated by the creative output of one or two individuals, less creative members can afterwards increase their creative output via role modeling to level up with the more creative members. Team creativity is in this case a shared construct that emerges from the convergence of individual members' creativity. On the other hand, if we think of a football team, a creative midfielder is often responsible for the level of creative football played by the team. The team can adopt a more or less creative style of play as a consequence of the input of one member. It is still a unit construct that we are looking at – the overall level of team creativity, but a configural one rather than a shared one, as different members have different contributions and these are not assumed to converge across individuals.

Theoretical proposals relating to team creativity have reflected the two underlying emergence forms. In their cognitive model of group creativity, Smith and colleagues (Smith, Gerkens, Shah, & Vargas-Hernandez, 2005) proposed that group creativity could be seen as an analogue of the individual cognitive system. Individual cognitive components have specific roles and functions that contribute to creative and non creative thinking and the authors suggest that the individuals in a group play the roles of these cognitive components in such a way that the group works as an overall mind. This isomorphism of the construct across levels (even though the author states the isomorphism is not complete) sets the model closer to a compositional emergence form. Woodman and colleagues' (1993) interactionist theory of creative behaviour on the other hand emphasises the different nature of individual and team creativity when describing two completely different sets of variables influencing the two outputs. This last proposition is thus closer to a configural ideal type.

As Kozlowski and Klein (2000) suggest, the type of emergence is influenced by the nature of the social-psychological interactions and can vary for a given phenomenon across situations, such as task types. Team creativity might therefore be compositional in some domains and compilational in others.

It is important to be clear about the type of unit level construct because this information should drive the form of measurement and strategy for analysis. The multilevel literature has provided a valuable set of recommendations on how to approach this question. According to this approach, individual level constructs should be measured with individual level data. The measurement of unit level constructs can be performed either with individual-level data that is afterwards combined, or with unit-level data (for example an expert source provides one single rating for the whole unit) (Kozlowski & Klein, 2000). There is, however, no universal agreement about this last point. Some researchers argue that unit level constructs should be assessed using unit-level data, as this avoids the ambiguity inherent in aggregated data (Rousseau, 1985); others argue that by using a global measure, the researcher lacks the data needed to test whether members are indeed homogeneous on the variables under consideration, and therefore researchers should only use unit-level data when there is absolute certainty about the level of the construct (Klein, Dansereau, & Hall, 1994).

In this line of reasoning, if one is just interested in studying individual creativity, the level of measurement is logically the individual. Self-ratings, peer-ratings, or leader/supervisor/expert informant ratings of the level of creativity demonstrated by each individual would be adequate forms of collection. Examples of this situation are abundant in the literature (e.g., George & Zhou, 2002). If one is interested in team creativity, two options are possible. The first option is to obtain a rating for the team as a whole. This might be a subjective rating of an expert informant (e.g., Tierney & Farmer, 2002) or other objective measures such as number of patents (e.g., Oldham & Cummings, 1996). The second option is to collect individual ratings, self or external, that are to be combined in some form later. The manner in which these individual ratings are combined depends to a large extent on the form of the ratings, and their level of isomorphism with the team-level construct (Bliese, 2000). Chan (1998) provided a useful typology of composition models (composition in this terminology has a broader meaning, including also what Kozlowski and Klein (2000) described as compilation models), which includes both consensus models (those most closely aligned to the earlier description of composition models), and compilation models. Chan described five types of composition models, any three of which might be used for measuring team creativity under certain circumstances.

The first, additive models, specify models in which individual constructs combine additively to form the higher-level construct. For example, it can be assumed that under Smith and colleagues (2005) model described above, that the level of team creativity is simply the total sum of all individual members' levels of creativity, in which case measuring individual members' creativity and aggregating would be all that is necessary to capture the level of team creativity. Alternatively, if team creativity were to be considered as a team-level construct without individual-level analogue (as suggested in Woodman and colleagues (1993)), then it could still be captured from individual data in two ways. Chan's referent-shift consensus model attempts to measure group-level properties by asking individuals about the group as a whole questions such as "to what extent does your team try out new ideas and approaches to problems?". As with all consensus models, it is necessary to demonstrate agreement of team members' views before data can be aggregated to the team level to form the team construct. The third of Chan's models which could be useful is the dispersion model. This is a compilation model that effectively measures the diversity of a lower level construct to obtain a higher-level construct that is not isomorphic. For example, it may be that team creativity is a function of differing viewpoints, or skills, or abilities within a team. Therefore the individual constructs could be measured, and the amount of diversity among them calculated in order to form the measure of team creativity.

When making this decision questions such as "Does it obey a composition or a compilation emergence model?" and "Is it a shared or a configural unit property?" have to be considered. According to Kozlowski and Klein (2000), shared unit properties emerge from shared perceptions, affect and responses, and have their roots at the psychological level, hence the data to assess these constructs should match the level of origin – the individual level. Collecting data at the individual level has the additional advantage of allowing to test whether the construct does result from a compositional emergence. If a compositional nature of creativity is assumed (via either an additive or consensus model), collecting individual level data is not only appropriate, but also a requirement to prove this assertion. One of the factors that will influence the type of emergence is the nature of the creative task. If the team has to perform an additive task (team performance is the sum of team member's performances; Steiner, 1972), the model of emergence is very likely a compositional one. The most appropriate form of measuring in this circumstance is the average of the individual ratings.

Configural properties result from individuals' characteristics, cognitions, or behaviours, but in this case they do not coalesce. Kozlowski and Klein (2000) recommend a variety of data-combination techniques, such as the minimum and the maximum scores, indices of variation, profile similarity or multidimensional scaling. The choice for each technique is highly dependent on the type of creativity task the team is facing. Taking Steiner's terminology as an example, if the task at stake is a disjunctive one (team performance is determined by the performance of the best team member), the adequate representation is the maximum score of the most creative team member. If the task is conjunctive (team performance equals the worst performer in the team), one should take the minimum obtained by a team member. If the task is somewhere between an additive and a disjunctive task, then one should calculate a weighted average (Pirola-Merlo & Mann, 2004). How the calculation that should be performed is not clear, and probably varies across different situations, depending chiefly on the type of task. Systematic efforts at measuring configural creativity are necessary to shed light on this problem.

Two empirical studies have started to address the nature of the emergence of team creativity by looking at the relationship between individual and team creativity. The results found by each study support a different model, providing confirmation of the contingent nature of the emergence. Taggar (2002) examined 94 student groups performing 13 open-ended tasks over 13 weeks. The author hypothesised that "group creativity is an interactive function of aggregated individual creativity and the specific behaviours within a team that measure team creativity-relevant processes". This assertion implies a synergistic perspective of creativity, which can be more easily associated with a compilation model. In this study individual (e.g., preparation, participation) and team relevant creative processes (e.g., effective communication, involving others), and individual creativity were peer-rated at the end of week 13. Team creativity was operationalised as the average of the 13 weekly assessments provided by an expert judge (team members received weekly feedback reports of these ratings). Taggar (2002) verified that the aggregation of the creativity individual ratings predicted group creativity as rated by the external judge. Furthermore, he found that creativity-relevant processes accounted for variation in team creativity beyond the variance explained by the aggregation of individual creativity. The results suggest that team creativity is not only the addition of individual level creativity but that the team creative relevant processes which emerge as part of the group interaction are also important. Pirola-Merlo and Mann (2004) challenged these conclusions and argued that it was possible to account for the findings reported by Taggar (2002) without accepting that team creativity is more than the aggregated creativity of group members. They claimed that in a typical interdependent project team, creativity emerges from the combination of individual creativity as the result of a fuzzy compositional form of emergence. This form is distinct from the compositional emergence presented by

Kozlowski and Klein (2000) and described earlier; in fuzzy compositional models the aggregate variable contains influences that are not captured by the lower level construct (Bliese, 2000). Contrary to Taggar, they claimed that team creativity is simply the aggregation of the creativity of individual members. They predicted that group processes would not account for significant variance in team creativity, after individual creativity had been accounted for. To test these assumptions, the authors analysed the relationship between individual and team creativity in a sample of 54 R&D teams over nine months. They measured individual, team, and project creativity. Individual creativity was computed as the average of three items; self report and leader ratings of creativity plus leader ratings of performance, rated monthly. Team creativity was assessed by asking members to rate the overall innovativeness of the work on the project completed in the last month. 'Time-general' creativity was measured by asking all team members at the end of the project to what extent they agreed with the item 'this team has developed innovative solutions to problems' measured in the initial questionnaire. Project creativity was assessed by asking team members to indicate the number of new products, processes, or patents and to rate the outcomes in terms of novelty, usefulness, creativity and innovativeness. They concluded that team creativity could be explained by aggregation of processes across both people and time: team creativity at a particular point in time could be explained by either the average or a weighted average of team member creativity, and the creativity of the project was explained by either the maximum of or average of team creativity across time-points. The differing conclusions of these two studies highlight how important it is to consider the nature of emergence when deciding upon the way the construct is measured.

In summary, it is not possible to generalise at this point about the nature of the emergence of team creativity. In certain domains creativity is a shared construct, whereas in others it is configural, and in others it will be somewhere along the continuum described by Kozlowski and Klein (2000). Furthermore, there is no single best way of measuring team creativity, either when it is assumed to be a shared or a configural property. The general rule that applies to configural and shared properties is that these should be assessed at the level of origin, and the model of data aggregation, combination and representation should be informed by the theoretical definition of the construct and the nature of its emergence (Kozlowski & Klein, 2000).

In this project both the individual and the collective team creativity of R&D team members are under scrutiny. The measurement of individual creativity is a less controversial issue and, as described in chapter five and in accordance with multilevel theory, it is here assessed at the level of origin, by asking team leaders to rate each individual member, using an individual referent. Based on the above analysis it was considered that the team creativity in R&D teams is better depicted by a compilation rather than a composition model. In R&D teams the most frequent scenario is that different team members are involved in different aspects of the same project. It is argued here, however, that the overall creativity of the project is not well represented by simply averaging the innovative activities of each member. Having a single R&D engineer who is extremely innovative might boost the overall level of the team innovation activities and the innovative character of the final product developed by the team, even if the other team members display a much inferior level of innovative activities and do not converge to the level of innovation activities of the innovative member. Often in a team it is sufficient in to have only one innovative member to boost the collective innovative performance (and it actually may be detrimental if all members display high levels of innovative activities). A leader evaluating such a team might rate their innovative activities very highly, given that as a team they are very innovative. However, if asked to rate individual members, it is possible that only one member would receive such high ratings, the creative centre of team, whereas the others would receive lower ratings. The average would suggest then that the team as a whole displays a low level of innovation activities, which is a misrepresentation of reality. Accordingly, creative and implementation activities are in this project assessed as a configural property by asking leaders to rate the team as a whole, rather than averaging the ratings given to each individual member. It is acknowledged that other operationalisations of team creativity could have captured the configural structure in a more precise manner (for instance, developing a rationale for how to combine the different contributions of individual members), but such an approach would involve an extensive effort that is beyond the scope of this project. It should however be noticed that systematic research on the nature of collective creativity across a range of different domains is needed in order to better understand how team creativity should be operationalised in each situation.

7.6 Team stressors and team innovation activities

Research focusing specifically on the impact of team stressors on team innovation related activities is very scarce. One of the few examples is the experimental study conducted by Karau and Kelly (1992) examining the relationship between time resources and performance quality in which creativity measures were included. The authors found that teams under a time-scarcity condition devoted greater attention than usual to working on the task but this higher focus was associated with solutions that were considered less creative and original than the ones produced by groups under the optimal time condition. Despite the lack of studies analysing the relationship between stressors and team innovation related activities, one can expect that this can be equated with the impact of stressors on information processing activities, given the extent to which the former are dependent on the latter in the R&D context,

Adopting Hinsz and colleagues' (1997) model of groups as information processors it is reasonable to assume that stressors will affect aspects of group functioning such as memory, retrieval, processing and response (Driskell et al., 1999). Based on this line of reasoning, it is expected that the impact of stressors on innovation related activities will follow the same pattern as observed for general information processing, i.e, it is predicted that stressors will have a negative impact on team innovation related activities via different mechanisms such as a decrease in quality of communication and a loss of team perspective which in turn disrupts team information processing activities such as encoding, storing and retrieving, which are critical for innovative activities.

Hypothesis 9: Team stressors will have a negative impact on the level of team creativity activities, i.e., there is a negative relationship between team stressors and team creativity activities.

Hypothesis 10: Team stressors will have a negative impact on the level of team implementation activities, i.e., there is a negative relationship between team stressors and team implementation activities.

7.7 Team mood and team innovation activities

Although to the author's knowledge there is not yet any study looking at the impact of team mood on team innovation activities, the relationship between team members' individual mood states and team innovation was already analysed in two experimental studies by Grawitch and his colleagues (Grawitch, Munz, Elliott, & Mathis, 2003; Grawitch, Munz, & Kramer, 2003). Grawitch, Munz and Kramer (2003) induced a positive, negative, or neutral mood on individual participants (opposite to the group as a whole) prior to their participation in a creative-structure building task that required creativity and implementation actions. The authors found that groups whose members had a positive mood induced were rated higher for their creative performance and exhibited more efficiency in their implementation, operationalised as the ratio between overall performance and time spent constructing the structure, than did those groups whose members had a neutral or negative mood induced. Positive mood did not, however, influence the number of ideas generated (idea fluency). In addition, negative mood was not found to hinder creativity or implementation efficiency, as compared to neutral mood. The authors also analysed group processes that could potentially mediate this effect, more specifically they tested if group members' positive mood would result in a stronger group focus on the task which in turn would lead to a better performance. The results showed that positive and neutral moods led to a stronger task focus, whereas negative moods created a stronger relationship focus within the group, but these processes were not related to group innovative performance.

A follow up study looking at the interplay between members' mood states and autonomy provided further support for the link between mood and creativity by showing that groups whose team members had a positive mood induced were rated higher for idea originality than groups that had a negative or a neutral mood induced.

However, once again there was no effect of mood on the fluency of ideas (Grawitch, Munz, Elliott et al., 2003).

The rationale provided by Grawitch and colleagues (2003; 2003) to explain the effects of mood on group innovative performance draws heavily on the mechanisms outlined to account for this relationship at the individual level. The authors made reference to increased individual cognitive flexibility, which should allow groups to develop more options for task completion; and to efficiency of information processed by individuals, which should influence the efficiency with which groups implement their solutions to the task. Given the failure to identify group processes involved, the authors admitted that the relationship between positive mood and group innovative performance may result only from an aggregated effect of mood on the individuals within the group, rather than the actual group level effect, but they suggested also that this might have been due to the fact that the processes assessed in their study were closely related with each other, and therefore left out other group processes that might have been relevant in explaining the mood- innovative performance relationship. The authors concluded than that it is important to consider both the direct impact of mood on performance, which results of the aggregation of the effects of mood at the individual level, and the indirect effect of mood on innovative performance, which might stem from the effect of mood on group processes.

In similar fashion, it is here suggested that beyond the direct impact that results from the aggregation of the individual level effects explained in chapter three, team mood also has an indirect effect on team innovative performance via its influence on team processes that are relevant for team information processing, which in turn are relevant for creativity. Although a thorough analysis of all the potential mediating processes is beyond the scope of this research project, it is important to develop a first attempt to account for the expected positive effects of team positive mood on team creativity. Mediating processes suggested by previous research relate to coordination activities and information processing style.

Sy, Cote and Saavedra (2005) verified that groups with a higher positive affective tone exhibited more coordination than those groups with a lower positive affective tone. Coordination amongst team members is a required condition for the effective articulation of team information processing activities such as encoding, storing and retrieving. If team members are unable to coordinate their contributions, the team as a whole is not able to adequately process them and integrate them in the team cognitive structures. It is therefore suggested that one potential mechanism to explain the effects of team mood on team innovative performance is increased team coordination.

Furthermore, the heuristic processing style that characterises the information processing of individuals in a high positive mood is very likely to be translated at the team level. If the group converges towards a positive mood, the team is likely to approach the task with a more flexible outlook, resulting in broader task mental models (Klimoski & Mohammed, 1994; Mohammed, Klimoski, & Rentsch, 2000) which in turn offer more scope for creative solutions. Based on this reasoning, the following hypotheses is formulated:

Hypothesis 11: Team positive mood will have a positive impact on the level of team creativity activities, i.e., there is a positive relationship between team positive mood and team creativity activities.

Concerning the relationship between positive mood and implementation, there are strong reasons to assume both a positive and a negative relationship. On the one hand, the increased team coordination promoted by positive mood is very likely to facilitate team implementation, and the only study that examined similar constructs reported a positive impact of positive mood states on implementation efficiency (Grawitch, Munz and Kramer, 2003). On the other, the direct effects that result from the aggregation of individual moods are likely to be either positive or negative, as explained in chapter three. Furthermore, the heuristic processing style elicited by positive moods is likely to be replicated in the group's information processes. If all team members are in a positive mood and converge towards a positive team mood, it is reasonable to think that the team's analysis of the task at hand will be more general and superficial and they may fail to identify potential errors, which can be fatal during implementation. In virtue of these logical but contradictory argumentations, as in chapter three, no hypothesis is presented here concerning the relationship between positive mood and implementation activities.

Aside from the direct impact of mood on team creativity that derives from the aggregation of the effects at the individual level, negative mood is also likely to affect team creativity in an indirect way via team processes. Although there is not much research analysing the impact of negative mood on team processes, it is reasonable to speculate that, by the same token that team positive mood is likely to elicit a more heuristic group approach to the task in hand, team negative mood will induce a more systematic approach, leading the group to focus on development of activities in an structured manner. Although this approach is not conducive to creativity, which benefits more from a more free-driven loose processing style, it can facilitate activities related to the implementation of innovation, given its thoroughness and capacity to detect potential errors or anticipate problems that might emerge. Given the above reasoning, the following hypotheses are drawn:

Hypothesis 12: Team negative mood will have a negative impact on the level of team creativity activities, i.e., there is a negative relationship between team negative mood and team creativity activities.

Hypothesis 13: Team negative mood will have a positive impact on the level of team implementation activities, i.e., there is a positive relationship between negative mood and team implementation activities.

Next, how the interplay between team mood and team stressors influences team performance is explored from three different perspectives.

7.8 Interplay between team stressors and team mood: Interaction models

In extension of the relationship between individual affect and cognition discussed in the previous chapter, the existence of a relationship between team affect and team cognition has also been suggested by several researchers. For instance, George (1996) argued that the highly interdependent nature of affect and cognition at the individual level of analysis suggests that group affective tone and team mental models might have reciprocal influences on each other. The author added that it is also likely that group affective tone impacts on the cognitive structures and processes by which group members make sense of situations and issues.

The theoretical rationales for the interaction between team stressors and team mood are necessarily different from those offered previously for the individual-level relationships, focusing on group rather than individual level processes. Despite these differences, it is considered that the mood related theories applied in chapter three still offer a relevant framework for the analysis of the interplay between stressors and mood in teams. Consequently, a parallelism can be drawn between the development of hypotheses at the individual and team level. In similar fashion as in the chapter three, the patterns of interaction between team stressors and team mood are analysed from three different perspectives, each leading to different conclusions.

