Abstract

In a globalized world developing at increasing speed, a focus on creativity and innovation has become of even greater importance as it is seen as a key to our future. Organizations therefore need to innovate to stay relevant, but our understanding of creativity and how we can optimize it for innovation is not fully understood. As a result, these topics have grown in popularity with researchers and educators in recent years.

This thesis explores the emerging field of neurocreativity and brings it in to a dialogue with well-established theories of creativity in the context of business innovation, with the intent to further our understanding. This was done with an interpretivist approach and by method of comparative analysis. This research philosophy allows for multiple views of a phenomenon to be combined in to a more coherent understanding, rather than focusing on one specific perspective. The selected theories were initially visually mapped out to provide an overview of their components, and to clarify their research objects and fundamental beliefs as well as ensure validity.

The findings indicate several limitations in current creativity literature when considered in relation to new insights emerging from neurocreativity research. Most fundamental is the critique of experts as appropriate observers in regards to creativity assessment. The findings suggest that experts are biased in favor of low levels of novelty, which narrows their ability to judge creative efforts. Furthermore, novelty is found an important factor for creating breakthroughs, which adds to the critique of experts as appropriate observers. This thesis suggests that neurocreativity is better suited for individual creativity assessment as it provides a framework for objective assessment without having to rely on an outcome, but that it does not extend to innovation. Additionally, the findings indicate that managers focusing on the social dynamics of creativity may benefit from extending their focus towards individual creativity as well, while also including employees as actors, as opposed to creativity being something managers foster and set the conditions for. This thesis concludes that neurocreativity contributes with a wealth of opportunities for further creativity research at the intersection of this new theory and prior creativity studies, as well as provide an insight that fosters change for business innovation in practice.
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Introduction

_Innovate or die_ has become a mantra to live by for many established companies (Business Insider, 2013). The story of a major corporate player, once part of the most successful companies in the world having become yesterday’s news as a result of its lack in ability to innovate, is not a one off event. Companies like Kodak, Netscape, AOL, and Nokia, are examples of this story, though the latter might be in for a comeback (Forbes, 2011). The rapid pace of technological innovation also topped a 2015 Forbes survey among Fortune 500 CEOs when asked about the greatest challenges their respective companies currently face (Fortune, 2015) – a list where 57% of the companies have been replaced in the last twenty years.

It is therefore no surprise that research and education on the topics of creativity and innovation have grown in popularity; a SCOPUS search reveals that the number of published articles on “creativity” and “innovation” annually, has doubled in the last ten years and more than quadrupled since 1996. My own place of study – Copenhagen Business School – established the “Organizational Innovation and Entrepreneurship” Master program in 2009, graduating the first students five years ago (CBS, 2009). Along with this development we find emerging consultancies (e.g. Smart Design, Fahrenheit 212, Happen Innovation Agency, Freshminds, Doblin, Gemic, Fjord, and Antedote) specializing in creativity and innovation with a promise to teach clients how to disrupt and revolutionize. But what exactly is creativity and how do we optimize it for innovation? A simple question to ask, but a bit more tricky to answer as the definition of creativity and how to facilitate and measure it is not fully agreed upon.

Companies perceived as highly innovative have therefore been the foundation for several researchers (e.g. Hill et al., 2014; Harvey, 2014; Ahuja & Lampert, 2001; Hippel et al, 1999; Hargadon & Sutton, 1997) in an attempt to seek out what differentiates them, and from where their creative capabilities arise. But while some researchers focus on creativity primarily from an individual perspective (Amabile, 1996, 1983) others view it more as the result of social dynamics (Paulus & Nijstad, 2010; Sawyer, 2008, 2006; Choi & Thompson, 2005). But which view are we to emphasize when trying to build a highly innovative company? Though scholars’ focus differentiates, they all shed some light on what creativity is.
Therefore, if we are to further our understanding we must try to use a systems approach, so that we do not limit ourselves to a single selected version, but rather, one that includes multiple views. This is an approach often seen in the humanities, but it has also been specifically put forward by Hennessey and Amabile (2010) in regards to creativity. The argument for this approach is not only based on the benefits of a combined view, but also since they see many scholars unfamiliar with what their fellow colleagues are doing within the same field of study – creativity and innovation.

But where the trend of creativity research has moved towards groups and leadership in recent years, I see a new opportunity to revisit the focus on the individual, given this new emerging scientific research regarding creativity and the brain.

**Neuroscience and Creativity**

According to Jung et al. (2013), though the majority of psychometric research studies in creativity have emerged in the latter half of the 20th century (Guilford, 1968; Torrance, 1974; Amabile, 1983), there has been limited progress regarding brain correlates prior to the advent of modern neuroimaging techniques. Whereas neuroimaging studies of intelligence have a 20-year history and span dozens of studies (Jung & Haier, 2007), similar studies of creativity are relatively few although spanning roughly the same period of time.

Neuroimaging of the creative process can be undertaken to assess brain traits and brain states associated with task performance (Jung et al., 2013). Both the behavioral and neuroimaging approaches can be combined to select people as high and low on trait measures of creativity, and then compare the state of their brain functioning as they perform creative tasks. Despite recent progress “it is likely impossible to capture someone being truly creative in a laboratory setting; rather, we describe ways by which to measure this cognitive construct by capturing particular elements found to be important to the creative process including, “insight,” “convergent,” and “divergent” cognitive processes.” (Jung et al., 2013:4).

From here we find a new field termed “neurocreativity” emerging on the backbone of neuroscience, where an array of neuroscientific insights have been boiled down to specific...
concepts (remote associations, priming, cognitive inhibition, fixation, and incubation effects) combined with a specific design process (The Double Diamond), and then introduced to a business audience to increase their individual creativity, which has been done with success (Onarheim & Friis-Olivarius, 2013).

In neurocreativity, creativity is defined as “...the forming of associative elements into new combinations which either meets specified requirements or is in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution.” (Mednick, 1962:221). Remoteness in this regard is understood at the individual neurological level. So were a car and a train could be closely associated, a car and a bird might not. If you are able to make a new combination out of a car and a bird, that is useful or lives up to certain requirements, it would be considered more creative than if you made that new combination out of a car and a train. Neurocreativity therefore provides us with a framework for creativity that allows for its recognition without having to refer to an outcome. But here we also find its limitation, hence the ability to measure the sources of creative cognition in an individual’s brain is at the level of “first approximation” (Jung et al., 2013), as with where in the brain we should find these sources (Drago et al., 2006; Flaherty, 2005; Dietrich, 2004; Heilman et al., 2003). In addition, the associated remoteness also varies between individuals, and as a result the level of creativity is then often measured by how much value the new combination adds, or how well it lives up to the requirements.

Though very new, and at the cutting edge of neuroscience, it is this new field of neurocreativity that I wish to bring in dialogue with already established theories on creativity within a business innovation context. The goal is to bring in a new interesting view that could contribute to a multiplicity perspective and help shed further light on the dynamics of creativity.
A New Frontier

Where neurocreativity is about combining different bits and pieces of knowledge inside one’s own head, scholars focusing on producing breakthroughs argue for a similar approach – just at a social network scale – where knowledge from different domains are recombined into new solutions. If we look at researchers focusing on how breakthroughs are achieved in practice, there is a trend towards know-who instead of know-how (Harryson, 2006); an approach which in this case also builds on the researcher himself (Sigvald Harryson) who owns and manages a consultancy specializing in technological breakthroughs for clients that has been very successful in doing so. Similarly we find knowledge brokering where knowledge spanning across different domains is argued as a way to create breakthroughs (Hargadon, 2003). This has also been the starting point for my research, as I have previously been an intern with Harryson’s consulting company (HCG) through which I have conducted preliminary research. The similarity between producing breakthroughs in practice and neurocreativity motivated me to do this study. Given the support of creativity being an essential factor for innovation, neurocreativity, despite its limitations, becomes an interesting research perspective to explore.

A lot of effort goes in to bringing a solution to market (entrepreneurship) which fosters the need for a distinction between our ability to create solutions that fit the current problem, and the social success of those solutions. This is done with the distinction between trait- and achievement creativity. The focus of my thesis is primarily aimed towards our ability to create solutions (trait creativity) and not the social success of them (achievement creativity) though acknowledging that drawing a fine line between the two in practice can be quit blurred. The focus of my thesis is therefore not innovation per se, but creativity which plays an important role in the innovation process, which is where I see neurocreativity being able to contribute the most, as it provides a framework for creativity without having to rely on an outcome.

Given this a new field and provided the distinction between trait- and achievement creativity, I set out to do an explorative study based on the following research question: “What can neuroscience contribute to our understanding of creativity in the context of business innovation?” and specified by asking the subquestions; “What can neuroscience contribute to
our understanding of creativity from the perspective of an individual?”, and “What can neuroscience contribute to our understanding of creativity as social dynamics?”. These questions emerge as the increased focus on innovation surges; people and their creative efforts are the foundation of innovation – without them there is none. Understanding creativity is therefore of great interest. The specified subquestions point us towards two of the main trends in creativity research which also have a focus on the individual, though there are some differences which will be elaborated later. Framing the questions this way allows for a broader analysis of neurocreativity in relation to the established theories, providing more ground for potential links to be made and thereby supportive of the explorative nature of this thesis. This also implies a natural limitation as the scope of this study is narrowed towards an area where I see neurocreativity has the most to contribute with. This implicitly also acknowledges that other theoretical approaches to creativity (e.g. from a leadership perspective) is missing out, but the intent of this explorative study is not find all the areas where neurocreativity may be able to contribute, but those where it can contribute the most. Limiting the initial scope to theories with the same research object (the individual), though some differences are present, provides for a starting point with increased possibility for a constructive dialogue, as a basic foundation is already in place.