7.8.1 Cognitive spreading activation

As described in chapter three, cognitive spreading activation theory assumes that information is stored in nodes in such a way that when a stimulus activates a node, the activation will spread through the network via cognitive spreading activation. As moods activate associate networks that are congruent with themselves, and people generally have more positive events networks then negative events, positive moods will elicit a wider activation, leading to a larger range of available responses to a problem. From this perspective, people in a positive mood are more cognitively flexible, meaning that they are more able to make associations, to see dimensions, and to see potential relations among stimuli, than people in a neutral state. This phenomenon might be reflected at the group level. George (1996) suggested that if individuals tend to experience positive moods in their team, then as individuals they may tend to be more cognitively flexible. Through social influence and other group processes, this individual cognitive flexibility may be reinforced and strengthened. For instance, the number of ideas shared will increase exponentially due to the inter-individual stimulation that occurs within the team, assembling together the different individual cognitive networks in a synergistic way. As a result of these individual and group level processes, the group as a whole can become more cognitively flexible, which will be reflected in the greater flexibility of its shared mental models.

Considering that stressors exert their influence, at least partially, by leading to a loss of team perspective, which in turn reduces important team information processes and other emergent states such as team mental models, a positive mood, from this perspective, would counteract the impact of stressors via two different pathways. First, if team members share a positive mood they are more likely to display gregarious behaviours in order to share information (Briefhoff & Muller, 1999), preventing to some extent the loss of team perspective. Second, if team members are in a positive mood, their team mental models become more flexible, which can be considered adaptive when facing innovative related tasks such as generating ideas and implementing solutions. The more flexible mental models compensate for the disruption of mental models caused by team stressors, resulting in a buffer effect. Based on this line of reasoning, from this perspective it is expected that when facing stressors teams in a high positive mood will perform better than teams in low positive mood, both in terms of creativity and implementation activities.

Hypothesis 14.1: Positive mood will buffer the negative impact of stressors on the level of creativity activities displayed by R&D teams; the level of creativity of teams in a high positive mood will suffer less from increased levels of stressors than that of teams in a low positive mood. In other words, the negative stressor-creativity slope will be steeper for teams in a low positive mood as compared to teams in a high positive mood.

Hypothesis 14.2 Positive mood will buffer the negative impact of stressors on the level of implementation activities displayed by R&D teams, the level of implementation activities of teams in a high positive mood will suffer less from increased levels of stressors than that of teams in a low positive mood. In other words, the negative stressor – implementation slope will be steeper for teams in a low positive mood as compared to teams in a high positive mood.

As discussed in chapter three, there is no evidence suggesting that negative mood affects individual cognitive activation and there is no sufficient information to speculate upon the effects of negative mood on a team level construct analogous to cognitive activation. As such, no hypotheses regarding the interplay between team negative mood and stressors are drawn based on this perspective.

7.8.2 Mood repair perspective

To recap, mood repair perspective sustains that individuals in the high poles of both positive and negative mood are concerned with and engage in activities for maintaining or changing their mood, respectively; whereas for those individuals in the lower ends of these dimensions mood is not salient and therefore no attempts are made to change or maintain them (Wegener & Petty, 1994). These mood repair activities are however cognitive consuming, and tax resources that are consequently not available for other activities. The implications of this phenomenon when transferred to the team level of analysis can be easily intuited. There is evidence that in teams with low levels of group conflict there is a tendency to acquiesce, which taken to the extreme can lead to groupthink phenomenon, ultimately resulting in decreased team performance (Janis, 1972). If the context is harmonious, individuals might refrain from engaging in activities that hold the potential to change the status quo, and in exchange drive their efforts towards maintaining harmonious relationships. In a similar fashion, if there is a positive mood within the team, team members employ their energies and canalise their team processes towards the maintenance of that mood. This is translated for instance in social activities such as informal chats or more frequent coffee breaks. Furthermore, Ilgen and colleagues (1995) verified that individuals engaged in a series of non-work role behaviours that were not directly related to their tasks but were not either what has been conceptualised as organisational citizenship behaviour. These activities, designated by the authors as schmoozing, included chatting, having office parties, or going for lunch with colleagues. Although these activities were not directly related with performance, they were correlated with high levels of job satisfaction. When facing stressors that might disrupt the team mood, one can predict that these schmoozing activities will be exacerbated in an attempt to undermine the threat imposed by stressors. Consequently, team information processing resources are directed not towards coping with the stressors, but towards maintaining the high levels of team positive mood.

On the other hand, those teams in a low positive mood are not sentitive to mood threatening factors, and consequently do not have to engage in mood repair activities. As such, the information processing resources of these teams are not charged with managing their mood levels and can be instead allocated towards responding to stressors.

Mood can also affect teams' information processing approach. According to Stasser and Birchmeier (2003), groups tend to follow one out of two possible information processing approaches. A preference driven approach is adopted when the goal is to discover popular beliefs and preferences. This style is characterised by the communication of opinions and preferences (for example voting) and identification of the dominant or majority positions. In this processing mode members may change their minds, but opinion change is likely to represent acquiescence or conformity on the part of dissenting members. On the other hand, an information driven approach is adopted when the goal is to inform members and identify options that are supported by the majority of evidence. This approach is characterised by communication and integration of relevant information. In this processing mode opinion changes flows from learning new information and reevaluation of options in light of what's learned. It seems reasonable to expect that teams in a high positive mood will adopt a preference-driven style as this represents the best bet in terms of avoiding conflict and keeping mood levels high. In a similar fashion as before, this tendency will be even greater when the team is facing stressors, as the threat to the mood is increased and teams in a high positive mood are more sensitive to mood related stimuli. In contrast with information-driven interaction, which is more conducive to the discovery and implementation of creative ideas, preference-driven interaction affords little opportunity for the emergence of innovative decision-making, as group decisions are largely a reflection of dominant sentiments of members at the onset of discussion.

In sum, taking into account this approach it is expected that positive mood will enhance the negative impact of stressors and consequently teams in a high positive mood will be more negatively affected by stressors than teams in a low positive mood when engaging in both creativity and innovation activities.

Hypothesis 15.1: Positive mood will accentuate the negative impact of stressors on the level of creativity activities displayed by R&D teams, the level of creativity of teams in a high positive mood will suffer more from increased levels of stressors than that of teams in a low positive mood. In other words, the negative stressor – creativity slope will be steeper for teams in a high positive mood as compared to teams in a low positive mood.

Hypothesis 15.2: Positive mood will accentuate the negative impact of stressors on the level of implementation activities displayed by R&D teams, the level of implementation of teams in a high positive mood will suffer more from increased levels of stressors than that of teams in a low positive mood. In other words, the negative stressor – implementation slope will be steeper for teams in a high positive mood in as compared to teams in a low positive mood.

By the same token, similar effects are expected for teams in a high negative mood. As with positive mood, high negative mood teams are also concerned with managing their mood levels. For teams in a high negative mood their affective states are very salient, opposite to what occurs in teams in a low negative mood. Adding support to this claim, Grawitch and colleagues (2003) found that teams in high negative mood tended to be more relationship oriented than task oriented, which probably is symptom of an attempt to improve team mood via social interaction. The presence of stressors, as a factor that can represent a threat to team mood, can further activate the engagement of teams in a high negative mood in mood repair activities, such as informal breaks and relationship oriented activities. This would lead to an additional taxing on the team resources available to cope with stressors. Based on this reasoning, it is hypothesised that:

Hypothesis 16.3: Negative mood will accentuate the negative impact of stressors on the level of creativity activities displayed by R&D teams, the level of creativity of teams in a high negative mood will suffer more from increased levels of stressors than that of teams in a low negative mood. In other words, the negative stressor – creativity slope will be steeper for teams in a high negative mood as compared to teams in a low negative mood.

Hypothesis 16.4: Negative mood will accentuate the negative impact of stressors on the level of implementation activities displayed by R&D teams, the level of implementation of teams in a high negative mood will suffer more from increased levels of stressors than that of teams in a low negative mood. In other words, the negative stressor – implementation slope will be steeper for teams in a high negative mood as compared to teams in a low negative mood.

7.8.3 Mood-as-information

As described in chapter three, according to the mood-as-information theory, moods provide individuals with information about their current situation. Positive moods signal that the world is currently safe and satisfactory, and there is no need of engaging in cognitive effort, whereas negative moods signal a problematic situation about which is necessary to take action (Schwarz & Clore, 1983, 1988). Individuals' cognitive processes are tuned to meet these perceived situational demands as the information provided by moods triggers different processing strategies. Positive moods promote the exploration of new associations and engagement in heuristic as opposed to effortful processing, whereas negative moods lead to careful, conservative, effortful processing (Schwarz, 1990).

On the grounds that the heuristic processing style elicited by positive mood on individual team members is transferred via social influence and other group interaction processes to the team level, the hypothesis described for the individual level of analysis finds here a direct parallelism.

A heuristic processing style in groups translates as a more free and flexible exchange of ideas which might counteract the loss of team perspective and consequent depletion of information processing mechanisms caused by stressors. Consequently, when facing stressors the creative output of teams in high positive mood should be less affected by stressors than the output of those teams in low positive mood. However, in a similar fashion to what is observed for the individual level, the same is not the case for implementation activities. Again, the heuristic processing style elicited by a high positive mood would not be beneficial to counteract the impact of stressors on team implementation activities, as these would only be facilitated by a systematic processing style. Based on this line of thought, it is predicted that when facing stressors the implementation activities of those teams in high positive mood will be more affected that the ones of those in low positive mood.

Hypothesis 17.1: Positive mood will buffer the negative impact of stressors on the level of creativity activities displayed by R&D teams, the level of creativity of teams in a high positive mood will suffer less from increased levels of stressors than that of teams in a low positive mood. In other words, the negative stressor – creativity slope will be steeper for teams in a low positive mood as compared to teams in a high positive mood.

Hypothesis 17.2: Positive mood will accentuate the negative impact of stressors on the level of implementation activities displayed by R&D teams, the level of implementation of teams in a high positive mood will suffer more from increased levels of stressors than that of teams in a low positive mood. In other words, the negative stressor – implementation slope will be steeper for teams in a high positive mood as compared to teams in a low positive mood.

Similar to what was argued in chapter three, it is suggested that the pattern of the interaction is inverted when considering the role of negative mood. Negative mood informs the team that the environment is threatening, and encourages a systematic processing style, favouring the choice of safer and more routine options rather than riskier and more unusual ones. If teams are in a high negative mood, the presence of stressors will be interpreted as an even more threatening factor, and the performance in creativity activities will consequently decrease. Teams will prefer to stand by routine, safer, options rather than engaging in trying new alternatives.

On the other hand, team activities that are essential for effective implementation, such as attention to error and accurate communication, are impaired by stressors, which deplete team's cognitive resources and affect the capacity to exchange and process information accurately. The heuristic processing style elicited by negative mood facilitates these activities, and can therefore counteract the negative impact of stressors. Based on this line of reasoning, one would expect the implementation activities of individuals in a high negative mood will be less affected than the implementation activities of individuals in a low negative mood when facing stressors.

Hypothesis17.3: Negative mood will accentuate the negative impact of stressors on the level of creativity activities displayed by R&D teams, the level of creativity of teams in a high negative mood will suffer more from increased levels of stressors than that of teams in a low negative mood. In other words, the negative stressor – creativity slope will be steeper for teams in a high negative mood as compared to teams in a low negative mood

Hypothesis 17.4: Negative mood will buffer the negative impact of stressors on the level of implementation activities displayed by R&D teams, the level of implementation of teams in a high negative mood will suffer less from increased levels of stressors than that of teams in a low negative mood. In other words, the negative stressor – implementation slope will be steeper for teams in a low negative mood as compared to teams in a high negative mood.

Given that the graphical depictions that illustrate these hypotheses replicate the ones presented in chapter three, in order to avoid repeating them here the readership is referred to figures 3.1 and 3.2.

These above outlined frameworks were tested in the same field study as described in chapter five. The methodological issues that are specific to the testing of the team level hypotheses as well as the results are described in the next chapter.

Chapter 8

Testing team level models:

Method, analyses and results

This chapter presents the results pertaining to the team level models of the statistical analyses performed on the data collected by means of the questionnaire survey presented in chapter five. Firstly, the psychometric properties of the data set are analysed. The factor analysis results, scale reliability tests and correlational results are introduced. Next, moderated regression analyses are conducted in order to test the hypotheses presented in chapter seven. This chapter concludes with a discussion of the results, theoretical contributions and recommendations for future research.

8.1 Method overview

As described in chapter five, this study was undertaken in a sample of R&D teams from varied sectors, belonging to a number of Portuguese R&D organisations. Two different sets of questionnaires were distributed to team members and team leaders/supervisors. The questionnaires were distributed via mail and collected by the author on the first days following the week targeted by the study. For the sake of legibility, all tables and figures are placed at the end of the chapter.

8.1.1 Measures

Similar to the design described at the individual level (chapter five), measures of mood and stressors were collected from the team members whereas team innovation activities were assessed by the team supervisor. A measure of team mood was obtained by aggregating the individual responses at the team level, in line with previous research (George, 1990). The time frame was short (one week) in order to avoid inadvertently measuring affect as a trait (George, 1996). Stressors were assessed using the same scales described earlier but having the team instead of the individual as a referent. In a similar fashion, team innovation activities were rated on identical scales as used to assess individuals, but using the team as a referent.

8.1.2 Control variables

The same team level controls as described earlier (chapter five) were included in these analyses, i.e., team size, creativity requirements over the week, project length, and stage of the project.

8.2 Factor analysis results

Similar to the procedure adopted in the individual level analysis, the distinctiveness of the three team stressors was tested using exploratory factor analysis (EFA) techniques. Principal axis factoring and direct oblimin rotation were employed as methods of extraction and rotation, respectively. Table 8.1 presents the results of the EFA including the items capturing team quantitative demands, team qualitative demands, and team role ambiguity. As was the case with the scales capturing the individual level stressors, the results show a clear three factor structure, providing evidence for the distinctiveness of the three team stressors.

8.3 Treatment of the data: aggregation of constructs

Aggregation of data at the group level requires both a theoretical basis and empirical justification (Kozlowski & Klein, 2000). All stressors and both positive and negative mood were aggregated to the team level, with theoretical justification for this procedure provided in chapter seven. To empirically justify aggregation, interrater reliability coefficients ($R_{wg}(j)$, James, Demaree, & Wolf, 1984) were calculated as evidence of consensual validity. All the variables under scrutiny showed good consensual validity (quantitative demands R_{wg} (j) = .82; qualitative demands, R_{wg} (j) = .84; role ambiguity, R_{wg} (j) = .89; positive mood, R_{wg} (j) = .89; and negative mood R_{wg} (j) = .88).

It has been suggested that in order to justify aggregation it is also necessary to show that there is more variance between than within teams. For this purpose *F*-statistics and eta-squared coefficients (ICC1) were calculated in order to demonstrate discriminant validity (cf. Bliese, 2000). ICC(1) provides an estimate of the extent to which individual-level variability on a given measure is explained by higher level units. A second indicator, the ICC(2), provides an estimate of the reliability of group means (Bliese, 2000). A one-way analysis of variance was conducted on each of the variables to determine whether between-group differences were more significant than within-group differences (Chan, 1998). Overall, the ICCs were not sufficiently high, which is not unexpected given the general small size of the teams (Bliese & Halverson, 1998). The ANOVAS were significant for all stressors and negative mood, showing more variance between groups than within groups. For quantitative demands $F = 2.40$; $p = .00$, ICC1 =. 33, ICC2 = .58; for qualitative demands; $F = 2.46$; $p = .00$, ICC1 = .33, ICC2 = .59; for role ambiguity, $F = 2.20$; $p = .00$, ICC1 = .29, ICC2 = .54; and for negative mood, $F = 1.59$; $p = .04$, ICC1=.17, ICC2 =.37. However, the one-way analysis of variance was not significant for positive mood, $F = 1.26$; $p = .20$, ICC1 = .08, ICC2 = 0.20. Although the low ICCs and non significant ANOVA for positive mood might suggest aggregation of these constructs is not appropriate, it is argued that these results are explained by the characteristics of the sample and should not impede aggregation. It has been argued that in situations in which several teams in the sample belong to the same organisation, as it is the case with this data set, it is likely that there will not be large differences between the teams (Schneider, 1975; Schneider & Reichers, 1983). Further, it has been suggested that in such cases the correct way to justify aggregation it to demonstrate agreement within a group rather than differences across groups (Schneider & Bowen, 1985). According to this perspective, the adequate test for within-group agreement would be a measure of homogeneity such as the R_{wgs} presented earlier, rather than an index like analysis of variance (ANOVA) or the intra class correlation coefficient (ICC), which are dependent on between-group differences being significant (George, 1990; Schneider & Bowen, 1985). Furthermore, as James (1982) and George and James (1993) stated, aggregation can be appropriate even without having statistical justification if the theory, research questions, and hypotheses of a study require a particular level of analysis. Taking into account that it is normal for groups within the same organisation not to differ greatly and given that the $R_{wgs}(j)$ show high levels of agreement, it was considered that there was enough empirical support to justify aggregation.

8.4 Correlational results and scale properties

The correlation table is presented in table 8.2, along with scale properties. Cronbach's alpha for all scales was above .70, providing evidence of good scale reliability.

8.5 Testing of hypotheses

8.5.1 Testing of main effects

Hypotheses were tested by conducting block entry multiple regression analyses. In order to test for the main effects of stressors and mood, each of these variables was regressed on all team innovation activities. All control variables were entered in a first step. In a second step, the stressor or mood under analysis was entered. Given the small size of the sample (41 team level units), each stressor and mood was tested separately. The results for these analyses are displayed in table 8.3.

Overall, only three main effects were found and two of these were only marginally significant. Quantitative demands was found to have a marginally significant negative effect on decision-making β =-.33, ΔR^2 = .09, $F(1, 35)$ = 1.95; p = .06. This result partially supports hypothesis 10, which referred to an expected negative effect of stressors on implementation activities. However, the fact that none of the other stressors had a significant impact on innovation activities suggests the operation of moderators.

Negative mood was found to have a significant negative impact on creativity activities, β = -.46, ΔR^2 = .13, $F(1, 35)$ = 3.02; p = .02, lending support to hypothesis 12.

Opposite to what was predicted by hypothesis 11, positive mood was found to have a marginally significant negative effect on creativity $\beta = -.26$, $\Delta R^2 = .06$, $F(1, 35) = 2.21$; $p = .1$.

In sum, although not conclusive, these results lend partial support to a negative impact of stressors on implementation activities (hypothesis 10) and are also in line with the expected negative impact of negative mood on creativity (hypothesis 12). The results, however, go against the hypothesised positive impact of positive mood on creativity activities (hypothesis 11). There is no evidence to support either the expected negative effects of stressors on creativity (hypothesis 9) or the positive effect of negative mood on implementation activities (hypothesis 13).

8.5.2 Testing of interaction frameworks

In order to test the moderator hypotheses, each of four team level innovation activities was regressed on quantitative demands, qualitative demands, role ambiguity, mood, and their multiplicative term (Tables 8.4, 8.5 and 8.6 respectively). Separate regressions for each stressor were conducted given the limited size of the sample. The control variables were entered into the first block of the regression. On the second block the stressor and mood state under analysis were entered, and on the third step the interaction term was entered. In all analyses predictor variables were centred in order to reduce multicollinearity (Aiken & West, 1991). To facilitate interpretation of the interactions, relationships were plotted according with the procedure suggested by Aiken and West (1991).

8.5.2.1 Interaction between stressors and positive mood

The results for the analysis of the interplay between positive mood and quantitative demands, qualitative demands and role ambiguity are depicted in tables 8.4, 8.5 and 8.6, respectively.

Creativity activities were predicted by interactions between positive mood and qualitative demands, $\beta_{\text{interaction}} = -.34$, $\Delta R^2 = .09$, $F(1, 33)=2.50$; $p = .04$ (figure 8.1) ; and between positive mood and role ambiguity, $\beta_{\text{interaction}} = -.35$, $\Delta R^2 = .09$, $F(1, 33) = 2.66$; $p = .04$ (figure 8.2).

Concerning implementation activities, avoiding procrastination was predicted by the interaction between positive mood and quantitative demands $\beta_{\text{interaction}} = -.30$, $\Delta R^2 = .07$, $F(1, 33) = 2.68$; $p=.07$ (figure 8.3), although this interaction was only marginally significant; and focus and obstacles was predicted by the interaction between positive mood and role ambiguity $\beta_{\text{interaction}} = -.46$, $\Delta R^2 = .15$, $F(1, 33) = 1.97$; $p = .012$ (figure8.4). Table 8.7 provides a summary of the significant interactions. Figures 8.1 to 8.4 illustrate the significant interaction effects reported above.

8.5.2. Interaction between stressors and negative mood

Negative mood was found to interact with qualitative demands, $\beta_{\text{interaction}} = .35$, $\Delta R^2 = .06$, $F(1, 33) = 2.16$; $p = .08$, and with role ambiguity $\beta_{\text{interaction}} = -.31$, $\Delta R^2 = .07$, $F(1, 33) = 2.42$; $p = .08$. to predict avoiding procrastination. However, these results were very close to non significance. For the sake of completion the results of the interplay of team negative mood with quantitative demands, qualitative demands and role ambiguity are presented in tables 8.8, 8.9 and 8.10, respectively.

8.6 Interpretation of results

In a general manner, the pattern of interactions between team stressors and team positive mood replicated the one found at the individual level. The interactions depicted show that when facing stressors, teams in high positive mood suffer more than teams in low positive mood, being that the latter can even benefit from the presence of stressors. These results are in line with the predictions forwarded by hypotheses 15.1 and 15.2., which postulated that in the presence of stressors teams in high positive mood will display lower level of creativity (H 15.1) and implementation (H 15.2) activities than teams in low positive mood.

Furthermore, these results contradict hypothesis 14.1, informed by the cognitive spreading activation framework, and hypothesis 16.1, informed by the mood-as-information framework, as both perspectives sustained that in the presence of stressors teams in high positive mood will display higher level of creativity activities than teams in low positive mood.

It is relevant to notice that the mood-as-information framework is also partially supported. When facing stressors, the implementation activities of teams in low positive mood is less affected than those of high positive mood, in line with hypothesis 16.2. However, as explained in the previous paragraph, this framework is invalidated by the failure of teams in positive mood to perform better in terms of creativity activities than those in low positive mood when facing stressors, as it would have been expected according to hypothesis 16.1.

The results deriving from the interplay between stressors and negative mood are not very informative to support either framework, given its borderline significance. However, it is still important to note that one of the interactions found offers further support to the mood repair framework, as it shows that when facing role ambiguity teams in high negative mood suffer more in terms of their implementation activities than teams in low negative mood (in line with hypothesis 15.4). Yet, the other interaction displays the opposite pattern, suggesting that when facing qualitative demands teams in high positive mood are less hindered in terms of their innovation activities than teams in low negative mood, which contradicts hypothesis 15.4, and instead supports the hypotheses 16.4, informed by the mood-as-information framework, which suggests that in the presence of stressors teams in high negative mood will be less affected in terms of their implementation activities than teams in low negative mood.

Table 8. 11 presents a summary of the evidence in support and against each of the hypotheses that were drawn in accordance with the three different frameworks. For the sake of simplicity, the six interactions found, and which are now used as evidence to support or reject each of the hypotheses, were numbered from one to seven

(1) Qualitative demands x positive mood to predict creativity (figure 8.1)

(2) Role ambiguity x positive mood to predict creativity (figure 8.2)

(3) Quantitative demands x positive mood to predict avoiding procrastination (figure 8.3)

(4) Role ambiguity x positive mood to predict focus and obstacles (figure 8.4)

(5) Quantitative demands x negative mood to predict avoiding procrastination (figure 8.5)

(6) Role ambiguity x negative mood to predict avoiding procrastination (figure 8.6)

As can be observed from table 8.11, the framework that receives stronger support is the mood repair framework. These results and its implications will be discussed in the next section.

8.7 Discussion

The objective of the study described in this chapter was to test whether the interplay between stressors and mood found at the individual level of analysis was replicated at the team level. The findings of this study revealed that, in support of the interactionist framework, the impact of team stressors on team innovation activities is dependent upon the levels of team mood.

By closely replicating the patterns identified at the individual level of analysis, this team level analysis brings further support for the effect of stressors-mood on innovation activities. It is however important to notice that the group-level relations reported in this chapter are not meant to replace the individual-level findings, nor should they be viewed as more important or meaningful. The relations found at both levels are significant and important for different reasons and are explained by different rationales.

Consistent with the predictions drawn, negative mood was found to negatively affect creativity activities, and partial support was also found for the expected negative effect of stressors on implementation activities. Opposite to what was predicted, positive mood was found to impair rather than facilitate creativity. No support was found for the expected positive effect of negative mood on implementation nor for the negative effect of stressors on creativity. These results suggest that these variables do play an important role in the display of the innovative activities but their effects are likely to be modified by moderators.

The pattern of results of the significant interactions suggest that in the presence of stressors both creativity and innovation activities are facilitated if teams have a low positive mood. As this was also the case for the individual level, these results seem to offer stronger support for the repair framework. It is important to notice however that this support is only partial. Given that the negative impact of qualitative demands on creativity is actually buffered by a low positive mood, it seems that something occurs rather than just the absence of consumption of resources that explains the deficit of a high positive mood. Any conclusion must be somewhat tentative considering the small number of studies that have probed this issue so far.

8.7.1 Limitations

It is important to take notice of the limitations of this study. Firstly, as was already noted in the discussion of the individual level results, the cross-sectional nature of this study impedes the derivation of conclusions about causality. It is possible that it is the engagement on creativity and team implementation activities that affects team mood and the level of stressors perceived, rather than the reverse. Although the majority of research has looked at mood and stressors as antecedents of creativity, it has also been suggested that the possibility to engage in creativity acts improves mood levels. Future research should employ experimental designs and field longitudinal studies to further explore these relationships. Secondly, although team mood was operationalised according to procedures recommended in previous studies, it might be more appropriate in future research to apply a reference shift model to assess team mood, rather than using only the aggregation of individual team members' moods. Although team members adapt to the groups' dominant mood within the work context, it is possible that they still maintain their own private moods, which were induced by occurrences outside the work sphere. This private mood is latent and is not projected to the group. This assumption is not in contradiction with George's stance that group mood emerges from the convergence of individual's moods. Group moods do emerge from key group members such as the leader, who can by contagion influence other team members' resulting in a consensual mood (Sy et al., 2005). However, once outside the work sphere, team members are not under the influence of the group mood and might refer again to their private moods. It is possible then that asking individuals to report about their individual mood states might prime them to focus on their own latent private mood rather than on the group mood, and as so the information obtained refers to how they individually feel rather than how they feel as a member of the group, resulting in lower levels of group agreement. In order to avoid this potential pitfall future studies should ask individuals to report upon both individual and team mood.

Although this issue was already discussed earlier, it is important to notice that a potential third limitation of this study relates to the low ICC(s) reported for stressors and mood, which might threaten the possibility of aggregation. Given the small size of the teams in this study and the fact that several of them are part of the same organisations, these results are not unexpected. As the $r_{wgs}(j)$, a measure considered by many researchers to be a more appropriate indicator in such circunstances, showed high within group agreement, together with the strong theoretical reasoning to support the collective character of these constructs (George, 1990; Keller, 2001), aggregation was deemed justifiable.

8.7.2 Contributions to theory

Its limitations notwithstanding, this study makes important contributions to theory.

Firstly, it extends mood theories to the team context and combines them with team processes theories in order to better understand the effects of team mood on team innovation activities. The application of theories such as cognitive spreading activation, mood repair and mood-as-information to teams offers a fruitful framework for future research on team cognition.

Secondly, this study builds upon a vast body of research conducted within the interactionist model of creativity and innovation (Woodman et al., 1993). By showing how the impact of a contextual variable, stressors, on team activities is contingent on a team emergent state, mood (Marks, Mathieu, & Zaccaro, 2001) this study contributes to the understanding of how team characteristics interplay with contextual factors to affect innovation.

Thirdly, this study contributes to an emergent body of research on team affective states by bringing further evidence for the impact of this construct on a range of innovation activities.

8.7.3 Future research

Although potential explanatory mechanisms accounting for how the interplay between team stressors and team mood affect team innovation activities have been discussed, these were not tested in this study. It is important that future research attempts to identify the variables that mediate this relationship. Which processes are affected by the interplay between stressors and mood? According to the mood repair framework, one potential mediator is schmoozing activity. In an attempt to keep their mood level high when this is threatened by stressors, team members tend to engage in more social activities such as going for coffee or chatting, which results in a loss of focus on work related demands and a consequent decrease of innovation activities. Future research should attempt to verify if in fact in the presence of stressors teams in high positive mood are more likely to engage in schmoozing activities, which in turn negatively affects the team's innovative performance.

Albeit this research draws mainly on a cognitive, information processing framework, it is possible that motivational mechanisms also play an important role in explaining the relationships between these variables. Future research might attempt to develop and empirically test a motivational based framework.

The stressors considered in this research are very likely the most general and frequent type found in the workplace. There is, however, a much broader range of stressors, and little is known about how they affect team innovation activities. Although the information processing framework that informs this research suggests a negative impact of stressors on innovation activities, a different perspective might lead to a different set of hypotheses. For instance, from a motivational perspective, the activation perspective suggests that an intermediate level of stressors is associated with the best levels of performance (Yerkes & Dodson, 1908). It is also possible that not all stressors have the same impact on innovation activities, and even that the same stressor might affect differently the varied innovation activities. A systematic research program is required in order to unveil which stressors are positively and negatively associated with the different innovation activities and to account for the underlying processes that lead to these effects.

Finally, the opposite pattern of results found for two stressors – qualitative demands and role ambiguity - when interplaying with negative mood to predict one implementation activity, avoiding procrastination, suggests that stressors might have distinctive characteristics, and that not all stressors interplay with mood in the same manner. Future research should further examine this possibility, and aim to develop a rationale that can account for such differences.

Table 8.1

EFA Team Quantitative Demands, Team Qualitative Demands and Team Role Ambiguity

Principal Axis Factor Analysis, Pattern Matrix, Oblique rotation

Item	Construct	Factor loadings		
We had to work fast.	Quantitative demands	**.847**	-.033	-.018
We had too much work to do.	Quantitative demands	**.705**	.061	.078
We had to work extra hard to finish a task.	Quantitative demands	**.702**	-.028	.024
We could do our work in comfort.	Quantitative demands	**.413**	-.013	.084
We had to work under time pressure	Quantitative demands	**.942**	.013	-.148
We had to deal with a backlog at work.	Quantitative demands	**.623**	.030	.012
The demands of work quality made upon our team were unreasonable.	Qualitative demands	.185	-.120	**.506**
Our assigned tasks were sometimes too difficult and complex.	Qualitative demands	.008	-.069	**.672**
Tasks seemed to be getting more and more complex.	Qualitative demands	-.043	-.053	**.785**
The organization expected more of us than our skills and/or abilities provide.	Qualitative demands	.002	.076	**.713**
We had insufficient training and/or experience to discharge my duties properly.	Qualitative demands	.026	.195	**.544**
We had clear planned goals and objectives for this project.	Role ambiguity	.015	**.837**	-.033
We knew exactly what was expected of me.	Role ambiguity	-.024	**.883**	-.049
We knew what my responsibilities were.	Role ambiguity	.098	**.867**	-.136
We felt certain about how much authority I had.	Role ambiguity	.034	**.637**	.188
Our responsibilities were clearly defined.	Role ambiguity	-.095	**.813**	.049

N=114-123

Table 8.2

Means, Standard Deviations, Correlations and Scale Reliabilities of Team Level Variables

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Team Size	4.00	1.07													
2.Project length	1.7	2.16	.04												
3.Stage	.44	.50	-.28	.03											
4. Week creativity requirements	4.68	1.72	-.05	-.12	-.15										
5.Quantitative demands	2.61	.48	.29	.27	.08	.17	(.85)								
6.Qualitative demands	3.22	.82	.05	.29	-.12	-.04	.49**	(.78)							
7.Role ambiguity	2.22	.56	-.26	.06	.00	.11	.03	.25	(.90)						
8.Positive mood	3.50	.39	-.08	-.20	.15	.07	.26	-.07	-.14						

Table 8.2

(continued)

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13
9.Negative mood	1.74	.48	.02	.50**	.03	.30	.57**	.42**	.41**	.01					
1.Creativity	4.20	1.04	-.14	.08	-.04	.39*	-.07	-.10	-.09	-.24	-.09	(.90)			
11.Decision-making	4.56	1.53	.00	.11	.16	-.33*	-.26	-.18	-.01	-.06	-.13	-.34*	(.89)		
12.Avoiding procrastination	4.93	1.39	.18	.08	.23	-.42**	-.18	-.02	.06	.00	-.15	-.30	.64**	(.92)	
13.Focus and obstacles	4.89	.87	-.13	.10	.30	.07	.10	-.10	-.12	.00	.11	.38*	-.08	.05	(.77)

$N = 41$. Note. + p<.10 *p<.05 **p<.001

Table 8.3

Regression of Team Innovation Activities on Team Stressors and Team Mood

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 1		.18	.08	.18		.13	.04	.13		.24	.16	.24		.12	.02	.12	
	Team size				-.06				.07				.20				-.02
	Project length				.14				.06				.00				.16
	Stage				.00				.12				.21				.39
																	+
	Week				.41**				-.30				-.38				.14
	requirements																
	creativity																
Step 2		.21	.10	.04		.22	.10	.09		.29	.19	.05		.12	.00	.00	
	Quantitative				-.21				-				-.24				.03
	demands								.33+								
Step 2		.19	.08	.06		.18	.06	.05		.24	.13	.00		.13	.00	.00	
	Qualitative				-.13				-.22				-.03				-.10

demands

Table 8.3

(continued)

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 2		.20	.08	.02		.13	.01	.00		.25	.15	.01		.14	.01.	.02	
	Role ambiguity				-.15				.03				.11				-.15
Step 2		.24	.13	.06		.14	.01	.00		.24	.13	.00		.12	.00	.00	
	Positive mood				-.26+				-.04				.00				-.04
Step 2		.30	.20	.13		.14	.02	.01		.25	.14	.00		.12	.00	.00	
	Negative mood				-.46*				-.13				-.10				.01

$N = 41$. Note. + $p<.10$ *$p<.05$ **$p<.001$

Table 8.4

Moderated Regression of Team Innovation Activities on Team Quantitative Demands and Team Positive Mood

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 1		.18	.08	.18		.13	.04	.13		.24	.16	.24		.12	.02	.12	
	Team size				-.06				.07				.20				-.02
	Project length				.14				.06				.00				.16
	Stage				.00				.12				.21				.39+
	Week				.41**				-.30				-.38				.14
	requirements																
	creativity																
Step 2		.25	.12	.08		.22	.08	.09		.30	.17	.05		.12	-.03	.003	
	Quantitative				-.13				-				-.28				.05
	demands								.35+								
	Positive mood				-.22				.06				.09				-.05

Table 8.4

(continued)

	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
	Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 3	.28	.13	.03		.27	.11	.05		.36	.23	.07+		.19	.02	.07	
Quantitative demands x positive mood				-.20				-.24				-.30+				-.30

$N = 41$. Note. + p<.10 *p<.05 **p<.001

Table 8.5

Moderated Regression of Team Innovation Activities on Team Qualitative Demands and Team Positive Mood

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 1		.18	.08	.18		.13	.04	.13		.24	.16	.24		.12	.02	.12	
	Team size				-.06				.07				.20				-.02
	Project length				.14				.06				.00				.16
	Stage				.00				.12				.21				.39+
	Week				.41**				-.30				-.38				.14
	requirements																
	creativity																
Step 2		.26	.12	.08		.18	.04	.05		.24	.11	.03		.13	-.02	.01	
	Qualitative demands				-.13				-.23				-.04				-.10
	Positive mood				-.26				-.05				.01				-.04

Table 8.5

(continued)

	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
	Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 3	.35	.21	.09*		.189	.02	.01		.27	.11	.02		.15	.-30	.02	
Qualitative demands x positive mood				-.34*				-.08				-.17				-.16

$N = 41$.Note. + p<.10 *p<.05 **p<.001

Table 8.6

Moderated Regression of Team Innovation Activities on Team Role ambiguity and Team Positive Mood

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 1		.18	.08	.18		.13	.04	.13		.24	.16	.24		.12	.02	.12	
	Team size				-.06				.07				.20				-.02
	Project length				.14				.06				.00				.16
	Stage				.00				.12				.21				.39+
	Week				.41**				-.30				-.38				.14
	requirements																
	creativity																
Step 2		.27	.15	.10		.14	-.02	.002		.25	.12	.01		.14	-.01	.02	
	Role ambiguity				-.19				.02				.12				-.16
	Positive mood				-.29+				-.04				.02				-.06

Table 8.6

(continued)

	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
	Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 3	.36	.23	.09*		.14	-.05	.00		.26	.10	.001		.29	.14	.15*	
Role ambiguity x positive mood				-.35*				.001				. 04				-.46*

$N = 41$. Note. + p<.10 *p<.05 **p<.001

Table 8.7

Summary of Interaction Tests between Positive Mood and Stressors to Predict Innovation Activities

	Creativity	Decision-making	Avoiding procrastination	Focus and obstacles
Quantitative demands x Positive mood			Mar. Sig.	
Qualitative demands x Positive mood	Sig.			
Role ambiguity x Positive mood	Sig.		.	Sig

Table 8.8

Moderated Regression of Team Innovation Activities on Team Quantitative Demands and Team Negative Mood

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 1		.18	.08	.18		.13	.04	.13		.24	.16	.24		.12	.02	.12	
	Team size				-.06				.07				.20				-.02
	Project length				.14				.06				.00				.16
	Stage				.00				.12				.21				.39+
	Week				.41**				-.30				-.38				.14
	requirements																
	creativity																
Step 2		.30	.18	.13		.22	.08	.09		.29	.16	.05		.12	-.04	.00	
	Quantitative				-.02				-				-.26				.04
	demands								.35+								
	Negative mood				-.44				.06				.09				.00

Table 8.8

(continued)

	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
	Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 3	.30	.16	.00		.22	.06	.00		.33	.19	.04		.15	-.03	.03	
Quantitative demands x negative mood				-.10				-.08				.30				-.26

$N = 41$. Note. + $p<.10$ *$p<.05$ **$p<.001$

Table 8.9

Moderated Regression of Team Innovation Activities on Team Qualitative Demands and Team Negative Mood

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 1		.18	.08	.18		.13	.04	.13		.24	.16	.24		.12	.02	.12	
	Team size				-.06				.07				.20				-.02
	Project length				.14				.06				.00				.16
	Stage				.00				.12				.21				.39+
	Week				.41**				-.30				-.38				.14
	requirements																
	creativity																
Step 2		.30	.18	.13		.18	.03	.05		.25	.12	.00		.13	-.02	.01	
	Qualitative				-.02				-.22				-00				.-
	demands																.12
	Negative mood				-.46*				.03				.10				-.07

Table 8.9

(continued)

	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
	Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 3	.32	.18	.02		.22	.05	.04		.31	.17	.06		.15	.03	.02	
Qualitative demands x negative mood				-.20				.26				.35+				-.20

$N = 41$. Note. + p<.10 *p<.05 **p<.001 Table 8.3

Table 8.10

Moderated Regression of Team Innovation Activities on Team Role Ambiguity and Team Negative Mood