I approached answering these questions by initially exploring the current state of this field, and then bringing relevant theories in to a dialogue with neurocreativity by method of comparative analysis. I found that neurocreativity supports certain aspects of our current understanding such as viewing creativity on a continuum, and the importance of creativity training. But I also found grounds for evoking changes for the established theories and thereby also for business innovation in practice. Suggested theoretical revisions include expanding the spectrum of the creativity continuum for which experts may be limited in appropriately assessing creativity, as well as high levels of individual creativity being prerequisite for high levels of group creativity to emerge. Based on these findings I outline specific research proposals as exploring the extent to which conscious creativity training can lead to a subconscious behavioral change that resembles the traits relating to personality types of highly creative people. I conclude that neurocreativity contributes with a wealth of new opportunities for further creativity research at the intersection of this emerging theory
and prior creativity studies, while also providing a framework for creativity without having to rely on an outcome. In addition it also contributes with insights on what the implications for business innovation in practice might be.

Following the current introduction is the theory chapter where I provide a frame of reference for creativity within the field of business innovation. Hereafter follows the methodology chapter where I introduce the ontological and epistemological standpoint allowing the reader to follow my research strategy. The concepts from neurocreativity and the specific design process used to introduce the framework to business students will then be elaborated to provide a specific framework which leads to the analysis. Succeeding this we find a discussion, where the implications and what new venues of research emerge as a result are discussed along with the final conclusion.
The theory chapter is where my investigation starts. I set out to explore our current understanding of creativity in the context of business innovation, and to find the field of research to which I wish to contribute. Given the limitation in scope and timeframe of my thesis, I chose to limit the selected theories to two overall frameworks; viewing creativity from the perspective of an individual and as the result of social dynamics, though not to be confused with the distinction between an individualist- and sociocultural approach. In addition, since the frameworks provided by the selected scholars are quite extensive, I have also narrowed them down to their most essential contributions. This is therefore not a thorough breakdown of every contextual relevant view within the field of creativity that primarily relies on an individual perspective or social dynamics, nor a full elaboration of those chosen, but select samples of work by well-known scholars representing these two perspectives.

Each subchapter will introduce the particular scholar’s work providing the reader with a frame of reference. Additionally, given theoretical differences I will in the analysis chapter initially elaborate on relevant aspects to keep in mind, as the selected scholars’ research object(s) may not align with that of neurocreativity, resulting in a lack of foundation for a productive conversation if not taken into account.

Creativity from an Individual Perspective

The principal scholar whose work I chose to bring into dialogue here is Teresa Amabile. Her work spans the last four decades, and she is one of the most cited scholars within the field of creativity relating to business innovation having provided a vast amount of accredited contributions (e.g. Amabile, 1998; 1997; 1996; 1983; 1982; Amabile et al., 1996; 1994). Given her immense amount of effort I selected her book *Creativity in Context* (Amabile, 1996) as the primary source, as it can be considered an assembly of much of her work. It therefore provides a good source of insight, though it cannot be viewed as a full representation for all of which she has contributed.
Amabile uses two definitions of creativity: “A product or response is creative to the extent that appropriate observers independently agree it is creative.” (Amabile, 1996:33) and argues that appropriate observers are those familiar with the domain in which the product was created or the response articulated. Thus, creativity can be regarded as the quality of products or responses judged to be creative by appropriate observers, and it can also be regarded as the process by which something so judged is produced (Amabile, 1996). Secondly “a product or response will be judged as creative to the extent that (a) it is both a novel and appropriate, useful, correct or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic” (Amabile, 1996:35). These two definitions distinguish as the former is as a consensual/operational definition, which is “…necessary for the development of useful assessment methods…” (Amabile, 1996:38), hence it specifies that the product is creative to the extent that appropriate observers agree it is creative. The latter, however, is a conceptual definition which is necessary for building a theory of creativity (Amabile, 1996) which goes beyond purely subjective assessment criteria (appropriate observers), and specifies that the path to a solution must also be heuristic rather than algorithmic, thereby further including the individual. The definition of the path to a solution being heuristic rather than algorithmic simply means that it must not be straightforward for the individual (Hilgard & Bower, 1975) and is therefore dependent on the individual performer’s knowledge. Her conceptual definition therefore rests on assumptions about what observers are responding to when they identify a product as highly creative.

Amabile focusses on the response (product/solution) and the individual’s path to that response in order to determine if both are creative, while arguing that an objective assessment cannot be made. If the response is heuristic for the individual and judged creative by appropriate observers, then both are to be considered creative. This relies on an assumption that “…products or observable responses must ultimately be the hallmark of creativity” and furthers this by assuming “…degrees of creativity, that observers can say with an acceptable level of agreement that some products are more creative or less creative than others” (Amabile, 1996:35). The essential point I wish to put forward here, is that she hereby views the individual and the response as equally creative in the specific context, as there is no separation in “creativity” between the two.
Preliminary Assumptions and Observations

Before introducing the componential elements and the framework for creativity that Amabile has provided, there are ten assumptions and observations that precede them (Amabile, 1996:82-83). These are Amabile’s own, and I have decided to explicitly cite these ten, despite I did not find all relevant to bring into dialogue with neurocreativity. This is partly due to two things; reassuring authenticity as will be described in the methodology chapter, so as to stay true to the voices of others. Secondly, since limiting the assumptions and observations to those I found relevant functions as a limitation in the reader’s critical review of my writings, and may also prevent the reader from spotting elements of possible dialogue that I may have missed. The ten assumptions and observations are cited below:

1) It is assumed that there is a continuum from the low levels of creativity observed in everyday life to historically significant advances in science, literature, and the arts. In contrast to popular views of creativity as a discrete entity, this assumption implies that it is possible for anyone with normal cognitive abilities to produce work that is creative to some degree in some domain of endeavor.

2) A closely related assumption is that there can be degrees of creativity within a particular individual’s work.

3) At least for high levels of creativity, there often seems to be a special “match” between individuals and domains (Feldman, 1980). There appears to be a particularly good fit, for example, between one individual and chess-playing, or between another individual and musical composition.

4) The ages at which peak creativity is achieved in different domains varies widely (Simonton, 1975a; Dennis, 1966; Lehman, 1953)

5) Although different individuals may differ widely in their potential for creative performance in any given domain, it does appear to be possible to increase creativity to some extent (Stein, 1974; 1975). Specifically, although innate abilities (“talents”) in a given domain do appear to be important for high levels of creativity, formal education seems essential in most outstanding creative achievements (Feldman, 1980).
6) Talents, education, and cognitive skills do not by themselves appear to be sufficient for high levels of creativity.

7) Particular clusters of personality traits are found fairly consistently among individuals exhibiting high levels of creativity (see Stein, 1974, for a review) but, again, they are not sufficient in and of themselves. Certainly, any given individual – even one exhibiting a particular “creative” personality-trait constellation – is not creative at all times or in all domains.

8) A great many outstanding creative individuals (e.g., Poincare, 1924) have described the phenomenon of “incubation”: After ceasing to consciously work on a difficult problem, they sometimes experience an apparent flash of illumination, during which the solution appears to them unexpectedly.

9) Although an eagerness to work diligently appears to be an essential component of high levels of creativity (Golann, 1963) and although a number of introspective accounts describe creativity as marked by deep involvement in the activity at hand, these accounts also stress the importance of intellectual playfulness and freedom from external constraints (e.g., Einstein, 1949).

10) Although it appears that extrinsic constraints can be detrimental to creativity (a central theme to be developed more fully latter), there are individuals who appear to produce consistently creative work under clear salient extrinsic constraints.

**Components of Creative Performance**

Amabile has created an overview (figure 1) of components she finds relevant for a creative performance, and a framework of creativity (figure 2, p. 18) for how those components may influence the creative process. She uses her consensual definition in this regard. Hereby the aim of the framework is to illustrate how these components may influence a process aimed towards producing a response that can be judged creative by appropriate observers.

The features of this framework go beyond a pure social-psychological approach in an attempt to create a broader theory of the creative process, hence it is “…not based on a specific program of empirical research” (Amabile, 1996:82) and should therefore be regarded as a
working model. This, in essence, is a hand reaching out to other perspectives – a hand I seek to grab hold of.

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**Fig. 1 Components of Creative Performance with updates (Amabile, 1996) re-illustrated for this thesis.**

<table>
<thead>
<tr>
<th>Domain-Relevant Skills</th>
<th>Creativity-Relevant Processes</th>
<th>Task Motivation</th>
</tr>
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<tbody>
<tr>
<td>Includes:</td>
<td>Includes:</td>
<td>Includes:</td>
</tr>
<tr>
<td>- Knowledge about the domain</td>
<td>- Appropriate cognitive style</td>
<td>- Attitude toward the task</td>
</tr>
<tr>
<td>- Technical skills required</td>
<td>- Implicit or explicit knowledge of heuristics for generating novel ideas</td>
<td>- Perceptions for own motivation for understanding the task.</td>
</tr>
<tr>
<td>- Special domain-relevant “talent”</td>
<td>- Conductive work style</td>
<td>Depends on:</td>
</tr>
<tr>
<td></td>
<td>Depends on:</td>
<td>- Initial level of intrinsic motivation toward the task</td>
</tr>
<tr>
<td></td>
<td>- Innate cognitive abilities</td>
<td>- Presence or absence of salient extrinsic constraints</td>
</tr>
<tr>
<td></td>
<td>- Innate perceptual and motor skills</td>
<td>- Individual ability to cognitively minimize extrinsic constraints</td>
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<td></td>
<td>- Formal and informal education</td>
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**Domain-relevant skills**

These skills comprise “...the individuals complete set of response possibilities from which the new response is to be synthesize, and information against which the new response is to be judged.” (Amabile, 1996:85). This component can be seen as a set of “cognitive pathways for solving a given problem or doing a specific task” (ibid). These pathways can vary as some could be more common or well-practiced than others, just as some are larger or smaller. “The larger the set, the more numerous the alternatives available for producing something new, for developing a new combination of ideas” (ibid).