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Creativity				Decision-making				Avoiding procrastination				Focus and obstacles			
Step 1		.18	.08	.18		.13	.04	.13		.24	.16	.24		.12	.02	.12	
	Team size				-.06				.07				.20				-.02
	Project length				.14				.06				.00				.16
	Stage				.00				.12				.21				.39+
	Week				.41**				-.30				-.38				.14
	requirements																
	creativity																
Step 2		.30	.18	.12		.15	.00	.02		.28	.15	.05		.15	.00	.03	
	Role Ambiguity				-.00				.09				.18				.19
	Negative mood				-.45*				-.18				-.20				.12
Step 3		.30	.16	.00		.19	.02	.04		.34	.20	.07		.16	-.02	.01	
	Role ambiguity x negative mood				.04				-.24				-.31+				-.13

$N = 41$. Note. + p<.10 *p<.05 **p<.001

Table 8.11

Summary of the Evidence in Support and Against each Team Level Framework

Framework	Hypothesis number	Prediction	Evidence in favour	Evidence against
Cognitive spreading activation	H14.1	Positive mood will buffer the negative impact of stressors on the level of creativity activities		• (1) Qualitative demands x positive mood – creativity • (2) Role ambiguity x positive mood - creativity •
	H14.2	Positive mood will buffer the negative impact of stressors on the level of implementation activities		• (3) Quantitative demands x positive mood – avoiding procrastination • (4) Role ambiguity x positive mood – focus and obstacles
Mood repair perspective	H15.1	Positive mood will accentuate the negative impact of stressors on the level of creativity	• (1) Qualitative demands x positive mood – creativity	

		activities	• (2) Role ambiguity x positive mood - creativity •	
	H15.2	Positive mood will accentuate the negative impact of stressors on the level of implementation activities	• (3) Quantitative demands x positive mood – avoiding procrastination • (4) Role ambiguity x positive mood – focus and obstacles •	
	H15.3	Negative mood will accentuate the negative impact of stressors on the level of creativity activities		
	H15.4	Negative mood will accentuate the negative impact of stressors on the level of implementation activities	• (6) Role ambiguity x negative mood – avoiding procrastination	• (5) Qualitative demands x negative mood – avoiding procrastination
Mood-as-information	H8.1	Positive mood will buffer the negative impact of stressors on the level of creativity		• (1) Qualitative demands x positive mood – creativity

	activities displayed by R&D team members		• (2) Role ambiguity x positive mood - creativity •
H8.2	Positive mood will accentuate the negative impact of stressors on the level of implementation activities	• (3) Quantitative demands x positive mood – avoiding procrastination • (4) Role ambiguity x positive mood – focus and obstacles •	
H8.3	Negative mood will accentuate the negative impact of stressors on the level of creativity activities		
H8.4	Negative mood will buffer the negative impact of stressors on the level of implementation activities	• (5) Qualitative demands x negative mood – avoiding procrastination	• (6) Role ambiguity x negative mood – avoiding procrastination

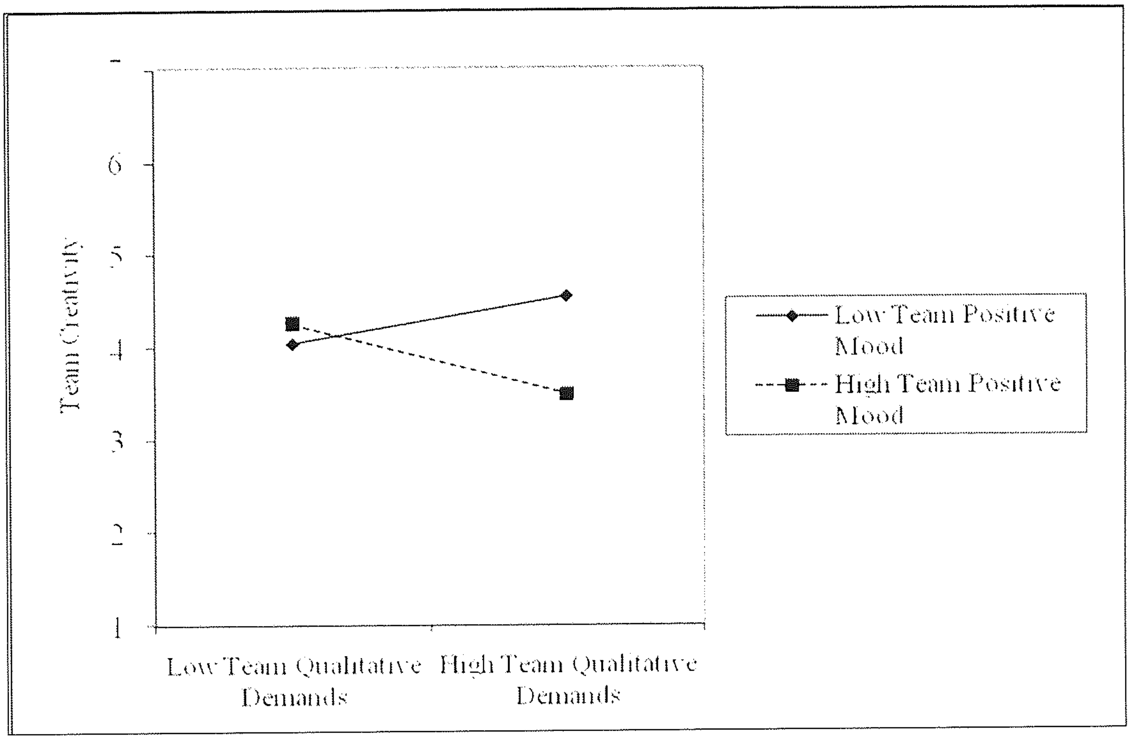

Figure 8.1. Interaction between team qualitative demands and team positive mood to predict team creativity activities

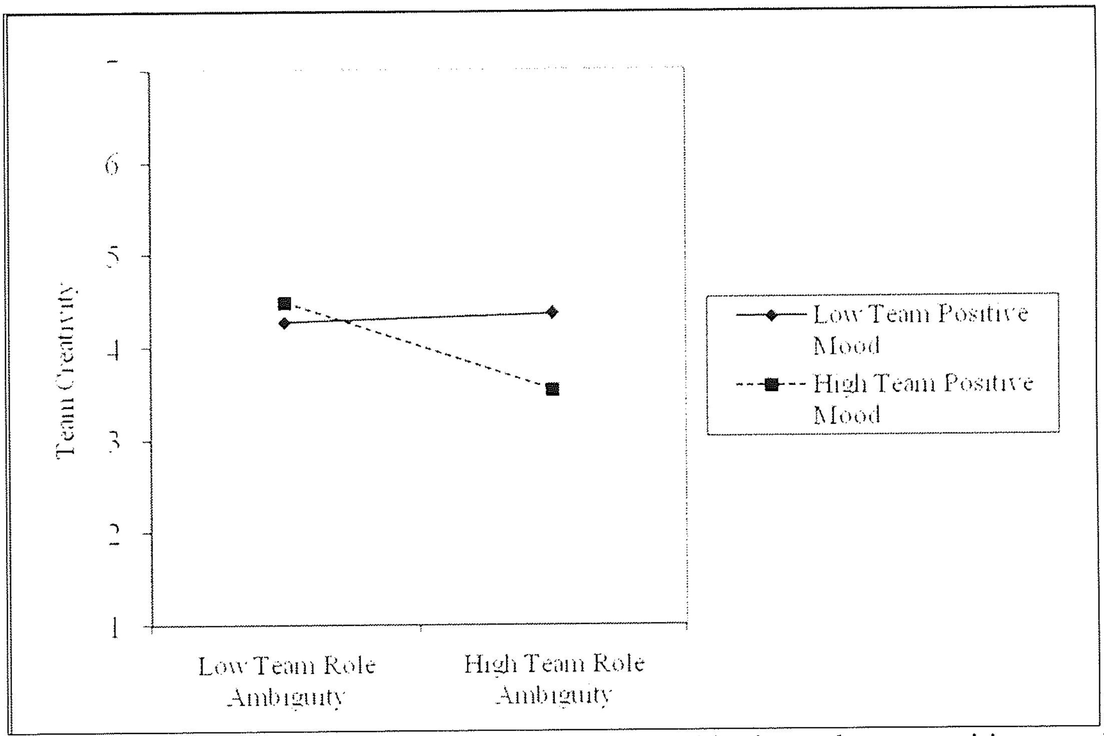

Figure 8.2. Interaction between team role ambiguity and team positive mood to predict team creativity activities

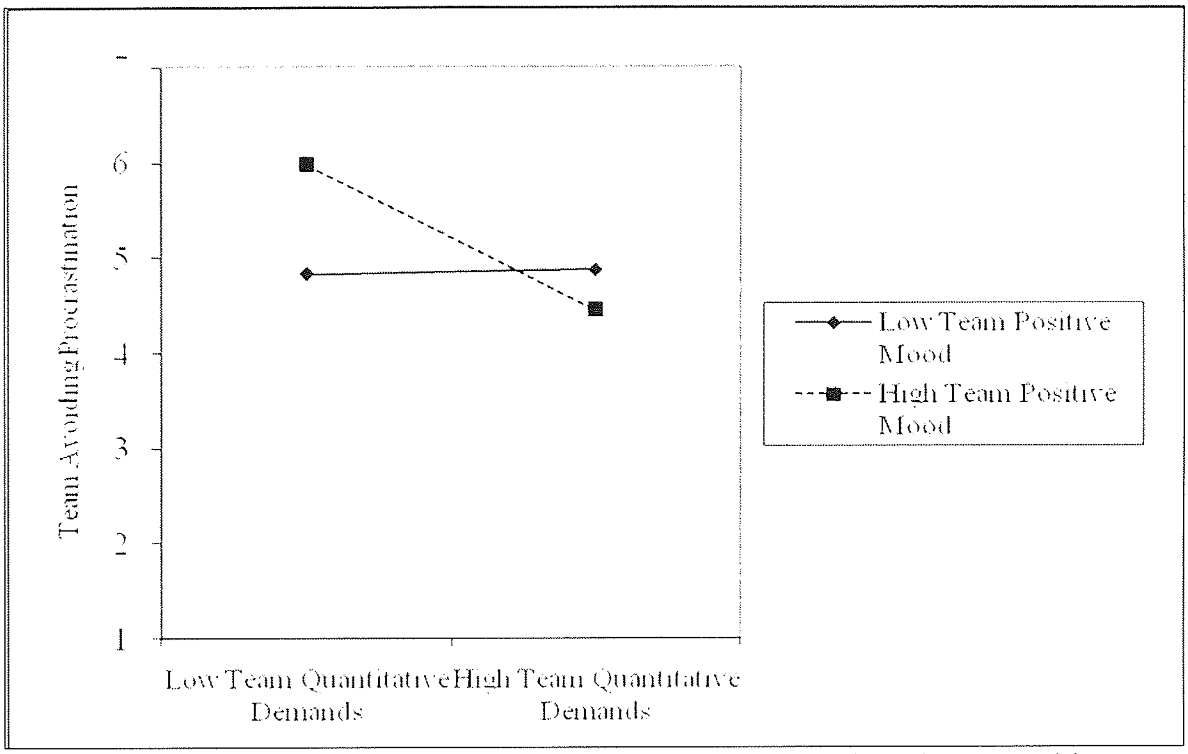

Figure 8.3. Interaction between team quantitative demands and team positive mood to predict team avoiding procrastination

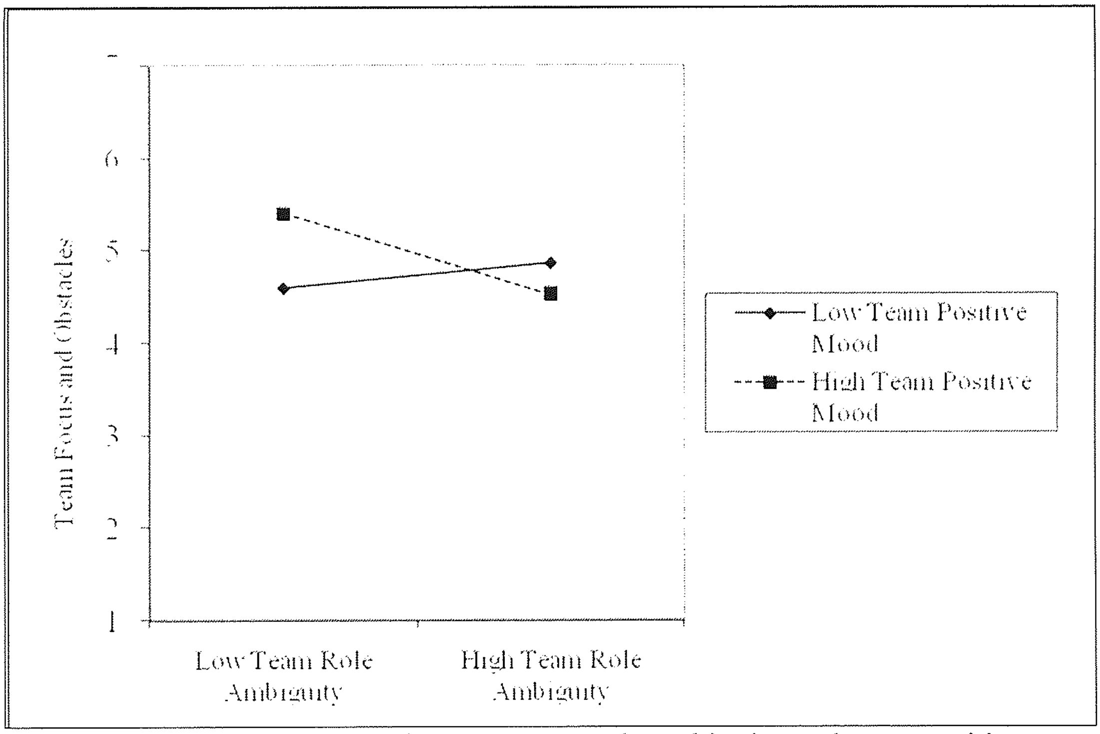

Figure 8.4. Interaction between team role ambiguity and team positive mood to predict team focus and obstacles

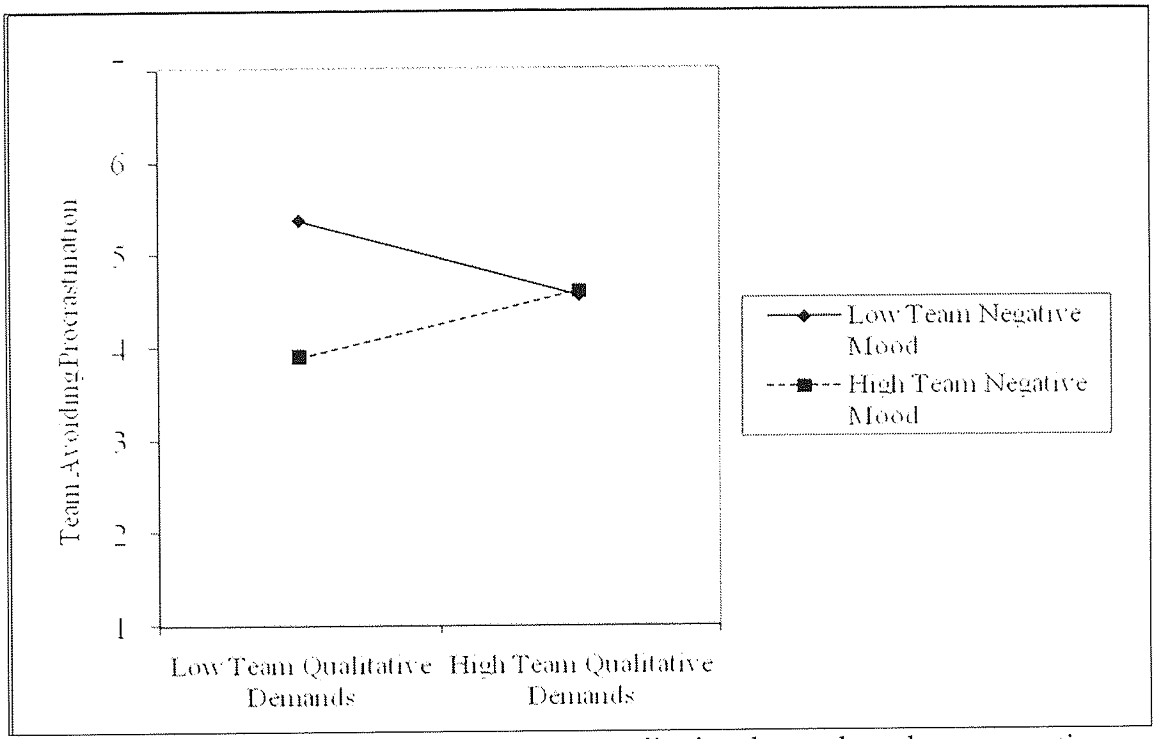

Figure 8.5. Interaction between team qualitative demands and team negative mood to predict team avoiding procrastination

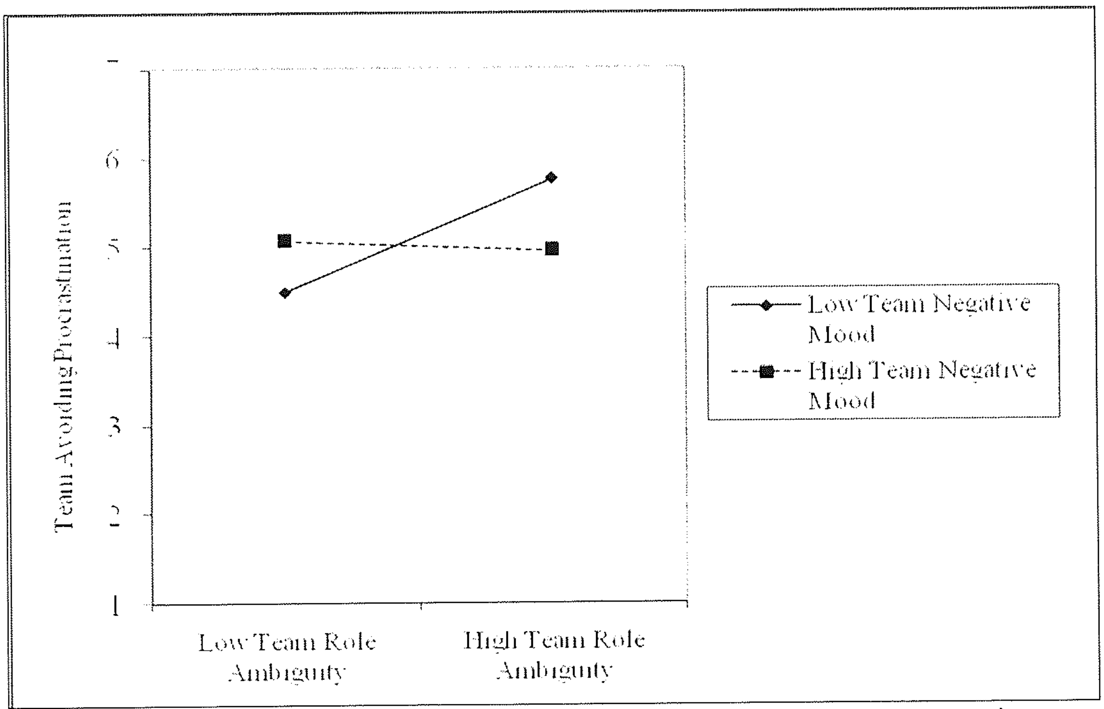

Figure 8.6. Interaction between team role ambiguity and team negative mood to predict team avoiding procrastination

Chapter 9

Further exploring the impact of stressors and mood on team innovative activities: An experimental study

This chapter presents an experimental study designed to test and extend the framework developed in chapters three and seven. The roles of goal orientation and of team reflexivity as respectively potential boundary condition and mediator of the relationship between time pressure-mood and innovation activities are suggested. These relationships are tested in a sample of fifty-four teams of students charged with a task involving both creativity and implementation outcomes. This chapter concludes with a discussion of the results and suggestions for future studies.