The components under this skillset include familiarity with *factual knowledge* within the domain such as facts, principles opinions about various issues, knowledge of paradigms, aesthetic criteria and performance “scripts” (Schank & Abelson, 1977). The argument for this view resides with the notion of it being impossible to be creative in nuclear physics if little or no knowledge about this field is known by the individual (Amabile, 1996). Other components in this skillset are *technical skills* such as laboratory techniques or studio art techniques, and *domain-relevant “talents”* contributing to creative producing. Amabile’s definition of talent is simply “…a special skill for which an individual appears to have a natural aptitude.”, and
depend upon innate cognitive, perceptual, and motor abilities, as well as formal and informal education (Amabile, 1996:86).

Creativity-relevant processes

Creativity processes are the “something extra” of creative performance. Despite an individual having high levels of domain-relevant skills such as technical abilities and factual knowledge, it is not considered sufficient for surpassing previous products or responses in the domain. The first component here is a cognitive style “...characterized by a facility in understanding complexities and an ability to break set during problem-solving” (Amabile, 1996: 88). Amabile references nine different features of cognitive style, for which I will cite all of them. This is not only due to the authenticity argument as mentioned previously, but also since this set of skills are cognitive which is where neurocreativity has its foundation. The detailed description therefore provides the reader with the possibility of following along more deeply situated in the later dialogue, as much of the following will be referenced.

1. Breaking perceptual set (as suggested by Boring, 1950; Katona, 1940; and Wertheimer, 1959). Duncker’s (1945) studies in “functional fixedness”, for example, demonstrated that subjects who solved his problem “creatively” were those who could see a thumbtack box as a platform for a candle, rather than just a container.

2. Breaking cognitive set (or exploring new cognitive pathways). Newell et al. (1962) suggest problem-solving can result in creative solutions when an old set of unsuccessful problem-solving strategies is abandoned and the search, as a result, moves off in a new direction.

3. Understanding complexities. There is evidence that cognitive complexity, an appreciation of and facility in working with complexity, is related to creativity in at least some domains of endeavor (Quinn, 1980).

4. Keeping response options open as long as possible. In a study of student artist, Getzels & Csikszentmihalyi (1976) found that those who approached their canvas without a definite plan produced more creative paintings than those who knew in advance what they were going to do. Kuhn (1963) views this ability to avoid foreclosure of alternatives as essential for scientific creativity: “Ability to support a tension that can
occasionally become almost unbearable is one of the prize requisites for the very best sort of scientific research”.

5. **Suspending judgement.** Schiller once advise a friend who complained about being uncreative: “In the case of the creative mind, it seems to me, the intellect has withdrawn its watchers from the gates, and the ideas rush in pell-mell, and only then does it review and inspect the multitude” (Brill, 1938:193). Suspension of judgement is the cardinal rule of Osborn’s (1963) brainstorming program, and apparently the facet of that program that is most responsible for positive results (Stein, 1975).

6. **Using “wide” categories.** Individuals who categorize information in “wide” as opposed to “narrow” categories, who see relationships between apparently diverse bits of information, may be more likely to produce creative works and responses (Cropley, 1967).

7. **Remembering accurately.** Cambell (1960) has proposed that those who can code, retain, and recall large amounts of detailed information will probably have an advantage in creative performance; there is, indeed, some empirical evidence to support this proposition (Pollert et al, 1969).

8. **Breaking out of performance “scripts”**. I [Amabile] proposed earlier that domain-relevant skills include performance “scripts” (Schank & Abelson, 1977) or “algorithms”, set sequences of steps for performing tasks or solving problems in a given domain. It may be important for creativity to be able to break out of well-used scripts occasionally, or at least to be able to examine them, instead of proceeding through them uncritically (Langer, 1978; Langer & Imber, 1979).

9. **Perceiving creatively.** Koestler (1964) has suggested the critical role of seeing things differently from the way most people see them, of being able to take advantage of serendipity by recognizing the importance of new information.

*Knowledge of heuristics* is the second component of the creativity-relevant skills, and can be defined as “any principle or device that contributes to a reduction in the average search to a solution” (Newell et al., 1962:78). A heuristic approach can therefore best be considered as a way of approaching a problem that leads to an alternating outcome, rather than a strict process or set of rules one must follow. The third component is a work style that is beneficial
to the creative production, and consists of several features (Amabile, 1996): (a) an ability to concentrate effort and attention for long periods of time (Campbell, 1960; Hogarth, 1980; Prentky, 1980); (b) an ability to use “productive forgetting” when warranted, which is an ability to abandon unproductive search strategies and temporarily put aside stubborn problems (Simon, 1966); (c) a persistence in the face of difficulty (Roe, 1953; Walberg, 1971); and (d) a high energy level, a willingness to work hard, and an overall high level of productivity (Bergman, 1979; Bloom, 1956; Davis & Rimm, 1977; Simonton, 1980; Wallach & Kogan, 1965).

**Task motivation**

The basic notion behind task motivation is that freedom of extrinsic constraint enhances creative thinking, and consists of two elements: the individual’s baseline attitude toward the task (“the trait”), and the individual’s perceptions of his reason for undertaking the task in a given instance (“the state”) (Amabile, 1996). Extrinsic constraint in this regard is defined as “…factors that are intended to control or could be perceived as controlling the individual’s performance on the task in a particular instance” (ibid:92). As such, the extrinsic constraints are not a feature of task performance, but something that is imposed by other people. In addition to the external constraints, internal factors, such as an ability to cognitively limit the extrinsic constraints, may also influence task motivation.

In short, Amabile proposes that “…a wide variety of extrinsic constraints will, by impairing intrinsic motivation, have detrimental effects on creative performance. Task motivation can be seen in this context as the most important determinant of the difference between what a person can do and what he will do.” Amabile, 1996:93). The former is determined by the domain-relevant and creativity-relevant skills; where the latter is determined by these two in conjunction with an intrinsically motivated state.

The intrinsic motivation principle of creativity (formerly the intrinsic motivational hypothesis in Amabile, 1983) is an essential part of Amabile’s overall theory of creativity, and one that furthers the notion of motivation to a great extent. However, the framework of
neurocreativity is currently limited from engaging in a productive dialogue on motivation to such a degree, that it would be appropriate to include the intrinsic motivational principle of creativity in its full form – one that by itself could span an entire thesis such as this one. But given that this principle is central to Amabile’s theory of creativity, and that I managed to find a point of interest where neurocreativity might be able to shed some light on a specific element that Amabile is quite critical of, I decided to briefly mention it here. I will, however, not elaborate further on the vast details of the intrinsic motivational principle of creativity, but the element for a productive dialogue found will be elaborated in the analysis-chapter.

**Framework of creativity performance**

To build a theory of creativity Amabile has created a framework illustrating how the above mentioned components might influence a creative process (figure 2). It describes “…how an individual might assemble and use information in attempting to arrive at a solution, response or product” (Amabile, 1996:93).

Just as I have chosen to limit other elements of her theory, this framework will also not be described in its full form. I have therefore limited this framework to the inclusion of the mentioned components in the previous section and how they are argued as influencing different parts of a creative process, as elements such as ageing, intelligence are beyond the current scope of neurocreativity. The process put forward by Amabile is to be seen in a more general sense, and not as the creative process, but rather one in which she has found to include the broad elements found in many other creative processes. It does also not distinguish between high- and low levels of creativity, but allows the possibility of a creative continuum.

**Task motivation**

Responsible for initiating and sustaining the process, and determines whether the search for a solution will begin and whether it will continue, while also determining some aspects of response generation.
Domain-relevant skills

The materials drawn upon during operation; determines what pathways will be available during the search for a response, and what criteria will be used to assess the response possibilities that are generated.

Creativity-relevant processes

Acts as the “executive controller” (Amabile, 1996) during response generation, influencing the way in which the search for responses will proceed.

This concludes what I have chosen to bring in from Teresa Amabile. As initially stated, this is not a full overview of her vast contributions, but essential elements aimed at providing a solid framework for her most notable work. This framework allows us to view creativity from an individual perspective and some of the many factors that influence the process within this view. But it also has its limitations as creativity is only measured by subjective assessment, and as we will see in the following, we may have to go beyond the individual perspective if we are to better our understanding of creativity.
Creativity as Social Dynamics

The principal scholar whose work I chose to bring in here is Keith Sawyer. Sawyer has, as Amabile, made several outstanding contributions relevant for creativity research in relation to business innovation (e.g. Sawyer, 2011; 2008; 2005; 2004; 2003). His main focus is on groups and he argues that collaboration leads to higher levels of creativity that any one of the individuals taking part in that group could have done on his own (Sawyer, 2008). Sawyer’s main research has therefore been on theatre and jazz groups (e.g. Sawyer, 2003; 2006) where the creative product that emerges as a result of the collaboration is a performance. He defines creativity as “the emergence of something novel and appropriate, from a person, a group, or a society” (Sawyer, 2006b: 33), and uses the term distributed creativity to refer to “situations where collaborating groups of individuals collectively generate a shared creative product” (Sawyer & DeZutter, 2009:82). But he does not focus as much on the product or performance as he does on what he argues are the characteristics of the groups and teams whose collaboration lead to highly creative outcomes.

The following framework is primarily based on Sawyer’s book “Group Genius” (2008), in which he combines several of his views into a more broad and coherent one. It consists of two overall parts and represents the core part of Sawyers view on the social dynamics of creativity; the first, “The Collaborative Team” is his characteristics of creative groups along with some conditions for creativity to happen; in the second part we find the “Collaborative Mind”, where he argues for the inner workings of our mind and connects it with the social dynamics he described in the first part.

But before we dig into further detail I should briefly introduce Mihaly Csikszentmihalyi as his work has laid the foundation for Sawyer. As of 2016 he is the Distinguished Professor of Psychology and Management at Peter F. Drucker and Masatoshi Ito Graduate School of Management at Claremont Graduate University. He was previously Sawyers Ph.D. supervisor, and the scholar who introduced the concept of flow which is a state of peak experience (Csikszentmihalyi, 1990a). It is this state of flow that Sawyer (2008) has extended from individuals to groups and furthered through his own research. Csikszentmihalyi’s research supported May (1959) who was one of the first to describe this experience: “intensity of
awareness, absorption, heightened consciousness, oblivious to the environment and to the passage of time” (p. 61). Csikszentmihalyi argued that people are more creative when they are in an experiential state that has the following characteristics (Sawyer, 2012):

- Clear goals
- High degree of concentration on the task
- A loss of self-consciousness
- Distorted sense of time
- Immediate feedback is continuous while engaged in the task
- Balance between the level of ability and the challenges of the task
- A sense of personal control
- The activity is intrinsically rewarding
- A lack of awareness and bodily needs, such as hunger or fatigue
- The focus of awareness is narrowed to the activity itself, so that action and awareness are merged.

Sawyer has elaborated and adapted these characteristics into a group setting, and just as Csikszentmihalyi argued that a state of flow is essential for individual creativity (Csikszentmihalyi, 1990a), Sawyer argues the state of group flow is essential for groups to produce highly creative outcomes (Sawyer, 2008).

Most of what Sawyer describes in the first part (the collaborative team), directly relates to innovation and not creativity per se in the context of innovation as is the focus of this thesis, which is an important distinction to keep in mind. But in the second part where he elaborates on how our minds work, he directly touches upon creativity (as defined by neurocreativity), and then uses this to support what he has initially argued. The possible relation to neurocreativity and how it may engage in a dialogue with Sawyer’s framework thus becomes clearer once you have read the second subchapter “The Collaborative Mind”. Given the focus of this thesis, I have therefore found it more relevant to elaborate on the details in the second part, but the initial part will be described none the less, as it helps us understand how researchers are currently investigating and understanding creativity in a business innovation context. This is also done to ensure authenticity and generally provide his views to be
presented in the context within which they have been created. Additionally, this allows the reader to be more critical when reading, as the broader context influences how we view the details.

**The Collaborative Team**

One of the main points in Sawyers view on creativity in groups is the need for improvisation. Along with other scholars (e.g. Weick, 2001; Kao, 1996; Eisenberg, 1990) he compares groups performing at their peak with improvising jazz groups, where the members play off each other’s input and collectively produce something they could not have done on their own. “Collaboration is the secret to breakthrough innovation” but “only certain kinds of collaboration work in the real world – improvisations that are guided and planned, but in a way that doesn’t kill the power of improvisation to generate unexpected insights” (Sawyer, 2008:ix-xiii).

**The Power of Collaboration**

Implicit and often explicit in most of Sawyer’s writings is a critique of “the lone genius” – that an individual is able to produce highly creative outcomes on his own. Instead, he argues that “it’s group genius that generates breakthrough innovation” (Sawyer, 2008:7). But group genius does not simply arise on its own. Through his research, Sawyer has identified seven key characteristics of effective creative teams (ibid:14-17):

- **Innovation emerges over time**
- **Successful collaborative teams practice deep listening**
- **Team members build on their collaborators’ ideas**
- **Only afterwards does the meaning of each idea become clear**
- **Surprising questions emerge**
- **Innovation is inefficient**
- **Innovation emerges from the bottom up**
I will not describe these characteristics in full detail here as they directly or indirectly will be elaborated in the following. I chose to mention them as they are part of Sawyer’s overall framework, and can be seen expressed throughout the rest of the elaboration. However, the use of these characteristics also shows that Sawyer focusses on the interaction between individuals and how these interactions and processes should be organized in a certain way to enable creative and innovative activities.

**Improvising Innovation**

Sawyer sees improvisation as a central part to innovation, because “planning works well to enhance efficiency but blocks innovation precisely because it’s designed to reduce the variance of what occurs between the group members” (Sawyer, 2012:245).

He relates this to *script-think* which is “the tendency to think that events are more predictable than they really are” (Sawyer, 2008:23). This is supported by well-known psychologists Mead (1932) and Dewey (1934) who have elaborated on this in detail, but the point here is that “the key to innovation is always to manage a subtle balance of planning, structure, and improvisation” (Sawyer, 2008:29). To this he adds that the most effective teams are self-managing and then uses improvisational jazz as a metaphor arguing that they have no leader and everyone contributes equally.

**Group Flow**

Given the importance of group flow for Sawyer’s theory, I have elaborated on this into a bit more detail than the other elements of his framework described in the first subchapter. The ten characteristics are cited below (Sawyer, 2008; 2012):

1. **The Group’s Goal**

   Match between group and goal. If the group’s goal is well defined, then a high degree of structure, cohesion, and shared knowledge are necessary to attain peak performance. But if the group’s goal is ill defined, as is the case with most creative
tasks, then peak performance requires a lower degree of structure and more diversity of backgrounds.

2. *Close listening*
   
   Rather than plan ahead what is to be said, everyone’s statements are genuinely unplanned responses to what has just been said.

3. *Complete concentration*
   
   The group is fully focused on its task, without external distractions.

4. *Being in control*
   
   The group has autonomy and authority to execute.

5. *Blending Egos*
   
   Each person’s ideas build on everyone else’s, so that at the end, no one can remember who contributed what.

6. *Equal participation*
   
   Everyone participates equally. The generally requires that everyone have a similar level of expertise and authority.

7. *Familiarity*
   
   Some degree of familiarity is necessary, because it results in *tacit knowledge* that enables better communication. But too much familiarity means that there is no possibility of unexpected connections that results in new ideas.

8. *Communication*
   
   The group members are always in communication, always talking.

9. *Moving it forward*
   
   Keep it moving forward. Each person builds on and elaborates the ideas generated by the others.
10. The potential for failure

The real potential for failure motivates peak performance, but only if the group is working in an environment that welcomes failure as a necessary and frequent correlate of innovation, rather than punishing failure.

Csikszentmihalyi (1990) discovered that extremely creative people are at their peak when they experience “a unified flowing from one moment to the next, in which we feel in control of our actions, and in which there is little distinction between self and environment; between stimulus and responses; or between past, present, and future (Sawyer, 2008:42), and the above mentioned ten characteristics from Sawyer extend this work to a group setting. But it is important to note that they are no guarantee for group genius, but flow-enabling conditions Sawyer argues group genius tends to emerge from. So whereas he before focused on the interaction between the individuals in the group, he here adds specific conditions that he argues are important. This shows that Sawyer moves beyond the social interaction per se, to include a more managerial perspective as well, which is a common approach to studies of high performing teams (e.g. Harvey, 2014; Florida & Goodnight, 2005).

From Groupthink to Group Genius

Sawyer, who uses interaction analysis to study groups, also focuses on groupthink which occurs when a group makes faulty decisions because group pressures lead to a deterioration of “mental efficiency, reality testing, and moral judgment” (Janis, 1972:9). The result is groups that tend to get fixated faster (Larey & Paulus, 1999) and brainstorming in groups therefore “tend to cluster in a few categories” which is referred to as topic fixation (Sawyer, 2008:65). Sawyer criticizes brainstorming, supported by Larey & Ortega (1995), and suggests a few techniques for mitigating the risk of productivity loss that can occur when groupthink emerges from brainstorming.

The first cause resulting in productivity loss is production blocking (Diehl & Stroebe, 1991a), where topic fixating as mentioned above in an example of this. Sawyer suggests electronic
brainstorming (Dennis & Valacich, 1993) and brainwriting, where the individuals take five minutes to write down their own ideas and pass them on to other group members, as methods meant to counter this.

In addition, Sawyer sees social inhibition and social loafing (Diehl & Stroebe, 1991a; 1991b) as the second and third cause of productivity loss when groups engage in brainstorming activities. The first is when group members hold back their ideas in fear of judgement by the other group members, which is strengthened when an expert or other person of authority joins the group (Collaros & Anderson, 1969). The second is when responsibility is distributed among the group members, so individuals “relax a little, and perhaps don’t work as hard” (Sawyer, 2008:66). A central view to the relaxed nature of people in groups may fall into revolves around conformity and “only by introducing diversity can we avoid the groupthink that results from too much conformity” (Sawyer, 2008:71). This concludes the first part of Sawyer’s framework and we now move on to his view of the inner workings of our mind in relation to the collaborative team.

The Collaborative Mind

In this second subchapter of what I have chosen to include from Sawyer’s framework, he changes his focus towards our mind (brain) and argues for a connection between its inner workings and the first part described above. As previously mentioned, I will elaborate his views here in more detail, as I here found the prevalent basis for a productive conversation.

Small Sparks

By referencing different historical events and the historical contexts within which they were created, such as how the Wright brothers came about building the first functioning winged airplane, or how John Reed made the ATM standard in banking, Sawyer again criticizes the idea of the “lone genius” as a sole inventor, and instead argues that these inventions were based on small sparks – sparks that originated in previous collaboration with others. “Psychologists have discovered that creative sparks are always embedded in a collaborative
process, with five basic stages” (Sawyer, 2008:81). These five basic stages are cited below.