9.1 Introduction

The results reported in chapters six and eight suggest that positive mood is not always a facilitator of the innovation process, such that in the presence of stressors being in a low positive mood is actually more conductive to effective performance on innovation activities than being in a high positive mood. This pattern was observed both in individuals (chapter six) and in teams (chapter eight). This finding raises several other questions that are relevant to explore. Before exploring these questions it is important to clarify that since both individual and the team level results brought more consistent support for the role of positive mood as a moderator of the relationship between stressors and innovation activities than for the role of negative mood, this chapter focuses solely on positive mood.

9.1.1. Boundary conditions and mediators

One of the issues that are important to clarify relate to the boundary conditions of the effect identified. For instance, is the interaction between mood and stressors replicated for all individuals, or are there certain individual characteristics that influence the direction or the likelihood of the interaction taking place? The same question can be translated to the team level if we consider the role of team composition. Individuals bring different personal characteristics into a team resulting in different team compositional configurations (e.g., Bell, 2007). It is reasonable to speculate that in certain teams mood is more likely to influence the impact of stressors whereas in others this moderator effect is less likely to happen, or can take a different direction.

Another question that has been theoretically explored earlier but not tested empirically concerns the processes through which this interaction takes place. Exploring this pathway implies identifying potential mediators of the interaction, with reference not only to schmoozing activities but also to other processes that might help to unveil the mechanisms underlying the interaction effect. In sum, given the findings identified in the field study it seems important on the one hand to identify in which situations the documented interaction occurs or not, in other words, to address the question: what are its boundary conditions, and on the other hand to understand via which processes it occurs.

Taking into account the number of constructs that might be involved and the possible complexity of the processes underlying this interaction effect, these research questions cannot be fully addressed in a single follow-up study, but call instead for a comprehensive research plan. Taking this into consideration, the following experimental study was designed as a first effort to systematically address the questions outlined above.

In addition, this study also aims to test in a controlled setting the non-existence of a negative relationship between the level of stressors and positive mood in order to rule out a mediation effect of positive mood. In order to verify if indeed stressors do not lead to a decrease in positive mood which in turn might influence innovation related outcomes, in this study mood was not manipulated but it has instead been assessed before and after the experimental task.

In order to address the issues above and to replicate the field findings, this study analyses the impact of one of the stressors integrated in the field study and positive mood on a task that requires both creativity and implementation activities. The frequency of interactions between each stressor and mood suggests that the effects of quantitative demands, which refer to time pressure, and role ambiguity were the most robust ones (five significant interaction effects for both time pressure and role ambiguity against only two for qualitative demands). Considering that in previous discussions with R&D professionals (cf. pilot studies, chapter 5) time pressure was the most frequently identified stressor, and also that it is simpler to translate it to an experimental setting, time pressure was the selected stressor. In contrast to the field study, the outcome variable of the experimental study is the *output* that resulted from innovation (creativity and implementation) activities (i.e., the product). Therefore, the term *innovation outcomes* will be used in this chapter when referring to the dependent variables. It is however assumed that these outcomes are a direct reflection of the activities and therefore no conceptual distinction is made in terms of the development of hypotheses.

In this initial effort to identify the conditions under which this interaction pattern can be observed and the mechanisms that underlie it, this study extends the initial framework by including one team composition variable – team learning orientation - and one team process – team reflexivity – as respectively a potential boundary condition and a mediator of the interaction effect. The rationale for the choice of these variables follows.

9.1.2 Goal orientation as a boundary condition

When facing a stressor an appraisal process takes place in which the degree to which the stressor represents a threat is evaluated (Lazarus & Folkman, 1984). Certain individual characteristics have an influence in this appraisal process. One variable likely to display such an effect is goal orientation. According to Dweck and colleagues (Dweck, 1986; Dweck & Leggett, 1988), individuals possess one of two attitudes towards learning. Individuals with a high learning orientation hold the assumption that intelligence is fluid and can be developed. When faced with a task they are usually concerned with improving their skills and developing their knowledge. On the other hand, individuals with a high performing orientation hold the assumption that intelligence is static and therefore there is no way of developing it. When faced with a task they are mostly concerned with their performance levels. VandeWalle (1997) further differentiated between those worried about showing that they can perform better than their colleagues (performance approach orientation) and those concerned about hiding a performance that is worse than of their colleagues (performance avoidance orientation). A comprehensive framework accounting for the emergence of goal orientation in groups has already been proposed (Dragoni, 2005), however in groups of short existence (such as in the laboratory), the team goal orientation is better conceptualised as simply reflecting the average trait goal orientations of its members.

On the background of the rationale presented above, it is reasonable to assume that teams composed of individuals with a high learning orientation are more likely to interpret stressors as an opportunity for learning. Teams with a high learning orientation and a high level of positive mood should not respond to stressors with mood repair activities. The reason for this is that stressors should not (or to a lesser extent) present a threat to mood. It is expected then that in teams with high learning orientation the interaction effect of time pressure – positive mood on team innovation outcomes is weaker than in teams with low learning orientation.

On the other hand, teams composed of individuals high in performance orientation (both approach and avoidance), are less likely to perceive time pressure as an opportunity to learn how to perform better and are instead more likely to perceive it as a threat to their performance. This should activate mood repair activities in teams with high positive mood, resulting ultimately in decreased performance. Consequently, it is expected that when goal performance orientation (both approach and avoidance) is high, the interaction effect of time pressure – positive mood on team innovation outcomes is stronger than when goal performance orientation is low.

Based on this reasoning, the following hypotheses are drawn:

Hypothesis 9.1: There is a three way interaction between learning orientation, time pressure and mood in such a way that in teams with a high learning orientation the interaction effect of time pressure – mood on innovation outcomes is weaker than in teams with low learning orientation.

Hypothesis 9.2: There is a three way interaction between performance approach orientation, time pressure and mood in such a way that in teams with a high performance approach orientation the interaction effect of time pressure – mood on innovation outcomes is stronger than in teams with low performance approach orientation.

Hypothesis 9.3: There is a three way interaction between performance avoidance orientation, time pressure and mood in such a way that in teams with a high performance avoidance orientation the interaction effect of time pressure – mood on innovation outcomes is stronger than in teams with low performance avoidance orientation.

9.1.3 Reflexivity as a mediator

From a mood repair perspective, one reason why teams in high positive mood are less able to cope with stressors might be because when facing stressors they spend more time in schmoozing activities, in order to keep their mood level high, instead of effectively allocating their efforts to the management of stressors. It is possible that the investment in mood repair activities is conducted with detriment to other team activities that are indispensable for effective coping with stressors, such as team reflexivity. Team reflexivity is defined as the extent to which teams reflect upon and modify their functioning (West, 1996). It has been suggested that teams who are able to reflect and plan their activities are more likely to be successful in innovation activities (West, 2000).

Underlying this assumption is the occurrence of a mediated moderation. A mediated moderation involves first showing an interaction effect of X and W on Y and then introducing a mediator of that effect (Muller, Judd, & Yzerbyt, 2005; Preacher, Rucker, & Hayes, 2007). As so, team reflexivity is expected to mediate the impact of the interaction between stressors and mood on innovative outcomes. Based on the above rationale, the following hypothesis is suggested:

Hypothesis 9.4: Team reflexivity mediates the impact of the interaction between time pressure and positive mood on innovative outcomes.

9.1.4 Replication of findings

Finally, this study attempts to analyse once again the impact of stressors on innovation activities and to replicate in experimental settings the interactive effect found in the field study. Based on the same rationale as presented in chapter three and seven, it is then hypothesised that:

Hypothesis 9.5: Time pressure will have a negative impact on team innovation outcomes.

Hypothesis 9.6: Positive mood moderates the relationship between time pressure and innovation outcomes in such a way that the innovation outcomes of teams in a high positive mood are more negatively affected by the presence of stressors than that of teams in a low positive mood.

The experimental design developed to test the aforementioned hypotheses is described next.

9.2 Method

9.2.1 Participants

Undergraduate psychology students at the University of Lisbon were invited to participate in partial fulfilment of a course requirement. Each student was also requested to enrol one volunteer in order to duplicate the sample size. Students and volunteers were randomly distributed in groups of three, each group consisting of two volunteers and one student or two students and one volunteer. This distribution was balanced across conditions. The mean age was 22.98 years (*SD*=2.83), and 70.8% were female. The total sample size was fifty-six teams. Two teams were later excluded from all analyses due to failure to understand the instructions in one case and a technical flaw of a recorder during the session in the other, providing a sample of 54 groups for the rest of the analysis.

9.2.2 Experimental procedure

Two separate sessions were conducted during each time slot. Upon arrival six participants were divided into groups of three and taken to two experimental labs. Participants were then introduced to the setting and informed that they would be involved in two studies. They were told that the first study consisted of an investigation of the impact of students' personal characteristics on attitudes towards academic work, which was a cover for the collection of self-rated measures such as goal orientation and positive mood. Demographics were also collected at this time. They were informed that the second study investigated how teams worked towards innovative outcomes. Students were distributed a questionnaire with a series of measures that allegedly referred to the first study and asked to complete them individually. This procedure took approximately 15 minutes. After completion, groups were told they were entering the second study and from then onwards they should be working as a team. The experimental assistant read the instructions for the experimental task and sat in the back of the room.

Once the experimental task was finished, group members were asked to complete a participant survey. The survey asked some post-experimental questions and self-report items relating to individual states and team processes, such as positive mood and team reflexivity. Groups were then fully debriefed and released.

9.2.3 Experimental task

The group task consisted of building a children's toy and comprised two distinct parts, performed one after the other. The first part involved the generation of ideas for a toy and selection of one idea for further implementation. The construction of the toy selected constituted the second part. This task was loosely based on exercises previously used in group experimental studies such as the lunar hotel (Grawitch, Munz, Elliott et al., 2003) and the structure building task (Weldon, Jehn, & Pradhan, 1991), but as none of the tasks identified in the literature fully served the objectives of the study, a new task was developed and piloted for the present study. The aim was to allow a detailed evaluation of the two main activities of the innovation process, the generation of ideas and subsequent implementation of the idea selected. As it was conceived, the toy task enables an appreciation of multiple criteria regarding both the generation of ideas and their implementation that can be reliably measured. This task was thought to closely reflect the tasks that many temporary groups working in organisational settings are faced with (but with different timeframes). So as to mimic a real organisational context, groups were given a problem for which they had sufficient autonomy to develop different solutions and to identify the best solution. In further analogy, groups also had to implement and apply their chosen solution but they were limited both by time and material resources, as would be common in a workplace context. Finally, this task promoted team interdependence, as it would be impossible for one member on their own, or for each member working individually, to accomplish the targets in the timeframe allowed.

The teams were described and shown the available materials, which consisted of one box of foil roll, seven styrofoam balls, fifteen popsticks tied with an elastic, and two plasticine blocks, each of a different colour. The selected materials were partially based on those used by Weldon and colleagues (1991), but it was decided to use a smaller range of materials in order to facilitate the comparison between the final products of each team. As each team had enough autonomy to choose which toy to built, which already is more complex than evaluating the implementation originality of just one product across all the teams, having in addition seven different materials would make the products less comparable. Having a limited number of materials enabled the judges to have a more objective evaluation as to how originally the materials were used.

Teams were given and read written instructions informing that the exercise consisted of two parts and both had the same value. In the first part they were asked to generate as many ideas as possible for a children's toy that could be built with the available material. They were informed that the toys should be as original as possible. They were also given a protocol form where they should note down every idea they had. During this part of the task a one page A4 advice note was left visible on the table reminding team members that only ideas written down in the protocol form would be counted, so they needed to write them all down. They were instructed that from the ideas generated they would have to select one to construct. This selected idea should be written down in the protocol, under the heading "selected product". Except for the totality of the aluminium foil roll, all material available had to be used in the construction. Teams were told that they had 20 minutes for the completion of the task and it was their decision when to move from the first part to the second part of the task. By allowing teams to make this decision it was possible to examine the impact of time pressure on readiness to transit between the two parts. Teams were informed that when they were ready for the transition they should hand the protocol form to the research assistant and in return the material would be handed out to them so that they could start the construction. Teams were provided with the evaluation criteria in advance so they could plan their actions using the criteria as a guide. Teams were informed that relevant criteria were a) the number and originality of the ideas generated in the first stage; b) the extent to which the idea was transposed to the materials in the second stage (which refereed to their ability to build the selected toy, making original use of the resources given) and c) the construction being finished within the time limit.

Time pressure manipulation. Because this study aimed to understand how time pressure in project groups affects group performance throughout the innovation process, time pressure was manipulated at the team level via the instructions provided. All teams were given 20 minutes to execute both parts of the exercise. In conditions under low time pressure teams were read and given written instructions stating "In other sessions we verified that this is a comfortable period and should enable you to finish on time". In conditions under high time pressure the instructions read "In other sessions we verified that this is a very tight period and you can't waste any minute otherwise you won't finish on time". As the time allocated to this task is relatively long, it was considered to be likely that the initial manipulation would lose its strength as time elapsed. In order to prevent this and to strengthen the time pressure manipulation all teams were informed that over the 20 minutes they would hear three ring bells. Teams in the low time pressure condition were informed that the bells had no meaning and they should ignore them, whereas teams in the high time pressure condition were told that the ring bells were a reminder that the time was passing and they should be hurrying up. Two tapes were recorded with three ring bells spaced with five minutes between them, the first one five minutes after the beginning of the innovation task and the last one at the end of the 20 minute period. The tapes were played during the task execution. It was decided to associate the bells with different information and play them in both conditions rather than just playing the bells in the high time pressure condition. This procedure was followed in order to prevent confounding effects of other factors that could have been elicited by the sound of the bells, such as cognitive disruption provoked by acute sounds. Note that in none of the conditions teams were told that the bells would be playing every five minutes, which would have created a stronger sense of time awareness. They were solely informed that there would be three ring bells. The way bell rings was only associated with time for teams under high time pressure, but these did not benefit from any additional information that would allow them to better regulate their efforts in relation to time.

9.2.3.1 Measures

All scales were translated to Portuguese using the same back translations method as described in chapter five for the scales employed in the field study (Brislin, 1986). These are described below.

Positive mood. Positive mood was assessed before and after the experiment by using the four positive valence items of the mood scale developed by Friedman and Forster (2002). An example is "How happy do you feel right now". Respondents were asked to answer in a scale from 1 = "Not at all" to 9 = "Extremely" ($\alpha = .78$).
The mood measure collected after the experiment was used for testing of hypotheses as it constitutes a closer representation of the *shared* mood that was expected to develop over the experimental task. Individual members' moods were averaged and aggregated within teams. Although the R_{wgs} for mood measure after the experimental task is .60, below the cut off point, it is still higher than the R_{wgs} measure for mood collected before the experimental task (.49), suggesting the convergence towards the emergence of a group mood. Given the level of agreement being lower than the .70 threshold point, this construct is cautiously referred to as aggregated team members' mood rather than team mood. A mean sample split was conducted in order to divide teams into two groups, high and low positive mood. Based on a mean sample split this variable was coded "1" for low (below mean) and "2" for high (above mean).

Team reflexivity. A eight item scale was developed based on the measure initially proposed by Swift and West (1998) in order to measure reflexivity. The items were adapted to better fit the experimental context. Example items include "In this team we adjusted our objectives according with the circumstances" and "We frequently discussed the extent to which we were being effective in our task". Participants gave their responses on a 5-point scale ranging from 1 = "Strongly disagree" to 5 = "Strongly agree". Cronbach's coefficient alpha for this scale was .62.

Goal orientation. Goal orientation was assessed at the individual level using the measure developed by Vandewalle (1997). Five items measured learning goal orientation, an example is "For me, development of my work ability is important enough to take risks". Four items measured performance avoidance goal orientation, for example "I would avoid taking on a new task if there was a chance that I would appear rather incompetent to others". Four items measured performance approach orientation. An example is "I try to figure out what it takes to prove my ability to others at work". Respondents rated the extent to which these statements reflected their behaviour ranging from 1 = "Not at all" to 7 = "To a large extent". Cronbach's alpha coefficients for learning, avoidance and approach orientation were respectively . 78, .72, and .73, ensuring good scale reliability. Goal orientation measures were aggregated at the group level of analysis, as in previous studies (e.g., LePine, 2005). R_{wgs} for learning, approach and avoidance goal orientation were respectively .86, .61 and.71. Based on a mean split each variable was coded "0" for low (below mean) and "1" for high (above mean).

Although the set of outcome variables obtained in an experimental task is necessarily different from the ones obtained in a field study, it was aimed in this experiment to obtain measures that would capture as much as possible the same constructs that were assessed previously in the field study. These are described next.

Group creative performance measures. Group creative performance was assessed by three different indicators. These indicators, described below in detail, were fluency, objective originality of ideas, and subjective originality of ideas. The experimental setting allows disentangling originality and fluency of ideas in a way that is not possible in the field setting. This constitutes strength of the experimental study and therefore it was decided to include both measures as indicators of creativity, although in the field setting there was simply one overall creativity measure.

Fluency. Fluency was assessed by counting the number of different toys written down in the protocol form. The number of ideas varied between one and 24. As groups spent different times generating ideas, the index for fluency was calculated by dividing the number of ideas generated by the time spent on the creativity stage (i.e., before the group handed in the form with ideas and hence moved on to the second stage).

Objective originality of ideas. The originality of each idea was calculated by dividing the number of times each idea appeared across all teams by the total number of responses in the data set. Based on this ratio, each idea was given an originality score.

For instance, "car" was the most frequently cited idea, appearing 34 times. The originality score for car was obtained by dividing 34 by the total number of answers, 352, giving the final result of .0085. "Voodoo toys" was suggested only once. The originality score for this idea was calculated by dividing 1 by 354, resulting in .00284 (for simplicity sake in further analysis all originality scores were multiplied by 100). As it can be observed, the highest score correspond to the less original idea. The average originality score for each team was calculated by dividing the sum of the originality scores of each idea provided by them by the total number of ideas the team gave. Again, a lower score corresponds to a more original set of ideas. The lowest score was .30 and the highest score was 9.70.

Subjective originality of ideas. Two independent raters blind to the manipulated conditions were trained for thirty minutes and then asked to assign each of the 132 different ideas a score from one to nine according to how original they thought the toy was. This technique has been often applied in creativity research (e.g. Shalley & Perry-Smith, 2001). In order to analyse interrater reliability the intraclass correlation coefficient for average measures was calculated. The estimated value of .92 suggested strong interrater agreement and the responses of each rater were averaged. After having one score for each idea each team's rating on subjective originality of ideas was calculated by averaging the scores of each idea provided by each team, in a similar fashion as described for objective originality of ideas. In contrast with objective originality of ideas, for subjective originality of ideas the highest scores represent the most original ideas.

Group implementation performance. Group implementation performance was assessed by two different sets of indicators. The first set comprises time measures which capture the time spent by each team to complete not only the overall task but also the time spent in transiting from the first to the second part. In the field study this measure was not considered a relevant outcome since each team was involved in a different project which in turn varied on their expected lengths. So, opposite to the experiment, lower completion times in the field study cannot be interpreted as an indicator of more effective implementation. The second set of indicators is more closely linked to the factors captured in the field study and comprises the components of implementation from a process perspective as described in the scale development chapter. These measures are next described in detail.