Sawyer (2012):

- **Preparation**
  This involves a period of working hard, studying the problem, and talking to everyone else working on it.

- **Time off**
  The team member changes context and engages in other activities – often in conversation with others.

- **The Spark**
  During the time off, a solution appears: but that solution is deeply embedded in the knowledge and social interactions of the preparation and time-off phases, and it builds on sparks that others have had.

- **Selection**
  An “Aha!” feeling doesn’t always mean the idea is good. Creative people are very good at selecting the best ideas for follow-up, or they collaborate with others in selecting them.

- **Elaboration**
  Working out the idea typically requires a lot of additional ideas. Bringing them all together always requires social interaction and collaboration.

In addition to these five stages Sawyer also talks about *fixation* and *insight problems* – the thought puzzles that require a sudden spark of insight to solve – and references the nine dot problem as an example used by Gestalt psychologists (figure 3). The goal is to connect all the dots with four straight lines without lifting then pen off the paper. If you have not tried to solve this problem before or if it has been some time since you did, try to take a minute to do
so before you continue reading. The fixation problem people often experience here is that they think the four lines have to be within the “box”. Once they realize they can go beyond (the moment of insight), they can solve the problem.

Weisberg & Alba (1981), whom Sawyer references, concluded that thinking outside the box is not enough to be creative; “you have to know how to think outside the box” (Sawyer, 2008:88). Further, Sawyer mentions priming in regards to confabulation, which is a memory disturbance in regards to people having no trouble “coming up with explanations for their behavior after the fact” (Sawyer, 2008:93). Sawyer puts this into context by referencing Maier (1931) who asked students to solve a problem (the two rope problem) in a given room, where the majority were unable to come up with a fourth solution before he primed them by “accidentally” brushing up against one of the ropes, so it started to swing, thereby giving the students a hint. To support this, Sawyer argues that insights emerge as a result of association by initially referencing Mednick (1962) and his RAT (Remote Associates Test), and furthers this by referencing Bowers (1990) who showed that the words subjects try to solve the RAT test with are linearly associated with the correct word.

Here Sawyer focusses us towards specific concepts that link to the inner workings of our mind. This can be seen as an extension, so it is not only the social interactions per se that are important, but how our minds influence and become influenced by the social interactions as well. This opens up for fields like neurocreativity to connect and provide insights that may help us understand our minds role in social interaction.

**Collaboration over Time**

“Successful innovators [...] don’t succeed by getting lucky and being blessed with a rare good idea. They succeed by way of many small sparks, and by drawing on collaboration over time to build those sparks into something tremendous” (Sawyer, 2008:105).
In order to connect these sparks into something tremendous, Sawyer references four everyday mental processes that he argues are the core of creativity (Sawyer, 2008: 110-114):

- **Conceptual Transfer**
  Also called analogical thinking (Gick & Holyoak, 1980).

- **Conceptual Combination**
  Each concept is stored in the mind as a set of properties and values. Conceptual combination is about combining the properties and values of the concepts.

- **Conceptual Elaboration**
  Taking an existing concept and modifying it.

- **Conceptual Creation**
  Combining different sparks/concepts ad hoc into something new (Barsalou, 1983)

An additional concept, related to the above mentioned, is *emergent attributes*, which are attributes that “are not true of either base concept” (Sawyer, 2008:114). Think of Rubber-army as an example. You might think of it as a “good toy”, but this is not an attribute inherent of either “rubber” or “army”, hence it is something that emerges as a result of the combination.

In summary, Sawyer believes that “collaboration makes the mind more creative because working with others gives you new unexpected concepts and makes it more likely that your mind will engage in the most creative types of conceptual creativity – combining distant concepts, elaborating concepts by modifying their core features, and creating new concepts” (Sawyer, 2008:124).

While not comprehensive, these are the essential elements of Sawyer’s contributions to understanding creativity in the context of business innovation. His framework permits us to view creativity as social dynamics; allowing us to see how certain conditions may foster a state of flow that he finds essential for high levels of creativity to emerge. It also allows us to
view the interactions between team members as an integral part of creativity itself, as the result of these interactions can have a positive affect where ideas function as building blocks other team members can reshape and reuse. However, if not under the right conditions these relations can also have a negative outcome resulting in fixation and groupthink. It is therefore not a straightforward solution, but one that requires a balance between structure, improvisation, certain conditions and social interaction.

But it also has its limitations as it does not directly provide any method for creativity assessment or measurement. Sawyer does, however, reference specific research (e.g. Howard-Jones et al., 2005) that has made use of subjective assessment criteria as Amabile does, and given that Sawyer builds on the work of Csikszentmihalyi who has made use of similar techniques, as I will get back to later, I will therefore attribute Sawyer a similar way of thinking about creativity assessment.

We have now gone through two broad frameworks that provide us with an extensive view of creativity that teaches us about this complex phenomenon, and some of the many factors that play a role in determining what the outcome of our creative efforts may be. But though creativity as social dynamics can be seen as an extension to that of Amabile, it still leaves us with the question of how we can objectively measure creativity, the link between individual and group creativity, and other factors that may influence the creative process which we are currently unaware of. Like Amabile who has called for the combination of normative and ipsative assessment methods (among others), Sawyer himself also calls for further investigation:

“Of course, studies of individual mental processes are also essential to a complete understanding of creativity; moving forward, studies that combine interaction analysis with studies of each participant’s mental processes could provide a full picture of how innovations emerge.” (Sawyer & DeZutter, 2009:90).
Methodology

The purpose with this chapter is to clarify the methodological foundation of my thesis. Providing an outlining of the ontological and epistemological stance that I have taken assists the reader in following my research philosophy, while supporting the logical reasoning and conclusions that I have drawn. The second part outlines the research strategy that I have chosen.

Research Philosophy

*If a tree falls in the forest and nobody hears it, did it happen?* An interesting proverb, as it relates to our view of the world.

My thesis is based on a moderate social constructivist nature. This means that I am assuming an ontological realism, which states that a physical reality exists independently of our recognition of it (Wenneberg, 2000; Crotty, 1998). But we cannot understand this reality independently of our subjectivity. Meaning therefore arises at the interplay between us as the subject and the object at hand (Crotty, 1998). Therefore, rather than advocating a single view of reality, I acknowledge that different views of what is real or true, can be characterized by individuals and their perceptions (Saunders et al., 2012). This approach allows for the use of theories of different ontological and epistemological nature to be brought together in dialogue – a dialogue aimed at furthering our understanding of creativity as a complex phenomenon.

Transferring this view to the epistemological level I am pursuing an interpretivist approach (Crotty, 1998). Knowledge should therefore be regarded as contextual and influenced by subjective interpretations, as theories and methods are selected and presented by me as the researcher. This means I will be unable to produce any universal truths or laws, which is also not the goal, as this thesis should be considered explorative in nature with the objective of opening up venues for further research.
Research Strategy

My research strategy consists of two parts; initially asking the research question: “what neuroscience can contribute to our understanding of creativity in the context of business innovation?” Secondly, bringing it in to a dialogue with altering perspectives on creativity, to see what (if any) contributions or fostered reflections emerge as a result of the analysis.

After having been introduced to neurocreativity through the studio based course Applied Neuro Creativity (ANC) at Copenhagen Business School, I furthered my exploration of this field reading relevant literature primarily suggested by the course lecturers (the lecturers who coined the term “neurocreativity”). Having studied innovation and entrepreneurship I had already been introduced directly or indirectly to several scholars with the field of creativity in a business context (via e.g. Simon, 2005; Kaufmann, 2004; Gartner et al., 2003, Hjorth, 2003; Simonton, 1999) which functioned as a starting point for my exploration of theories to include.

The specific researchers have been selected given their well-known contributions to the field of creativity. This is not to say that they are the only valid or adequately contributing researchers that could have been brought in, nor do I argue that they are to be considered the best within their fields. However, I do argue them being generally notable and regarded as important scholars. Since it can be quite difficult to choose and say, which are most notable, which stresses my subjective influence; the selection process was facilitated by SCOPUS-searches and the Google Scholar citation index (see Appendix 1, 2, 3, and 4). The final decision was based on relevance of found theories within a business innovation context (keyword search), supported by the work’s number of citations. The work of the primary scholars used, are therefore also among their most cited contributions.

In order to put the theories in a dialogue I initially mapped them out by drawing a visual representation (see Appendix 5, 6, and 7) to provide an overview of the different aspects. I arrived at my findings by using a framework from comparative analysis (Walk, 1998) where the different views are initially introduced (here also drawn visually) before the dialogue was engaged and points of interest discovered. This was done to avoid reading through the
selected literature with a specific lens, thereby narrowing the search to notions of support or “easy” comparison.

Similarly, this method also supported a hindering of predetermined conclusions, and allowed for a more open-mined starting point, though without neglecting my subjective influence. The result of this approach also means that the dialogue is not as straightforward as one might have hoped, hence e.g. research object(s), underlying definitions, and beliefs vary to some extent between the scholars. These are furthermore explored by digging in to the selected scholar’s sources upon which they base their theories. Relevant aspects relating to these differentiating factors are therefore included in the analysis to provide for a more productive conversation.

Given my thesis is not only exploratory but also qualitative in nature, the question of validity then arises. The tension between quantitative and qualitative research in regards to validity is not new (Whittemore et al., 2001), and not an issue we should expect being resolved any time soon. The standards of validity in regards to qualitative research are challenging because of the necessity to incorporate rigor and subjectivity as well as creativity into the scientific process (Johnson, 1999). Before I engaged in the analysis I therefore introduced a few criteria, as it is my responsibility as the researcher to clearly state prioritized criteria, and specific techniques employed (Koch, 1994). These criteria based on Whittemore et al. (2001) will be presented in two forms; primary and secondary, and helped guide my research in an effort to provide validity to my thesis.

My primary criteria included authenticity as I focused on exhibiting a high awareness of subtle differences in the voices of others (Lincoln, 1995), so as to ensure that the theories presented are true to the original work to the extent subjectively possible. Furthermore, primary criteria include criticality and integrity to critically examine my own bias (Marshall, 1990) which, as briefly mentioned above, are (among others) expressed through selected theories, method and overall research design. The point is to acknowledge my subjective influence, and seek integrity at each phase of inquiry to potentially avert verificationism and dogma (Johnson, 1999). A practical implementation of this can be seen in how I initially mapped out the chosen theories before engaging them into dialogue. This helped to ensure that I did not simply look
for elements of support, but also include contradictions that could argue against neurocreativity, or elements for which no contribution can be made, as it goes beyond the limitations of neurocreativity. In addition, I wrote a brief summary of my own beliefs and thoughts about this thesis, and what I was seeking to find before engaging in the analysis. This was done to preliminarily state my own bias. I reflected upon that bias following a few days of productive writing to ensure that I was not simply confirming my initial beliefs.

Though the following secondary criteria “…are not as broad as the primary criteria and do not directly map with the primary criteria, they are important standards of quality identified in the literature” (Whittemore et al., 2001:531). Included here, therefore, is congruence as to foster a clear link between the research question, methodology and findings. The findings shall also be examined in regards to practice, which will be elaborated in the discussion chapter, so they are put into context outside of the study itself (Sandelowski, 1986). Despite these criteria and my reflection upon them throughout my thesis, there will be elements of my subjective influence that escape, thus the reader must also be critical of my writings.

Though this study design allows for a qualitative view of a new perspective on creativity in a business innovation context, limitations follow as well. Giving the subjective nature of the study design, a different researcher may conclude contrary to my findings though having done a similar study. However, this is only encouraged as the ontological and epistemological standpoint of this thesis is based on different views providing different insights, and when combined producing a more illuminated view of a complex phenomenon. The same goes for the selected theories. Having used different theories and scholars may have provided different insights, or changed the discourse of the dialogue, resulting in different findings.

A limitation also arises in the scope of the definition of creativity, which is mainly influenced by previous researchers. The views and definitions of creativity in this thesis can therefore not be argued as adequately representing all that creativity may have to offer. Instead, it represents a view from a specific field with a specific interest. This means that there may be several creativity elements to be found in the dialogue that pass beyond notice given the limitations of the definitions used.
I also do not produce any empirical data. This limits my thesis as support for any findings rely solely on empirical data gathered by others. I could have done an empirical study using neurocreativity as a framework, and set out to gather data on a specific context, but though it was considered I decided not to do so. I believe the scope of such a study would limit my overall discussion of creativity in a business innovation context to a very particular area, and thereby prevent a broader discussion. In addition, in order to engage into a thorough gathering of empirical data, an initial overview and discussion would be needed to guide the research as this is currently very limited given the novelty of neurocreativity. This thesis can therefore be seen as part of the initial research contributing to the foundation for further analysis where a gathering of empirical data could be included.
Neurocreativity

The purpose of this chapter is to bring the reader up to speed on what neurocreativity has to offer in regards to creativity. The reader will be introduced to the five key concepts of neurocreativity along with a specific design process used as part of the introduction to a business audience. The goal is for the reader to understand the concepts, and the implications they suggest leading to increased creativity in a practical context.

As with many other fields of study, single and fully agreed upon definitions are hard to come by. With creativity from the perspective of neuroscience we find no exception. There does, however, seem to be a consensus regarding “original” and “useful” as being part of the definition (e.g. Feist, 1999; Martindale, 1995; Poincaré, 1913). Original in the sense of unusual does not adequately fulfil being creative (Eysenck, 1993), as a psychotic person might answer 4.513 to the question of 4+4. Definitely original, but finding a use for such an answer is unlikely. Originality in combination with useful or adaptive therefore seems to make good sense. The definition used by neurocreativity researchers is therefore the following, as also stated in the introduction:

“...the forming of associative elements into new combinations which either meets specified requirements or is in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution.” (Mednick, 1962:221)

This definition provided by Mednick who is known for his contributions to the field of psychology and psychiatry (specifically the etiology of psychopathology) is used not only based on both “useful” and “new” (original) being included, but also because of the remoteness mentioned, which fits how neuroscientists view creativity in regards to the neural networks of our brain. There are, however, some constraints to this definition, since the question of how original and how useful the new solution must be in order to be perceived as being creative quickly arises. Instead of an either/or approach creativity can here be viewed on a scale which fits the remoteness aspect of the definition, so as to argue for the extent to which a new solution is creative. The more useful and original it is, the more creative it could be considered. A second constraint arises in regards to the “remoteness” of the associated
elements. What for one individual may be a solution based on two closely associated elements, may for another be two very distant. This means that a comparison on the level of creativity between two individuals having produced the same solution is not possible based on the solution itself. Though most solutions are created by more than one person, the remoteness aspect is still relevant, though the complexity of measuring it only becomes more difficult – a measurement still not possible at the individual level (Jung et al., 2013). For this reason, typical creativity tests measuring divergent thinking (Balder & Onarheim, 2013) are still being used.

Because a lot of creativity research is focused on the finished products there have been some methodological differences in how to study and measure creativity (Friis-Olivarius, 2013). This problem is termed the “process vs. product criterion issue” (Brown, 1989). The essential part of this discussion is whether creativity should be viewed as a cognitive ability or as a real-world creative production that only few individuals manage to achieve. This fosters an important distinction that I wish to make, namely the difference between trait- and achievement creativity. Trait creativity is the creative ability or potential ability of the individual, and is conceived as a latent underlying creative behavior normally distributed in the population (Hovecar & Bachelor, 1989; Michael & Wright, 1989; Woodman & Schoenfeldt, 1989). Achievement Creativity is the social success of the product of this ability, and is dependent on an interaction between the creative ability and internal factors like intelligence and motivation, as well as external factors like the surrounding environment. It is distributed in the population roughly following Price’s law (Eysenck, 1995), which states that the square root of the total number on contributors will produce 50% of the publications. Then, if there are 1,000 scholars contributing to a specific field, roughly 31 of them will produce half of all the articles published as the square root of 1,000 is approximately 31.

Hence there is a difference between trait- and achievement creativity, it is important to be able to measure trait creativity independently of achievement creativity. This is often done via cognitive ability tests which have become the essence of how neuro scientists view creativity today (Friis-Olivarius, 2013). Joy P. Guilford (1950) developed the first psychometric creativity which are based on divergent thinking (DT), which refers to the “unbound ideational
searching” or “open-ended thinking” which are typically evoked in regards to working on task that does not have a right or wrong answer (Abraham & Windmann, 2007). Guilford’s test was the starting point for many creativity tests that have followed, all with a general consensus that divergent thinking is the best method to investigate creative ability (Friis-Olivarius, 2013). It is on the basis of these tests in combination with the remaining field of neuroscience, that the following five key concepts have their foundation.

Though Mednick’s Associative Model is the only one mentioned in the following, given its direct relevance for one of the specific key concepts, other models like Finke’s Geneplore model (Finke et al, 1992) and Campbell’s view of creativity as a Darwinian process (Campbell, 1960) should not go without a mention, as the following concepts are built upon viewing creativity as a pluralistic phenomenon. The main focus here is the five key concepts along with the design process, and not a detailed description of the neuroscience behind them, as this is outside the scope of my thesis. These concepts have been termed “neurocreativity” and have been developed by Balder Onarheim and Morten Friis-Olivarius who have also taken part in introducing these concepts to students through the course Applied Neuro Creativity at business schools in Denmark and Canada. The effects of this course are determined by giving students pre/post-course tests on divergent thinking. The results show that participating students gained additional fluency in divergent thinking with an individual relative average of 28.5% (Onarheim & Friis-Olivarius, 2013). The following subchapters will guide the reader through the concepts that have led to this increase.

**Remote associations**

*Within a semantic neuronal network, concepts are associated with different strength to one another. The extent to which one concept [...] activates another concept is reflected by the remoteness of the two concepts.* (Friis-Olivarius, 2013).

Remote associations are relevant to the level of creativity of a process or solution, along with creativity at the individual level as previously discussed. Highly creative individuals are argued as having flat associative hierarchies. This means that though such individuals may reply with
a conventional response to a given stimulus, the response is not excessively dominant compared to more remote associations. This is what Mednick’s Associative Model illustrates (figure 4).

In a more practical setting, Mednick argues for massed work sessions being better than distributed work sessions. The reason for this is twofold. The first is because the individual is “…more likely to achieve temporal contiguity of the requisite associative elements within a single intensive work period than is an individual who has distributed his work in shorter periods over several days”. Secondly, “…it may take some time for an individual to work on a problem enough to go beyond its obvious aspects” (Mednick, 1962:230). This means, among others, that the interruptions many experience on a daily basis drawing ones attention to other work, may have a negative influence on the ability to produce a more creative solution. The essence of his argument here, is that spending massed time on a problem may evoke the more remote associations related to that problem, and that it is among these remote associations that the key to a more creative solution will lie.