Time of transition and time of completion. Effective implementation implies being able to accomplish the tasks in due time and avoid procrastination. As such two important indicators of effective implementation made available by this task were time of transition to the second part of the task and time of completion of the task. *Time of transition* consisted of the amount time that elapsed from the beginning of the task to the moment teams submitted their protocol form in exchange for the materials. Higher transition times reflected more delay in moving from one stage to the other and consequently this is an indicator of less effective implementation. *Time of completion* consisted of the amount of time spent since the beginning of the task until the groups announced they had completed the construction of their toys.

Effective originality selection. In alignment with the theoretical rationale presented in chapter four introducing the development of creativity and implementation measures, selection of ideas is not considered to be part of the creative generation activities but is instead part of the implementation activities. One of the reasons for this exclusion from generation activities has to do with the distinctive types of cognitive processing involved in idea generation and idea selection. Whereas the former requires a heuristic and divergent processing style in which any idea is acceptable and the more the best for their group performance, in the latter teams have to engage in systematic and convergent processing. When choosing an idea to implement, teams are already engaged in the implementation activities of the innovation process, as they are anticipating the difficulties associated with each option and analysing them in terms of the possible difficulties that might emerge. Although in the field study the assessment of decision-making, which is the concept analogous to effective originality selection, was based on evaluations provided by supervisors on a rating scale, an alternative form of assessment was preferred in the experimental study since a more objective assessment was available. The effectiveness of the selection was calculated by dividing the originality score of the most original idea provided by the team by the score of the idea selected. Because the most original idea was the one with the lowest score, the maximum result - one - occurred when the idea selected coincided with the most original idea. The less original the idea selected, the lowest the effective originality selection result was. For instance, one team chose to implement a snow man, which had been considered their most original answer achieving a score of .014 (the lowest score).

The effective originality was calculated by dividing .014/.014, which equalled 1. Another team chose to build a car, which was their least original idea (rated .097). Their most original idea had been an umbrella (rated .003). Their effective originality score was calculated by dividing .003 by .097 which equalled .003, considerably lower than 1. All results were multiplied by ten to avoid excessive decimal numbers. The lowest score was .31 whereas the highest score was 10. As it can be observed, having a high score in this outcome measure is not dependent on the quality of the ideas generated previously since all teams can achieve the maximum score of one as long as they select their most original idea, even if that idea is not original in relation to those of other groups.

Originality of construction. Two independent raters were asked to evaluate the extent to which each toy had been successfully constructed considering the amount of detail achieved by making an original use of the materials available in a scale from 1 = "*Construction is not at all originall*", to 9 = "*Construction is very original*". Toys were evaluated in terms of how original teams were in using the materials in order to build their initial idea rather than compared with other different toys in the sample. By assuming this procedure it was avoided that teams which had selected more original toys (for instance a fantasy menu) would be benefited in comparison with teams that had chosen to implement less original toys (such as a bowling game). The intraclass correlation coefficient for average measures was .93, suggesting high interrater agreement. The responses of each rater were averaged in order to obtain the team score.

Time pressure manipulation check. Three items were used to assess the success of the time pressure manipulation. Participants indicated the extent to which they agreed with the following statements relating to the experienced time pressure during the task "We felt the pressure of time" and "We were rushing because of the time". Responses matched to points on a Likert-type scale ranging from 1= "Very untrue" to 5 = "Very true". The alpha coefficient for the scale was .73.

9.3 Results

In this section the results of the experimental study described above are presented. To enhance legibility, all tables and figures are placed at the end of this chapter.

9.3.1 Manipulation check.

To assess the effectiveness of the time pressure manipulation an independent sample *t*-test was applied, including the induced time pressure condition as the fixed effect and the averaged scores in the time pressure manipulation scale as dependent variable. The overall effect was significant, $t(166) = -2.15$; $p = .02$ (one-tailed). A priori comparisons of the estimated marginal means using least significant differences revealed that individuals in the high time pressure conditions reported higher levels of time pressure ($M = 3.70$, $SE = .90$) than individuals in the low time pressure condition ($M = 3.41$, $SE = .80$).

For the sake of completion, the same procedure was conducted using as the dependent variable the aggregated mean scores of the manipulation check scale. Again, the overall effect was significant, $t(52) = -1.75$; $p = .04$ (one-tailed). A priori comparisons of the estimated marginal means using least significant differences revealed that teams in the high time pressure conditions reported higher levels of time pressure ($M = 3.74$, $SE = .58$) than teams in the low time pressure condition ($M = 3.45$, $SE = .66$).

9.3.2 Effects of time pressure on innovation outcomes

For the sake of logic flow the testing of hypotheses regarding the main effect of time pressure are presented first (H 9.5), followed by the testing of the interaction hypothesis (H 9.6). Testing of hypotheses on the interplay between time pressure, positive mood and goal orientation (H 9.1, H 9.2 and H 9.3), and on the mediating role of reflexivity (H 9.4), are presented after.

Means, standard deviations, and intercorrelations for the performance variables are presented in table 9.1. The data are presented for the three creativity indicators and the four implementation indicators. Correlational analyses yielded moderate to high correlations among several of the dependent variables.

Table 9.2 presents means for the outcome variables for each time pressure condition. To test the hypotheses regarding the impact of time pressure on creativity and implementation activities a multivariate analysis of variance was performed (MANOVA) having as independent factor time pressure and dependent variables fluency, objective originality of ideas, subjective originality of ideas, time of transition, time of completion, effective originality selection and originality of construction. The result for the MANOVA was significant, $F\,(7, 46) = 2.53$; $p = .03$. A closer inspection of the results of single ANOVAs indicated a significant main effect of time pressure condition on time of transition, $F\,(1, 52) = 5.33$; $p = .03$, eta square = .09. A priori comparisons of the estimated marginal means using least significant differences revealed that teams under high time pressure were faster in transiting to the second stage ($M = 7.60$, $SE = .42$) than groups under low time pressure ($M = 9.35$, $SE = .65$). There was also a main effect of time pressure on time completion, $F\,(1, 52) = 8.27$; $p =$. 00, eta square = .14. Again groups under high time pressure were faster in completing the task ($M = 20.05$, $SE = .60$) than groups under low time pressure ($M = 22.40$, $SE =$ .55). There was no significant difference concerning effective selection originality $F\,(1, 52) = .48$, *ns* or originality of construction $F\,(1, 52) = 1.76$, *ns*. In regard to creativity related outcomes there was no main effect of time pressure neither on fluency $F\,(1, 52) = 1.71$, *ns*, nor on the originality of ideas, either objectively, $F\,(1, 52) = .16$, *ns*, or subjectively measured, $F\,(1, 52) = .26$, *ns*. These results contradict hypothesis five.

9.3.3 The interactive effects of time pressure and positive mood on innovation outcomes

A multivariate analyses of variance (MANOVA) was conducted in order to examine if aggregated team members' positive mood moderated the impact of time pressure on creativity and implementation outcomes. Time pressure and positive mood were entered as independent factors and fluency, objective originality of ideas, subjective originality of ideas, time of transition, time of completion, effective originality selection and originality of construction were entered as dependent variables. The result for the MANOVA was not significant, F (7, 44) = .94, *ns* .

However, a closer analysis to the results of the one-way ANOVA indicate the existence of a significant interaction between time pressure and positive mood to predict originality of selection F (1, 50) = 4.84; p = .03, partial eta squared = .09 (figure 9.1) and originality of construction, F (1, 50) = 5.18; p = .03, partial eta squared = .09 (figure 9.2). Table 9.3 presents means for the outcome variables for each condition and Table 9.4 presents the results of the univariate analyses of variance. For sake of brevity table 9.4 only includes the significant results. A table including the complete results of the MANOVA is placed in appendix 4 (table 9i).

These results replicate the patterns found in the field study (chapter six and chapter eight) and suggest that teams under time pressure perform better, at least with respect to implementation outcomes, when positive mood is low, whereas teams under low time pressure exhibit higher levels of performance when positive mood is high. These results lend partial support to hypothesis 9.6, however, it is important to notice that this was only found for two outcomes. In the future it is important to explore which (and why) innovation activities or outcomes are influenced by the interaction stressors-mood.

9.3.4 The interactive effects of time pressure, mood and goal orientation on innovation outcomes

Hypotheses 9.1, 9.2 and 9.3 proposed a mulitiplicative contingency effect such that the effect of the interactive term time-pressure-positive mood on innovation outcomes is weaker when learning orientation is high than when learning orientation is low (hypothesis 9.1) and the effect of the interactive term time-pressure-positive mood on innovation outcomes is stronger when performance approach orientation (hypothesis 9.2) or performance avoidance orientation (hypothesis 9.3) is high than when performance orientation is low. In order to test these hypotheses three multivariate analysis of variance (MANOVA) were conducted, including time pressure, positive mood and the goal orientation variable under scrutiny as predictors, and fluency, objective originality of ideas, subjective originality of ideas, time of transition, time of completion, effective originality selection and originality of construction as depended variables (tables 9ii, 9iii and 9iv in appendix 4 show these results).

Regarding learning goal orientation, the MANOVA was not significant, F (7, 40) = .89; *ns*, and analyses of the individual ANOVAS showed no significant effect on either of the outcome variables. These results suggest that, opposite to hypothesis 9.1 learning orientation does not interact with time pressure and positive mood to affect innovation outcomes (appendix 4 table 9ii).

With respect to performance avoidance goal orientation, the MANOVA was not significant, F (7, 40) = .54; *ns*, and analyses of the individual ANOVAS showed no significant effect on either of the outcome variables. These results suggest that, opposite to hypothesis 9.3 performance avoidance orientation does not interact with time pressure and positive mood to affect innovation outcomes (appendix 4 table 9iii).

Finally, regarding performance approach goal orientation, the MANOVA was not significant, F (7, 40) = .14; *ns*, however an inspection of the individual ANOVAS showed a significant effect of the interaction between the three predictors on time transition, F (1, 46) = 5.19; p =.03, partial eta squared = .10 (appendix 4 table 9iv). Figures 9.3 and 9.4 illustrate these results. It was found that for teams with low goal approach orientation, a low positive mood is detrimental to innovative performance (teams take longer to transit from one phase to the other), whereas high positive mood facilitates performance (note that the y axis represents the time spent until transiting to the next stage and that in this situation as values in the y axis increase implementation performance, operationalised as the speed in transiting from the first to the second phase, decreases) (figure 9.3). These results suggest that when under time pressure teams who have no concerns about showing others that they can perform well are benefited by a positive mood. This effect might be explained by the high energy levels that characterise the positive pole. For individuals who are concerned about exhibiting a good performance to others, time pressure is associated with improved performance for both high and low positive mood, but more so for low positive mood (figure 9.4). These effects follow an opposite pattern to the one found earlier when looking solely at time pressure and positive mood, and to the one found in the field study. A reason for this might be the very different nature of the outcome, that relates not to engagement in activities but promptness is moving from one stage to the other. Although the pattern described in hypothesis 9.5 is not supported, this result suggests that there are boundary conditions to the relationship between stressors-mood and innovation performance. Goal performance approach can play a role, and so can the nature of the creative output.

9.3.5 The mediator effect of reflexivity on the association between time pressure-positive mood interaction and innovation outcomes

Regression analysis was conducted to examine whether reflexivity mediated the association between time pressure - positive mood and the implementation outcomes that were found to be affected by this interactive factor, effective originality selection and originality of construction. In order to address this question the procedures recommended by Muller, Judd and Yzerbyt (2005) were followed. The first criterion, for the interaction between the moderator and the independent variable to significantly predict the dependent variable, was met by prior analyses showing that the interactions between time pressure and members' mood states significantly predicted effective originality selection and originality of construction.

The second criterion requires the interaction between the moderator and the independent variable to significantly predict the mediator. In order to verify if the second criterion was fulfilled, reflexivity was regressed on the interaction term time pressure-mood.

The third criterion requires the mediator to significantly predict the dependent variable while controlling for the interactions between the moderator and the independent variable and between the moderator and the mediator. In order to verify if this criterion was fulfilled effective originality selection and originality of construction were regressed on reflexivity controlling for the interactions time pressure – mood and time pressure –reflexivity.

The final condition requires the relationship between the interactive term and outcomes is expected to reduce when entering the mediator.

As it can be observed in the fifth column of table 9.3, the second condition was not fulfilled. Reflexivity was not predicted by the interaction term. For the sake of completion, the tests for criterion three are displayed in models two of table 9.3. Again, the condition was not satisfied, as reflexivity did not predict either effective originality selection (R^2 = .14, ΔR^2 = .00) or originality of construction (R^2= .22, variation ΔR^2= .00). These results offer no support to hypotheses 9.3 and suggest that the interaction stressors-mood operates via other mechanisms.

9.4 Discussion

The objective of this experimental study was to replicate the effect found in the field study and to start the exploration of its potential explanatory processes and boundary conditions. Teams were asked to generate ideas for a toy and to select one of these ideas to subsequently implement. This task allowed the reproduction in an experimental setting of an innovation challenge that is close to the reality of R&D teams. As the groups in the experimental study, R&D teams are also required and given sufficient autonomy to generate ideas for solving an open problem, they have to identify the best possible and most feasible solution given the existent resource limits, and have to afterwards be able to implement the chosen solution. Teams were submitted either to a high or a low time pressure condition. In agreement with the framework developed in chapters three and seven, it was expected that teams under low time pressure would perform better in both the creativity and implementation components of the task given that their cognitive resources would be less taxed with the threat of time pressure.

As expected, the interactive effect reported in the field study both at the individual and team level was replicated in this study. Although this was only the case for two of the innovation outcomes, it still adds further confidence in the role of the interplay between stressors and mood on innovative performance.

No effect of time pressure was found for either of the creativity related outcomes. On the other hand, teams under high time pressure were faster in their transition to the second stage and in completing the task. It is important to note that although teams under time pressure spent less time in the creativity stage they did not generate less ideas than those teams that were under low time pressure, neither were these ideas judged to be less original. One could conclude from here that teams under high time pressure do devote less time to the early activities of the innovation process but that is done without harm to the respective outcomes. It seems that being under time pressure led to a more pragmatic approach and a stronger sense of hurry, leading teams to earlier closure of the generation of ideas and faster completion of the task. This finding can be accounted for by activation theory, which suggests that a certain level of stressors is necessary for optimal performance. These results are also in line with proposals suggesting that the relationship between stressors and innovation outcomes can be a curvilinear one (Baer & Oldham, 2006; Ohly et al., 2006). However, these findings should also be interpreted cautiously. The creative generation task was relatively simple and unconstrained (there were no right or wrong answers). It is very likely that with a more complex task involving demanding problem solving the less time devoted to creativity activities comes at a cost in terms of innovative performance. Future research should test the generalisability of these findings to several degrees of task complexity.

Analysis of potential boundary conditions offered some support for the role of performance approach orientation as a modifier of the relationship stressors-mood and performance. Goal approach orientation was found to modify the relationship between time pressure and positive mood when predicting time of transition between stages. Although the pattern obtained did not support the hypothesised one, likely due to the very distinct nature of this specific outcome, this result suggests that the interplay between stressor and mood when influencing innovative performance is altered by other conditions.

Opposite to what expected, a decrease in reflexivity is not the process responsible for the decrease in innovative performance of teams in high positive mood when facing stressors. This, however, constitutes solely an initial attempt at identifying the underlying mechanisms and future research should explore other avenues.

9.4.1 Limitations

This experimental study has several limitations that should be noticed. One important limitation is that mood was not manipulated but instead assessed after the experimental task. Although this design enabled obtaining evidence for the convergence of mood in groups and it allowed to rule out a potential mediation effect (since it showed that time pressure did not affect mood), a two-by-two design in which both positive mood and time pressure were manipulated would have enabled a more definite test of this effect. In virtue of this limitation, although these results suggest, in line with the field study, that positive mood interacts with time pressure to predict innovation related activities, the results should be interpreted with caution.

Another limitation associated with this study derives from the timing allowed to the experimental task, as part of the groups did not finish the experiment on time. During the pilot sessions all groups terminated the task within the time limit, so this problem was not anticipated. It was decided after the first session in which a group exceeded the time limit that the procedure to follow would be to inform team members at the 20th minute that the time limit had been reached and that they should finish as soon as possible. It was considered preferable to allow the groups to finish building their toy otherwise there would be no final product to judge, which would lead to the exclusion of a considerable number of teams. This procedure however carries the risk of inducing a sense of time pressure on those teams that were under the low time pressure condition, questioning the efficacy of the initial manipulation. Although this constitutes a serious limitation of the experimental task and should be reviewed in the future, it is the author's opinion that this inadvertently induced time pressure does not affect any of the outcome measures provided before the end of the twentieth minute such as fluency, originality of ideas, effective originality of selection and time of transition and has a minor impact on the final originality of construction, as the time spent building the toy after the 20th minute is considerably less than the time spent building the toy before the 20th minute, and by then the majority of the planning had already taken place.

Finally, it should be noticed that the reflexivity scale employed showed weak reliability, and that might hinder the validity of the conclusions ruling out reflexivity as a mediator.

9.4.2 Future research

The potential avenues for research discussed at the end of chapter eight apply here as well, and as so in order to avoid repetition only one specific point will be developed in this section. As stated above, this study initiated a search for potential explanatory mechanisms of the relationship between stressors-mood and innovative performance. Future research should explore alternative avenues. One construct that emerges as a potential candidate is team situational mental models. Team situational models are dynamic, context-driven mental models concerning key areas of the team's work, such as the objectives or roles of colleagues (Cooke et al., 2003). These are the building blocks of implicit coordination, which captures the ability of a team to act in concert by predicting the needs of the task and the team members and adjusting behaviour accordingly without requiring overt communication. Implicit coordination is of extreme importance in high interdependent tasks, as it is the case for R&D teams (Rico, Sanchez-Manzanares, Gil, & Gibson, 2008). It can be the case that the engagement in mood repair activities induced by stressors when positive mood is high impedes the development of accurate and shared team situational models, which in turn hinder implicit coordination mechanisms required to respond to stressors in an innovative manner.

With respect to other boundary conditions of this effect, it is important to consider also the role of contextual factors. One potential candidate is leader support. It is possible that when teams are facing stressors a supportive leader can channel the team's focus and efforts towards the task, and hence prevent the extent to which teams in high positive mood engage in distracting mood repair strategies.

In sum, this experimental study brought further support for the interactive impact of stressors and mood on innovation outcomes and initiated the study of potential boundary conditions and explanatory processes.