Another interesting aspect related to remote associations that follows Mednick’s model is that “…if a newcomer to a field has the requisite information, he is more likely to achieve a creative solution than a long-time worker in the field.” (Mednick, 1962:224). We often rely on the most experienced team members with the most important innovation tasks, but according to Mednick, this might not be the best way, which is a notion also supported by scholars of breakthrough innovation (e.g. Harryson, 2006; Hargadon, 2003).
**Priming**

*Priming* refers to "...facilitative effects of an encounter with a stimulus on subsequent processing of the same stimulus (direct priming) or a related stimulus (indirect priming)" (Tulving et al., 1982). In other words, priming is the effect in which exposure to a certain stimulus influences a response to a later stimulus.

In a practical setting; showing a person a banana functions as a priming effect. The individual to whom this is shown, the banana and that to which the individual associates with it, are more “at the top of the mind” so to speak. This means that if that same individual is then asked about food in general, the likeliness of the response being associated to that of a banana, is higher than if the individual had not been initially primed. This effect is therefore also used within advertisement to prime consumers into purchasing certain goods or services. In this regard it is also relevant to mention *negative priming* which is

"...an experimental paradigm in which a distractor stimulus, irrelevant for the task at hand, subsequently is re-presented as the target stimulus and somehow has to be dealt with. The common finding is that when we have to react to a stimulus that was previously inhibited, this significantly increases reaction time compared to when there was no prior exposure.” (Friis-Olivarius, 2013).

This is best shown by illustrating the “Stroop Effect” (Stroop, 1935). Try to name the printed color as fast as you can, while ignoring the written word:

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Green Yellow Red Blue
Yellow Blue Red Green
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The second time you were a bit slower, right? It is important to note that "...negative priming has not yet been studied in direct relation to creativity. However, there is indirect evidence due to the strong link between psychoticism and creativity." (Friis-Olivaruis, 2013). Psychotic patients that have done this test have shown to complete it without being negatively affected, while in some cases actually having had a positive effect as a result (Beech et al., 1989).
Cognitive Inhibition

Cognitive Inhibition is an automatic process thought to prevent information overload. This can also be seen as a “magnifying glass effect”. “In normal cognitive functioning, stored memories of past experience are used to guide current perception, thus reducing information load making cognitive inhibition vital for normal thought processes to occur.” (Friis-Olivarius, 2013). In other words, to prevent information overload our brain limits our access to that which we associate, with what we are currently doing (center of the magnifying glass; see illustration), instead of all our memories at once. Working in multidisciplinary teams, where each individual builds upon the ideas of others, is a way of constantly moving our cognitive inhibition, so we do not limit the possible combinations of elements to those which are already closely associated, thereby facilitating a more creative solution.

Cognitive inhibition is also relevant to think about in regards to constraints. This is because the specific criteria for a given product or solution play an important role as “…they form […] part of the stimulus set which is determining which associative elements are being elicited and thus becoming eligible for entering into combination with other elements”. (Mednick, 1962:225). In regards to the metaphor, the given constraints influence to where our internal flashlight is pointing. At the same time we cannot avoid using constraints as these are argued as being at the premise of creativity (Horowitz, 1999), because if there are no constraints there is no problem to solve, and thereby no potential for creativity (Onarheim, 2011).

Fixation

Fixation refers to “…something that blocks successful completion of various types of cognitive operations, including those involved in memory, problem solving, and creative idea generation.” (Smith & Lindsey, 2011). As a metaphor (see illustration) we could imagine
having a flashlight in a dark room where we are unable to see outside the border of the light and unable to move it. We are in this sense stuck (fixated) with looking at a specific object.

An example of this is seen in regards to design fixation, where a study showed that participants briefly exposed to flawed designs were unable to overcome those same flaws in their own designs (Jansson & Smith, 1991). It can also be seen in regards to the way a certain problem is defined as the definition can assume a certain solution, or specific working context within which previous similar solutions have been found.

"Initially fixating definitions may be associated with the typical work context, since that context is likely the one in which previous problems were defined and solved. Thus, one’s attempts to redefine design problems might be facilitated by considering fixated problems outside of one’s typical working situation.” (Smith & Lindsey, 2011:87)

A more classical example is where individuals briefly exposed to the word ANALOGY find it easy to complete the word fragment A_ _ L _ G Y a short time later. But when the same person is showed the word fragment A _ L _ _ G Y (ALLERGY) it is particular hard to solve (Smith & Tindell, 1997). This is due to the implicit memory bringing up the incorrect answer (ANALOGY). An interesting element in this regard is that people cannot avoid this type of fixation even though they are explicitly warned about it. It is therefore not as much about avoiding fixation, as it is being aware of its affect and how to overcome it. If you have ever experienced not being able to remember a person’s name, but at the same time feel that it is just about to pop up in your mind (tip-of-the-tongue-phenomenon), then you have experienced fixation. Going back to the metaphor you would in this case be focused on a specific association without being able to move away from it. In order to successfully overcome fixation we need incubation effects.
Incubation Effects

“Incubation effects are cases in which insightful ideas or solutions of problems are realized after the difficult problems temporarily are put aside.” (Smith & Lindsey, 2011) The interesting thing about incubation effects is that “it is not time working on a problem that helps, but rather time away from the problem that is the key.” (Smith, 2003). The point with incubation effects is that individuals (or teams) can benefit from spending time away from the problem at hand, rather than trying to force through it.

The two causes that have been best supported by scientific evidence are the opportunistic assimilation theory (Seifert et al., 1995) and the forgetting fixation theory (Smith, 1995a; 1995b). The opportunistic assimilation theory states that insightful ideas can be triggered by stimuli that are serendipitously encountered at some time after repeated failures have sensitized one to an unsolved problem. Thus, this theory focuses on hints that point the problem solver towards successful solutions. The forgetting fixation theory states that fixation, a cognitive block to successful problem solving, is a precondition for observing incubation effects; in the absence of fixation, problem solutions are realized in straightforward ways. By putting fixation out of mind, at least temporarily, one can apprehend the problem without the counterproductive influences of inappropriately applied knowledge. This explanation focuses not on pointing towards a solution, but rather on releasing the problem solver from counterproductive work.

The Double Diamond

The final perspective, is the Double Diamond Design process (figure 5), which is a simplistic method for switching between divergent- and convergent thinking. It was developed by the UK Design Council (Design Council, 2005) as a qualitative study of the modern design process. Although the Double Diamond is not part of the five key concepts it is still relevant to include, as it is part of the neurocreativity framework taught to business students. The reason for this is the emphasis on combining periods of divergent thinking (unbound “ideational searching” or “open-ended thinking”) with periods of convergent thinking, as divergent thinking alone is not a sufficient condition for creativity training (Persaud, 2007). Persaud’s point is that we
cannot become more creative, by simply adding more creativity in the sense of more ideas and thoughts. They must also be contextually applied and put to use. The scholars behind the concept of neurocreativity argue that “…divergent thinking can be thought of as a process that leads to novelty and convergent thinking to usefulness” (Onarheim & Friis-Olivarius, 2013:4), thereby making it an integral part of neurocreativity.

The above covers the extent to which the field of neurocreativity has currently reached an understanding of creativity. Though limited, and hereby supportive of the explorative nature of this thesis, it does provide some interesting perspectives when engaged in a conversation with well-known theories in the area of creativity in the context of business, which will be presented in the following analysis-chapter.
Analysis

In this chapter I describe the specific points of interest that I found between neurocreativity and the selected theories previously introduced. The overall structure will be similar to the one used to describe the theories above. I have structured each point by initially stating a claim (italics) that is mine, presenting arguments to support, followed by what possible implications it might have. The latter will also directly or indirectly indicate possible venues for further research, which is part of what this thesis aims to provide. Each of the two subchapters will end with a brief summary containing the most interesting elements that will be discussed and critically reflected upon in the Discussion-chapter.

A Dialogue (Part 1)

Before describing the points of interest, some initial clarification is needed. As I stated in the initial part of the theory chapter, there is a theoretical difference that will need elaboration if the following is to be considered productive and valid. This relates to the research object. Amabile focuses on the response (product/solution) and the individual’s path to that response in order to determine if both are creative, which is to be judged by appropriate observers. The specific point I put forward previously is that this also implies a view of the individual and the response being equally creative, as there is no separation in “creativeness” between the two. This view also relies on an assumption that an objective assessment cannot be made (Amabile, 1996).

Neurocreativity differs in this regard as it provides a framework for measurement that distinguishes between the potential creativity of the individual (trait creativity) and the social success of the product of that ability (achievement creativity). This means that where Amabile focuses on the product itself as an indication of individual creativity using a normative assessment method, neurocreativity focuses on the individual in relation to the individual herself (ipsative assessment). This means that an argument based on neurocreativity as increasing creativity may not be fully recognized by Amabile’s theory given the difference in research objects and criteria assessment.
A practical illustration of this is seen if you were to propose a response (solution) to a given problem that for you was easy to suggest (algorithmic). Despite experts praising your solution you would not be considered creative by Amabile. Within the frame of neurocreativity you would also not, assuming a strong association among the elements combined into that solution. If, however, you arrived at that solution with a heuristic approach, but appropriate observers did not judge your solution positively, then you would not be considered creative by Amabile, but you would be by neurocreativity assuming a weak (remote) associated strength among the elements involved.

Despite relying on normative-criterion assessment Amabile does, however, argue that an ipsative approach should be included in further research (Amabile, 1996; 1983). This opens up for a measurement of creativity based on the individual alone, while also allowing for a creativity assessment distinction between the two, which neurocreativity provides a framework for. The following claims are the discoveries from my analysis in regards to creativity from an individual perspective.

**Assumptions and Observations**

After analyzing Amabile’s preliminary assumptions and observations, I found some interesting similarities, though I did not find all ten relevant to include as some are beyond the current scope of the neurocreativity framework.