Table 9.1

Means, Standard Deviations, and Intercorrelations for Predictors and Team Creativity and Implementation Outcomes

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. Time Pressure	.52	.50												
2. Positive Mood	1.54	.50	-.15											
3. Learning Orientation	.44	.50	-.26	-.07										
4. Performance approach orientation	.50	.50	.07	.04	.00									
5.Performance avoidance orientation	.61	.49	-.08	-.06	.03	.27								
6. Reflexivity	3.48	.31	.23	-.11	-.06	.00	-.12							
7. Fluency	8.43	4.96	.18	-.10	.17	.09	.22	-.11						
8. Objective originality of ideas	3.98	.78	-.07	-.16	.05	-.20	-.11	.14	.22					
9. Subjective originality of ideas	3.22	1.71	.17	.15	-.09	.21	.02	.08	-.23	-.77**				
1. Effective originality selection	3.75	3.66	.10	.08	-.10	-.13	.01	.18	-.22	-.13	.16			
11. Originality of construction	4.53	1.71	-.18	.06	.07	-.23	.01	.24	-.16	.19	-.10	.58**		
12. Time of transition	8.44	2.90	-.30*	-.13	-.04	-.10	.00	.03	-.41**	.09	-.15	.03	.02	

Table 9.1

(continued)

	M	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
13. Time of completion	21.18	3.20	-.37**	-.30	.05	.05	.10	.12	-.46**	-.06	.04	.03	.00	.55**

N = 54. Note: $^{*}p<.05$; $^{**}p<.01$

Table 9.2

Means and Standard Deviations for Creativity and Implementation Outcomes by Time Pressure Condition

Variable	Low Time Pressure		High Time Pressure	
	M	*SD*	*M*	*SD*
1. Fluency/time	7.52	.85	9.27	1.04
2. Objective originality of ideas	2.91	.27	3.51	.37
3. Subjective originality of ideas	4.04	.12	3.93	.17
4. Effective originality selection	3.39	.65	4.08	.76
5. Originality of construction	4.85	.39	4.23	.25
6. Time of transition	9.35	.65	7.60	.42
7. Time of completion	22.40	.55	20.05	.60

$N = 54$

Table 9.3

Means and Standard deviations for each experimental condition

		Time Pressure					
		Low			High		
		M	*SD*	n	*M*	*SD*	n
Effective Originality Selection							
	Low Positive Mood	1.53	.86	10	4.70	4.49	15
	High Positive Mood	4.54	3.38	16	3.37	3.38	13
Originality of Construction							
	Low Positive Mood	4.1	1.5	10	4.6	1.5	15
	High Positive Mood	5.1	2.1	16	3.77	.95	13

N = 54

Table 9.4

One Way Analysis of Variance for Effective Originality Selection and Originality of Construction

Effective Originality Selection

Source	*df*	*F*	*p*
Time Pressure (TP)	1	.72	.40
Positive Mood (PM)	1	1.01	.31
TP x PM	1	4.84*	.03

Originality of Construction

Source	*df*	*F*	*p*
Time Pressure (TP)	1	1.22	.27
Positive Mood (PM)	1	.14	.70
TP x PM	1	5.18*	.03

N = 54. *Note* *p<.05

Table 9.5

Regressions for Reflexivity, Implementation Outcomes and Mediated Moderation

		R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β	R^2	adj R^2	ΔR^2	β
		Effective originality selection Model 1				Effective originality selection Model 2				Originality of construction Model 1				Originality of construction Model 2			
Step 1		.02	-.02	.02		.02	-.02	.18		.03	.00	.03		.03	.00	.03	
	Time Pressure				.11				.11				-.18				-.18
	Positive Mood				.10				.10				-.03				-.03
Step 2		.11	.05	.09		.14	.07	.12		.13	.07	.09		.22	.15	.18	
	Time pressure x p. mood				-.98*				-1.04				-.10*				-.110
	Reflexivity x p. mood								.20								.32
Step 3						.14	.05	.00						.22	.14	.00	
	Reflexivity								.04								.16

Table 9.5

(continued)

		R^2	adj R^2	ΔR^2	β
		Reflexivity			
Step 1		.06	.02	.06	
	Time Pressure				.22
	Positive Mood				
					-.07
Step 2		.06	.00	.00	
	Time pressure x Positive Mood				.15

$N = 54$

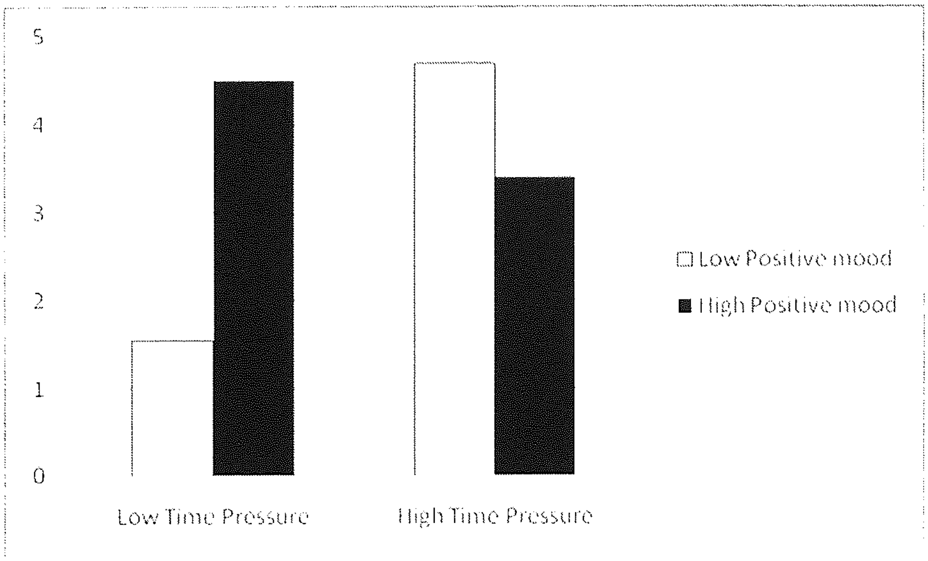

Figure 9.1 Interaction between time pressure and positive mood to predict effective originality selection

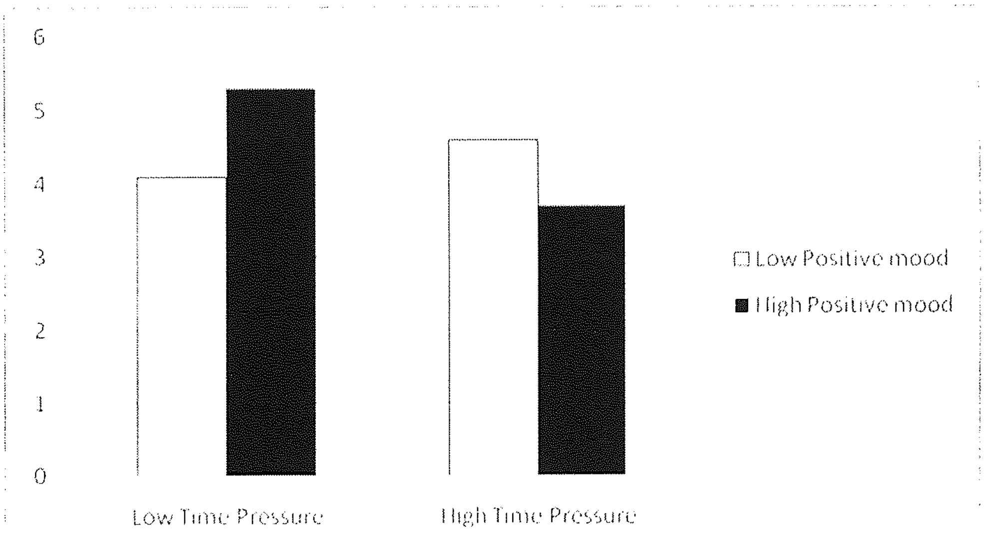

Figure 9.2 Interaction between time pressure and positive mood to predict originality of construction

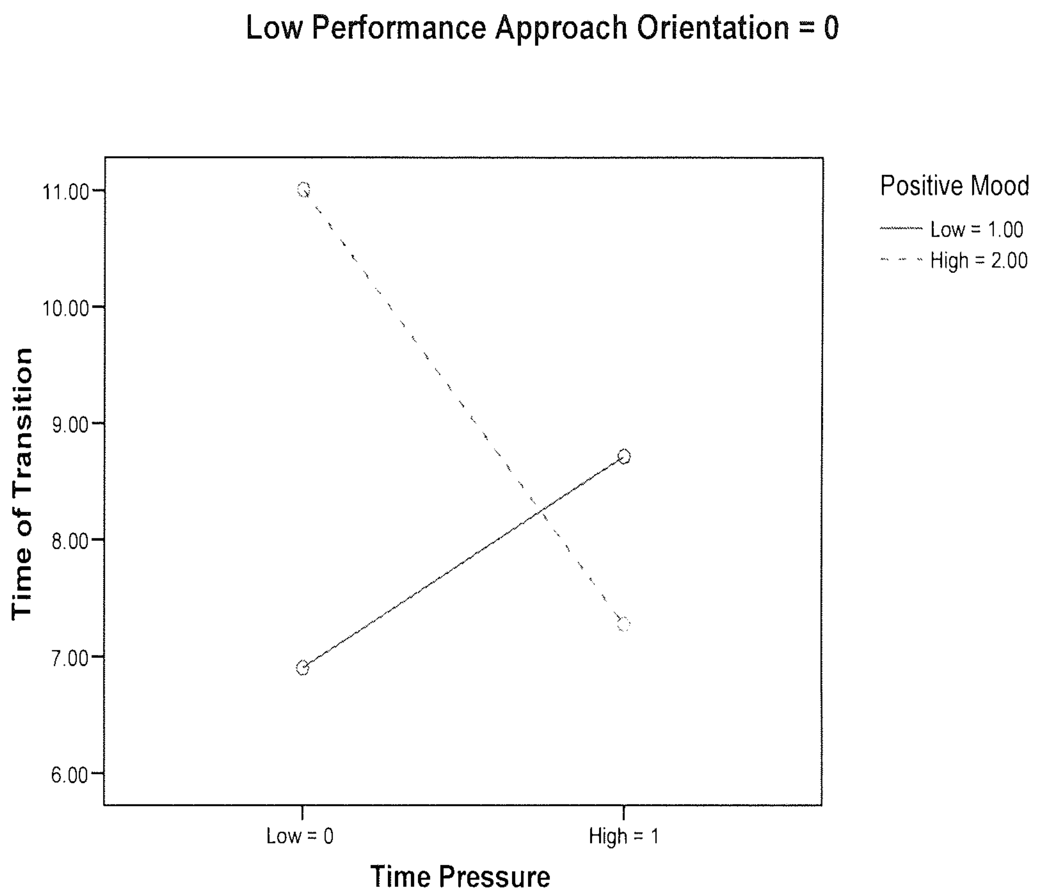

Figure 9.3 Interaction between time pressure and positive mood to predict time transition when goal performance approach orientation is low

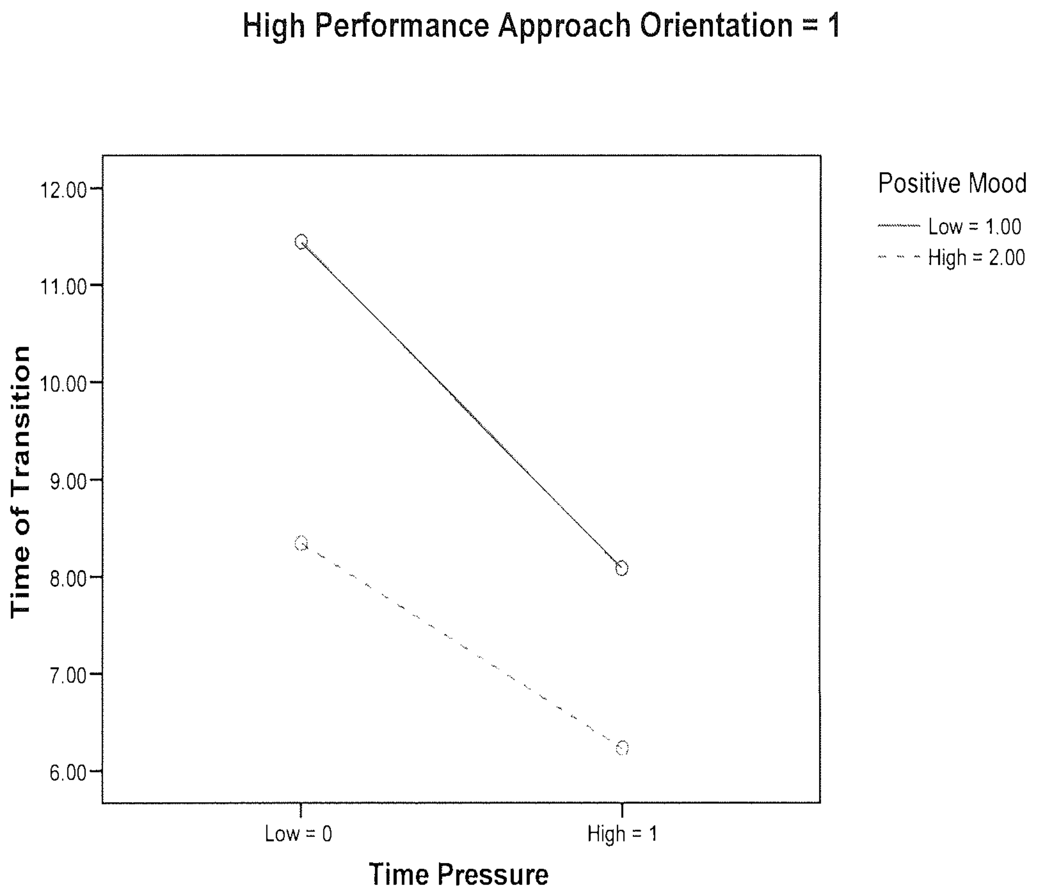

Figure 9.4 Interaction between time pressure and positive mood to predict time transition when goal performance approach orientation is high

Chapter 10

Concluding discussion

The objective of this chapter is to provide an overall view of this thesis with reference to key findings, limitations and future research. The chapter starts by summarising the objectives of this thesis and the methodological approach adopted, followed by an outline of the key findings. Next the theoretical and practical implications are discussed and the limitations are presented. The chapter concludes with directions for future research.

10.1 Thesis overview and key findings

Innovation is a particularly valuable in today's organisations as it is usually associated with organisational success (Damanpour, 2001; Damanpour & Evan, 1984). However, for innovation to occur companies are dependent on the performance of their individual employees. It is therefore important to understand how innovative performance is affected by both contextual factors and characteristics specific to the individual or the team. This thesis contributes to the understanding of this question by focusing on the impact of stressors and mood on innovation activities.

The objective of this thesis was three-fold. Firstly, to understand how the innovative performance of R&D professionals is affected by stressors and mood. Secondly, to examine these variables in the context of R&D *teams*. Thirdly, to develop an instrument capable of distinguishing between the creativity and implementation activities required during the development of an R&D project.

In order to meet the above objectives several studies were undertaken. The first set of studies consisted of the development of a tool to assess innovation activities. Then a large field study analysed the impact of stressors and mood in a sample of 123 individuals nested in 41 R&D project teams. The final experimental study examined the same relationship in a sample of 54 teams of students (n = 162 individuals) and explored potential mediators and boundary conditions.

The research question was approached from an information processing framework. The key finding of this thesis relates to how mood influences the relationship between stressors and innovation activities. Results of both the field and the experimental study suggested that when facing stressors, contrary to what common sense would suggest, being in a high positive mood is not facilitative of innovation activities. Furthermore, this effect was observed in both individuals (chapter six) and teams (chapter eight).

This finding is explained on the grounds of hedonic contingency theory and mood repair perspective (Wegener & Petty, 1994). The hedonic contingency theory suggests that individuals aim to keep positive moods high. In the presence of factors that can threaten mood, individuals for whom mood is salient engage in mood repair activities. It is then suggested that the identified interactive effect occurs because when facing stressors, individuals (and teams) in high positive mood are more likely to engage in mood repair activities in an attempt to keep their positive mood high. A consequence of this engagement in mood repair activities is that individuals are distracted from the actions that would be necessary to effectively address the stressor, resulting in a decreased innovative performance. Lazarus and colleagues' concept of coping might shed light the relationship between mood repair activities and innovative performance (Folkman, 1984; Lazarus & Folkman, 1984). According to the authors, coping refers to cognitive and behavioural efforts to master, reduce or tolerate the internal or external demands that are created by factors which are appraised as taxing or exceeding the resources of the person (Folkman & Lazarus, 1980, 1988). Individuals can adopt one of two coping strategies, emotion focused coping, which is focused on regulating emotions that emerge with a stressor, or problem focused coping, which is directed at addressing the stressor. As emotions are more salient for individuals in high positive mood, these individuals, because they need to engage in mood repair activities, should be more likely to use emotion focused coping (which more efficiently addresses their mood needs) than to use problem focused coping. Emotion focused coping involves activities such as wishful thinking, distancing one-self from the problem, and emphasising the positive. In contrast, problem focused coping involves efforts in analysing, understanding and solving the problem (Folkman & Lazarus, 1985). Considering that responding effectively to stressors is a requirement for innovative performance, it seems logical that mood repair activities and its associated emotion coping strategy should lead to a decrease in innovative performance. In teams, schmoozing – going for coffee with colleagues, chatting about non-work related issues-, are possible mood repair activities (Ilgen, Dass et al., 1995).

This finding builds up into an extensive body of research that identifies how contextual factors interact with individual characteristics to predict innovative performance (Shalley, Zhou, & Oldham, 2004; Woodman et al., 1993; Zhou, 1998).

The analysis of how stressors interplay with mood contributes towards the comprehensiveness of the interactive model of creativity.

A particular strength of this project is the combination of different methodological approaches to address the research question. The interaction pattern found in the field study was replicated in the experimental study, providing evidence for both internal and external validity (chapter six, chapter eight, and chapter nine).

A second strength of this study is the focus on two levels of analysis, the individual and the team. Theorists have criticised the study of phenomena by focusing only at one level of analysis and have pleaded for more research integrating various levels (Anderson, De Dreu, & Nijstad, 2004; Hackman, 2003). Focusing on two levels allows an examination of the extent to which an effect is replicated across levels and enables an understanding of the different mechanisms involved at each unit. Furthermore, focusing on two levels also enables the testing of the extent to which group level variables influence the relationship between individual level variables – cross level interaction (Klein, Dansereau, & Hall, 1995). For instance in the present study it is reasonable to hypothesise that team mood moderates the impact of individual stressors on innovation activities. This model was also tested but received no support, so the multilevel design enabled the ruling out of potential cross-level interaction effects.

10.2 Implications

10.2.1 Implications for theory

As discussed in chapters three and seven, three theoretical perspectives – cognitive spreading activation, mood repair perspective and mood-as-information - appeared to offer powerful theoretical frameworks to explain the relationship between stressors – mood and innovation activities.

As mentioned above, both the findings of the field and of the experimental study showed that when facing stressors being in high positive (and also negative) mood is more detrimental than being in a low positive (or negative) mood, providing stronger support for the mood repair perspective.

These findings can, however, also inform other theories that account for the impact of mood on creativity, such as cognitive spreading activation. Supporters of the cognitive spreading activation perspective argue that positive mood enables wider network activation, resulting in higher cognitive flexibility, which in turn improves creativity. This approach has strong empirical support (Ashby et al., 1999; Isen, Daubman et al., 1987) and the validity of its argument is not contested here, however, this study suggests that the relationship between mood and creativity can be affected by other variables. In the presence of stressors, positive mood does not facilitate innovative performance. Similar to stressors, other variables might modify the impact of mood on innovation outcomes. Taking into account the number of contradictory studies described in chapter three, this is highly likely. It is then suggested that researchers should expand these theories in order to account for potential moderators.

The present findings also have implications for goal management theories. Schmidt and DeShon (2007) suggested that people seek to achieve various types of goals at work. One type of goal relates to one's role description - task related goals, whereas the other type relates to one's self, and an example is management of mood. Building on this reasoning, Fay and Sonnentag (2008) suggested that when performance is hindered by lack of skill or situational circumstances, individuals stop temporarily to pursue task related goals and give priority to self related goals. The present study suggests that this investment in self-related goals can hinder the achievement of task related goals - individuals who are in high positive mood and have therefore to engage in mood repair activities are less innovative than those who are not in a high positive mood, and therefore do not have to engage in such activities. To the author's knowledge, research has not yet attempted to integrate these different types of goals and how people pursue them. Whereas one stream of research has focused on the prioritisation of work goals (Schmidt & DeShon, 2007), the other has focused on how people manage self related goals (Carver & Scheier, 1982; Steele, 1988). This study suggests that one comes at the cost of the other, and therefore more theorising is needed to integrate the effects of theses competitive goals.

A methodological contribution worth mentioning is the development of an instrument capable of capturing and disentangling the different creativity and implementation activities that are required within a realm of an on-going innovative project.

Innovative activities can occur when such an outcome is implied in the job description, an example is the work of R&D professionals, but they also can take place in jobs in which the job requirements do not involve the development or implementation of new ideas. For instance, although a nurse's job description does not involve changing or creating new work processes, nurses often come up with new suggestions that can improve their work efficiency (West et al., 2003). Whereas the former type of creativity can be referred to as externally driven or task-related innovative performance, the latter refers to internally driven creativity, or extra-role creativity (Borman & Motowidlo, 1993; Unsworth, 2001).

In contrast with other instruments available in the literature (e.g., George & Zhou, 2002; Scott & Bruce, 1994; Tierney & Farmer, 2002), these scales are specifically focused on capturing task related innovative performance rather than extra-role innovative performance, making them particularly useful instruments when analysing contexts in which creativity is part of the job requirements. Furthermore, the use of these scales can also contribute to a better understanding of how the activities of the innovation process are differently affected by the same factors. Contradictory findings found for the impact of, for example, time pressure on innovation suggest that it is very likely that researchers are tapping into different aspects of the innovation process.

By disentangling these activities it is possible, at least in the realm of ongoing projects that require innovation, to understand which factors affect which activity, and how.

10.2.2 Implications for management

Common sense suggests that people have their most creative ideas when they are in a positive mood, for instance when singing in the shower. Managers might be influenced by this notion and try to promote positive mood within their work settings at all times. Although it is not suggested here that managers should instead promote a negative mood, or that they should never promote a positive mood, it is important to create awareness of the fact that positive mood is not always beneficial. More specifically, when facing stressors having a low positive mood can be much more conducive to improved innovative performance. Based on these findings, it is suggested that when managers perceive that the level of stressors is high they should refrain from trying to compensate their employees for the pressure experienced by providing them with distractive activities, and should instead guide their efforts towards the task at hand.

Another important point to make, again against common sense, is that stressors are not always negative. Role ambiguity, at least in an R&D setting, can have a positive effect on creativity. Managers should therefore refrain from being too specific in the setting of objectives when creativity is required.

Time pressure can also have beneficial effects. By creating a sense of time pressure managers can, at least in some circumstances, accelerate the work rhythm of a their teams without loss of creative or implementation performance. It should be noticed, however, that these findings have to be interpreted cautiously, as they are based on an experimental study in which the generation task was relatively easy and lacked complexity. Future research should examine to what extent they can be generalised to real work settings, and examine the type of task as a moderator of this effect. It is very likely that in complex creativity tasks time pressure still accelerates performance but with a quality cost.

10.3 Study limitations

The majority of the limitations of each study have already been discussed in the respective chapters, however, some overall limitations should be mentioned here.

It is important to note that although the interaction between stressors and mood to predict innovation activities occurred for several of the different outcomes, in both the experimental and field studies, and for both individuals and teams, this interaction was not always significant. This suggests that other factors can influence the nature and direction of this relationship and further research should explore the boundary conditions of this effect.

A second limitation relates to the operationalisation of the team level mood construct. In the field study it would have been appropriate to capture mood using both an individual and a team referent. Such an approach was not followed due to the large number of items that this would have added (20 items), which could have limited participation in the study. In the experimental study a manipulation of mood rather than its measurement would have ensured stronger internal validity. It is however noteworthy that this effect emerges even when mood was not induced.

Another limitation relates to the role of state and trait mood. The impact of a trait variable can influence the relationship between the state variable and the outcome under analysis. When analysing the impact of transient states is therefore important to measure and control for the correspondent trait variable. This approach was not adopted for parsimony's sake, however, in future studies the role of trait mood should be controlled.

A final limitation relates to sample restrictions. The field study involved a sample of R&D teams from a number of different organisations. These organisations are integrated in very diverse R&D industries, which gives confidence about the generalisability of the findings to other contexts in which innovative performance is also part of the job requirements. However, replication in other settings, especially in work settings where innovative performance is not part of the job description, would be required.

10.4 Avenues for future research

10.4.1 Application of alternative frameworks

The analysis of how stressors and mood affect innovative performance was approached from an information processing perspective. The reported interactive effect can be considered robust, as it was observed for both individuals and teams and replicated in an experimental setting. However, although the predictions of the mood repair perspective received the strongest support, this framework could not entirely account for all findings. Several of the plotted interaction patterns showed that rather than only being less negatively affected by stressors, individuals and teams in low positive mood actually benefited slightly from the presence of stressors (cf. figures 6.1-6.4, 8.1). This speaks for a differential impact of stressors. It might, therefore, be relevant to explore this question from the perspective of a complementary framework.

As discussed in chapter six, motivational theories can offer a useful alternative. According to activation theory, the highest level of performance is achieved when there is a moderate arousal. Individuals in low positive mood hold the advantage of not having their resources misplaced in mood management activities, however the lack of energy that characterises people in low positive mood impedes them to engage enthusiastically in creativity and innovation activities. It is then possible that the activation role of stressors suggested by the Yerkes-Dodson Law (1908) gives individuals in low positive mood the prompt to act, conducing individuals in low positive mood to display higher levels of innovative performance.

10.4.2 Development of a framework to understand the impact of stressors on innovative performance

Reflecting the lack of consensus in the literature regarding the impact of stressors on innovation performance (Amabile et al., 2002; Andrews & Farris, 1972; Ohly et al., 2006), this study also finds contradictory results. Even though the interaction pattern is fairly consistent, there are also differential effects, in other words, not every stressor plays the same role for every dependent variable. For instance, role ambiguity was found to have a negative impact on creativity but a positive effect on decision-making and avoiding procrastination. Furthermore, the experimental study showed that teams under time pressure work faster and move earlier from the generation of ideas to their implementation without their creative output being negatively affected.

These findings are in alignment with recent developments in stress research, which has abandoned the idea that all stressors function in the same way. For instance, LePine and colleagues (LePine et al., 2004; Podsakoff et al., 2007) argued that challenge stressors, such as time pressure or qualitative demands, should facilitate performance whereas hindrance stressors, such as role ambiguity, will have a detrimental impact on performance. Although the results presented do not fit perfectly into the pattern offered by the above framework, they still support the idea that a more differential perspective on the effect of stressors is needed. This study reinforces the notion that the impact of stressors is complex and a systematic research program is necessary in order to better understand it.

Unsworth's (2001) typology of creativity types was discussed earlier (chapter two) as a potential starting point for the development of a framework accounting for the effect of stressors on innovation. It was suggested that externally driven (or task related) creativity is hindered by the effect of stressors, whereas internally driven creativity (or extra-role, contextual) is facilitated. However, the findings of this study suggest that even focusing only on task related creativity (these were R&D teams involved in projects that required the generation and subsequent implementation of ideas) the impact of stressors can vary across different innovation activities – the same example referred to above is relevant here, role ambiguity was found to have a positive impact on creativity but a negative impact on decision-making and avoiding procrastination. An alternative approach to the impact of stressors on innovation is the proposal forwarded by West (2002). West focuses on the innovation stage to explain the impact of stressors (the author refers to it as external demands, but the one can think of stressors as the translation to the individual of organisational level external demands). According to the author creativity requires a relaxed environment in which cognitive processes are not hindered; therefore it is negatively affected by stressors. Implementation, on the other hand, requires a strong stimulus, a sense of pressure, to occur. Consequently, implementation benefits from the presence of stressors. Despite being intuitively appealing, this proposal is not reflected in the results of this thesis. The effects reported above for role ambiguity show exactly the opposite pattern. One possible explanation for this relies on the different conceptualisations of innovation. In West's model implementation has a very strong behavioural nature, it refers to the decision to put a plan into action, which should be prompted by factors such as time pressure. In contrast, in this study the implementation activities –decision-making, avoiding procrastination and focus and obstacles - have a much stronger cognitive underpinning, which can be equally hindered by stressors.

Based on this analysis, one can conclude that the development of a new framework including both motivational and cognitive factors is necessary in order to understand the impact of stressors on innovation. The factors that need consideration are a) nature of the innovation outcome under analysis – e.g., creative process (engagement in creative though), individual idea, final team product, final organisational product; b) level of motivation to perform a task; c) cognitive resources available.

10.4.3 Identification of mediators and boundary conditions

Although the potential mechanisms that mediate the relationship between stressors-mood and creativity were theoretically explored, the only empirical test for the role of team reflexivity as a mediator found no support (chapter nine). Future research should explore other possible intervening variables. The role of situational team models and implicit coordination as potential candidates is discussed in chapter nine.

Furthermore, results also suggest that the above mentioned relationship can be modified by other variables. Goal performance approach orientation was identified as one such variable (chapter nine). Future research can explore also contextual factors such as leader support, as suggested in chapter nine.

10.4.4 Methodological developments

Although this thesis combined different methodological approaches, it should be recognised that each has its limitations in addressing the research question. The level of perceived stressors can vary sharply over the course of a week, or even a day. In addition to this, moods can also change over the period of hours (Watson, Clark, & Tellegen, 1988). These transient states might not be well captured in a questionnaire in which respondents are asked to answer with reference to a one-week or a one-month period. Individuals might be influenced by their state when responding to the questionnaire and therefore not be able to provide an accurate average of the level of stressors or mood experienced during the referred time frame; or even if they are able to accurately provide this average, the extent to which this constitutes the best predictor of the innovation outcomes under scrutiny is debatable. One methodological approach that overcomes these problems to a great extent consists of the use of diaries in which participants are required to report several times over the day on their transient states (Bolger, Davis, & Rafaeli, 2003; Sonnentag & Zijlstra, 2006). Furthermore, this method might enable the recording of outcome variables of interest, such as engagement in creative thinking. Although still rare, this approach has already been applied in analysing both the impact of stressors and mood on creativity (Amabile et al., 2005; Amabile et al., 2002), but never in the same study. The application of this method would allow not only the retesting of this effect but most importantly, it would enable the study of the individual cognitive processes that can mediate this effect.

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Appendix 1

List of items included in field survey

1. Individual stressors

1.1 Individual quantitative demands

I had to work fast.

I had too much work to do.

I had to work extra hard to finish a task.

I could do my work in comfort. (inverted)

I had to work under time pressure.

I had to deal with a backlog at work.

1.2 Individual qualitative demands

The demands of work quality made upon me were unreasonable.

My assigned tasks were sometimes too difficult and complex.

Tasks seemed to be getting more and more complex.

The organization expected more of me than my skills and/or abilities provide.

I had insufficient training and/or experience to discharge my duties properly.

1.3 Individual role ambiguity

I had clear planned goals and objectives for this project. (inverted)

I knew exactly what was expected of me. (inverted)

I knew what my responsibilities were. (inverted)

I felt certain about how much authority I had. (inverted)

My responsibilities were clearly defined. (inverted)

2 Team stressors

2.1 Team quantitative demands

We had to work fast.

We had too much work to do.

We had to work extra hard to finish a task.

We could do our work in comfort. (inverted)

We had to work under time pressure .

We had to deal with a backlog at work.

2.2 Team qualitative demands

The demands of work quality made upon our team were unreasonable

Our assigned tasks were sometimes too difficult and complex.

Tasks seemed to be getting more and more complex.

The organization expected more from us than our skills and/or abilities provide.

We had insufficient training and/or experience to discharge our duties properly.

2.3 Team role ambiguity

We had clear planned goals and objectives for this project. (inverted)

We knew exactly what was expected of us. (inverted)

We knew what our responsibilities were. (inverted)

We felt certain about how much authority we had. (inverted)

Our responsibilities were clearly defined. (inverted)

3. Mood

3.1 Positive mood

interested

excited

strong

enthusiastic

proud

alert

inspired

determined

attentive

active

3.2 Negative mood

distressed

upset

guilty

scared

hostile

irritable

ashamed

nervous

4. Individual innovation activities

"name of the R&D team member..."

4.1 Individual creativity activities

Cr1- Suggested many ideas

Cr2- Actively suggested new possibilities for the project

Cr3- Suggested new ideas concerning varied aspects of the project

Cr4- Suggested very diverse ideas

Cr6- Demonstrated originality in their work

Cr10- Suggested feasible ideas to the project

Cr11- Generated novel, but operable work-related ideas

5.2 Individual decision-making

Imp1- Wasted too much time generating ideas

Imp2- Spent a lot of time deciding which ideas were worth pursuing

5.3 Individual avoiding procrastination

Imp7- Could have developed the project at a faster pace

Imp8- Wasted some time while implementing plans

Imp9- Procrastinated in the execution of plans

Imp10- Got stuck in neutral even though s/he knew how important it was to get started

5.4 Individual focus and obstacles

Imp15- Even when things got confusing, s/he didn't lose sight of our project's vision

Imp 18 –Had a clear focus on how to progress

Imp16- Overcame the obstacles that emerged

Imp17- Developed solutions for unexpected problems while implementing plans

Imp 19 – Anticipated eventual problems

5. Team innovation activities

5.1 Team creativity activities

Cr1- The team suggested many ideas

Cr2- The team actively suggested new possibilities for the project

Cr3- The team suggested new ideas concerning varied aspects of the project

Cr4- The team suggested very diverse ideas

Cr6- The team demonstrated originality in their work

Cr10- The team suggested feasible ideas to the project

Cr11- The team generated novel, but operable work-related ideas

5.2 Team decision-making

Imp1- The team wasted too much time generating ideas

Imp2- The team spent a lot of time deciding which ideas were worth pursuing

5.3 Team avoiding procrastination

Imp7- The team could have developed the project at a faster pace

Imp8- The team wasted some time while implementing plans

Imp9- The team procrastinated in the execution of plans

Imp10- The team got stuck in neutral even though we knew how important it was to get started

5.4 Team focus and obstacles

Imp15- Even when things got confusing, we didn't lose sight of our project's vision

Imp 18 – The team had a clear focus on how to progress

Imp16- The team overcame the obstacles that emerged

Imp17- The team developed solutions for unexpected problems while implementing plans

Imp 19 – The team anticipated eventual problems

6.1 Creativity requirements

Over the last week, this project required the team to be creative.

Appendix 2

List of items included in experimental study

1.Time pressure manipulation check

We felt the pressure of time.

We got more concerned as the minutes were passing.

We were rushing because of time.

2. Positive mood manipulation check

How calm do you feel right now?

How happy do you feel right now?

How content do you feel right now?

How relaxed do you feel right now?

3. Learning goal orientation

I often look for opportunities to develop new skills and knowledge.

For me, development of my work ability is important enough to take risks.

I enjoy challenging and difficult tasks at work where I'll learn new skills.

I prefer to work in situations that require a high level of ability and talent.

I am willing to select a challenging work assignment that I can learn a lot from.

4. Performance approach goal orientation

I try to figure out what it takes to prove my ability to others at work.

I'm concerned with showing that I can perform better than my co workers.

I enjoy it when others at work are aware of how well I am doing.

I prefer to work on projects where I can prove my ability to others.

5. Performance avoidance goal orientation

I'm concerned about taking on a task at work if my performance would reveal that I had low ability.

I would avoid taking on a new task if there was a chance that I would appear rather incompetent to others.

Avoiding a show of low ability is more important to me than learning a new skill.

I prefer to avoid situations at work where I might perform poorly.

6. Team reflexivity

The team frequently reviewed its objectives.

The team's working methods were frequently discussed.

We frequently discussed the extent to which we were being effective in our task.

In this team we adjusted our objectives according with the circumstances.

The team strategies were seldom changed (inverted).

We frequently analised how well we were exchanging information between us.

The team frequently reviewed its approach to problems.

The way the team made its decision was seldom adjusted (inverted item).

Appendix 3

Additional table relating to chapter six

Table 3i

Testing Main Effects Individual and Team Level Control Variables on Individual Innovation Activities

	Creativity				Decision-making				Avoiding Procrastination				Focus and Obstacles			
	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*
Gender	.39	.21	1.78 (93)	.08	-.08	.37	-.21 (93)	.83	.80	.4	1.48 (93)	.14	.06	.25	.26 (93)	.80
Age	.04	.02	1.62 (38)	.11	-.04	.03	-1.54 (38)	.13	-.00	.01	-.04 (38)	.96	-.00	.02	-.10 (38)	.92
Education	.17	.21	.82 (38)	.41	.16	.19	.85 (38)	.40	-.23	.15	-1.43 (38)	.16	.27	.17	1.58 (38)	.12
Creativity requirements	.35	.08	4.05 (34)	.00	-.20	.12	-1.73 (34)	.092	-.25	.72	5.56 (34)	.00	.14	.04	1.93 (34)	.06
Project length	.00	.00	1.26 (34)	.21	.01	.00	1.65 (34)	.11	-.01	.01	-2.45 (34)	.02	-.01	.00	-.26 (34)	.22

Table 3i

(continued)

	Creativity				Decision-making				Avoiding Procrastination				Focus and Obstacles			
	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*	γ	*SE*	*t*	*p*
Stage	.07	.30	-.21	.83	.45	.42	1.07	.30	.80	.33	2.38	.02	.30	.29	1.06	.30
			(34)				(34)				(34)				(34)	
Team Size	-.13	.08	-1.82	.08	.10	.10	.98	.34	.28	.08	3.5	.00	.01	.08	.13	.90
			(34)				(34)				(34)				(34)	

Appendix 4

Additional tables relating to chapter nine

Table 9i

Results of single ANOVAs for the interaction between time pressure and positive mood

	df	*F*	*p*	Partial eta squared
Fluency/time	1	.20	.66	.00
Objective originality of ideas	1	.12	.73	.00
Subjective originality of ideas	1	.00	.97	.00
Effective originality selection	1	4.84	.03	.09
Originality of construction	1	5.18	.03	.09
Time of transition	1	.46	.50	.01
Time of completion	1	.01	.93	.00

N=54

Table 9ii

Results of single ANOVAs for the interaction between time pressure, positive mood and goal learning orientation

	df	*F*	*p*	Partial eta squared
Fluency/time	1	.02	.90	.00
Objective originality of ideas	1	4.16	.05	.08
Subjective originality of ideas	1	2.70	.11	.06
Effective originality selection	1	.08	.78	.00
Originality of construction	1	.48	.49	.01
Time of transition	1	1.61	.21	.03
Time of completion	1	.00	.98	.00

N=54

Table 9iii

Results of single ANOVAs for the interaction between time pressure, positive mood and goal performance avoidance orientation

	df	*F*	*p*	Partial eta squared
Fluency/time	1	.04	.85	.00
Objective originality of ideas	1	.55	.46	.01
Subjective originality of ideas	1	.88	.35	.02
Effective originality selection	1	.19	.66	.00
Originality of construction	1	.58	.45	.01
Time of transition	1	.04	.84	.00
Time of completion	1	1.01	.32	.02

N=54

Table 9iv

Results of single ANOVAs for the interaction between time pressure, positive mood and goal performance approach orientation

	df	*F*	*p*	Partial eta squared
Fluency/time	1	.03	.87	.00
Objective originality of ideas	1	.62	.43	.01
Subjective originality of ideas	1	2.12	.15	.04
Effective originality selection	1	.73	.40	.02
Originality of construction	1	.00	1.00	.00
Time of transition	1	5.19	.03	.10
Time of completion	1	.63	.43	.01

N=54