1. *Creativity can be viewed on a scale of “creativeness” and it is therefore not a question of whether or not something is creative.*

Amabile views creativity as a continuum from low levels of everyday creativity to essential advances in science and literature, while also adding the assumption of possible variety in creative work produced by the same individual. This implies that anyone with normal cognitive abilities can produce work that to some extent or another could be considered creative (Amabile, 1996).
This aligns very well with the remote association aspect (Mednick, 1962) of neurocreativity in which the combination of closely associated elements can result in a low level of creativity, but be creative none the less. Neurocreativity, therefore, provides further support for Amabile’s view in this regard, as opposed to the view of creativity as a discontinuous quality that is qualitatively and quantitatively different from other work in the domain (e.g. Feldman et al., 1994; Gardner, 1998). The strength of this view is the inclusion of creativity in many degrees where even low levels can qualify.

2. **Though levels of potential creativity can vary between individuals, it is possible to increase creativity through training.**

Amabile acknowledges that it is possible to increase creativity to some extent by referencing Stein (1974; 1975) and sees the role of formal education being an significant factor in this regard (Feldman, 1980).

This recognition warms the hearts of neurocreativity scholars, as an increase in creativity through education is the goal of the established course Applied Neuro Creativity offered to business students in Denmark and Canada (Onarmheim & Friis-Olivarius, 2013). But since the referenced research was completed roughly forty years before the field of neurocreativity was initiated, this general support can hardly come as a surprise. However, Stein (1974; 1975) views creative individuals as persons using distinctive psychological mechanisms linked to personality traits, and argues that despite “…trial and error, discovery, serendipity, or problem solving can all occur in the creative process…” the individual “…who produces novelty through trial and error should be different” (Stein, 1974:35). So where Stein views these distinct psychological mechanisms as linked to personality traits of creative individuals, neurocreativity (via the key concepts) provides, to some extent, these mechanisms directly to anyone through training. The question is then whether someone trained to be more creative can surpass one whom by personality trait “naturally” makes use of these mechanisms given both have the same potential for creativity. And secondly, to what extent (if any) the psychological mechanisms and the key concepts from neurocreativity could even be considered similar or related. In order to answer this question more research associated with
the psychological mechanisms and their influence in regards to creative processes are needed. Specific suggestions for further studies will be elaborated in the final chapter.

3. **Incubation effects have a positive influence on the creative process.**

Amabile recognizes *incubation* (effects) referencing Poincaré (1924) and his observations of outstanding creative individual who has “*...experience[d] an apparent flash of illumination...*” after having ceased to consciously work on a difficult problem (Amabile, 1996:83). She furthers these observations by referring to Simon (1966) who has proposed an information-processing account of incubation effects as the result of *selective forgetting*.

This resembles the *forgetting fixation* theory (Smith, 1995a; 1995b) as described in the chapter on neurocreativity, since Simon’s (1966) focus on selective forgetting is about setting the problem aside and returning later. However, there is an important distinction between the two as the former relates to the *spreading activation hypothesis* which states that during an incubation period, activation spreads to the (neural) nodes representing the relevant concepts. Thus, problem solvers become more sensitive to them, and the problem solving process is facilitated (Sio & Rudowicz, 2007). This is opposed to Simon’s view; “*suppressing the activation of the nodes representing the irrelevant concepts that fixate problem solvers’ minds*” which results in the problem solver becoming less sensitive to these irrelevant concepts (ibid:307), which relates to the *selective forgetting hypothesis*. Though there is a general consensus that incubation effects positively influence the creative process, there is debate in regards to the underlying effect and if it relates to the spreading activation hypothesis (e.g. Smith, 1995a; Yaniv & Meyer, 1987) or the selective forgetting hypothesis (e.g. Simon, 1966; Smith & Blankenship, 1991). Though I will not elaborate further on this difference, I will, however look into further detail as to how Poincaré recognizes this effect as he is also referenced by Amabile.

Poincaré’s view is based on incubation being performed largely unconsciously by what he calls the *subliminal self* (Koestler, 1964:164). Whether this unconsciousness is understood in Freudian terms where the self is superior to the conscious mind (Bargh & Morsella, 2008) or
as Poincaré does; a sub-personal automation that mechanically runs through various combinations of ideas (Koestler, 1964) the point is that neurocreativity fosters conscious cognitive behavior. Whether the conscious training then leads to a subconscious change in regards to creative performance becomes an interesting venue for other researchers to explore.

To bring the dialogue back to Amabile; acknowledging incubation affects functions as common ground where neurocreativity (and neuroscience in general) provide new insights to observations that social-psychological research has yet to adequately understand. These insights relate to conscious cognitive behavior, whereas Amabile’s view relates to unconscious cognitive mechanisms as the above elaboration of her references illustrate.

4. *Spending time deeply involved with the issue at hand increases the creative performance.*

Amabile supports observations of “*deep involvement in the activity at hand*” as an essential component (Amabile, 1996:83), but stresses the importance of intellectual playfulness and freedom from extrinsic constraints with reference to Einstein (1949). She relates this to being intrinsically motivated, and argues that the focus towards the attainment of extrinsic motivation limits the attention towards the exploration of new pathways. Essentially meaning; the more intrinsically motivated you are the more of your focus you will put on the task at hand.

Mednick’s argument for massed work sessions being better than distributed work sessions is based on the higher likelihood of achieving temporal contiguity of the requisite associative elements during massed work sessions, since it can take time for an individual to move beyond obvious aspects of a given problem (Mednick, 1962). In this sense, Amabile and Mednick each provide a useful perspective. Essentially Mednick argues you need to spend a lot of time working on the problem in order to find the more remote associations, while Amabile says that the more intrinsically motivated you are the more effective (focused towards exploration) you will be. The question is then if the time required to reach the point
of temporal contiguity can be reduced as the level of intrinsic motivation goes up, and additionally, what does the ability to focus then mean for an individual’s potential for creativity? These are some of the questions that become possible to ask when we join the neurocreativity research with Amabile’s theories, and will be interesting questions for other researchers to explore.

**Domain-relevant skills**

In relation to the domain-relevant skills I have made two claims, one of which goes beyond the components of this domain and also functions as a more general critique in regards to Amabile’s overall theory of creativity.

5. *All possible cognitive pathways are not straightforwardly accessible.*

One of the main points Amabile introduces under the domain-relevant skills, is the view of these as the “*complete set of response possibilities from which the new response is to be synthesized*” and furthers this by adding that “*the larger the set, the more numerous the alternatives available for producing something new, for developing a new combination of ideas*” (Amabile, 1996:85).

The issue here, according to neurocreativity, is that though these cognitive pathways may very well be possible, they are not straightforwardly accessible. Our mind’s cognitive inhibition, as described in the chapter on neurocreativity, limits the information to which we have access, to what we have previously found to be relevant in the given context. This means that any cognitively normally functioning individual, whether an expert or novice, will not be able to make use of all the possible pathways for creating a new solution. This is why Amabile’s notion in this regard cannot stand alone. Neurocreativity with its unique concepts may help an individual realize how the brain works to such an extent, that more possible pathways can be utilized, though without the promise that all, nor even close to all, will become accessible. This, then, implies a suggested revision of Amabile’s theory, so that it is not the “*network of possible wonderings*” (Newell & Simon, 1972) that is relevant per se, but
the extent to which the individual can make use of that network, for which neurocreativity provides some useful cognitive tools. The network of possible wonderings is still relevant as we can see it as an outer barrier for what a specific individual has potential for, but the point is, that given how our brain works, this potential cannot straightforwardly be taken fully advantage of.

6. **Specific domain knowledge may limit rather than foster creativity.**

This relates to two elements of Amabile’s theory; firstly to the use of appropriate observers in regards to creativity assessment. Secondly, it relates to experts as producers of creative solutions within their own domain of expertise.

A recent study by Boudreau et al. (2016) showed that experts within the field of medicine who were given the task of evaluating proposals for publics grants, gave the lowest scores to those with the highest level of novelty, and the highest scores to those that were only slightly novel (figure 6). Though novelty does not equal creativity, it is an important element as the definitions of creativity in this thesis illustrate (Amabile, 1983, 1996; Mednick, 1962). Given a solution’s level of creativity increases with higher levels of novelty, though not as a direct proportional relationship, Amabile’s definition; that something is creative to the extent that experts (appropriate observers) within the domain agree it is creative, becomes somewhat skewed. This is due to the high scores of creativity relating to those responses only slightly novel in nature. This means that domain experts as appropriate observers may limit rather than foster creative efforts through their subjective assessment. This would also imply that experts could only be considered appropriate in regards to assessing creativity where the levels of novelty are low, and when the response is within their own domain of expertise.

If we look as this from a neurocreativity perspective we find support that goes beyond the general critique of ipsative- versus normative assessment criteria. To be considered an expert within a certain domain, the individual must have at great deal of relevant knowledge. In other words; the expert’s network of possible wonderings (Newell & Simon, 1972) must be greatly influenced (and therefore also limited) by what is already known within that domain.
If remote associations, as described by Mednick (1962), is the key to high levels of creativity, then it would not take much remoteness of the associations relative to the knowledge in that domain, for a proposal from the expert to be considered highly creative by ipsative assessment if the proposal was also useful. But why should we view this relative to domain knowledge in general? Because Boudreau et al. (2016) views novelty “in relation to its departure from all past research” (p. 3). Novelty here, interestingly resembles the remote association aspect from Mednick; though instead of it being in an individual’s brain it is seen in regards to the specific domain knowledge.

![Fig. 6 Novelty and evaluation relationship (Boudreau et al., 2016).](image)

![Fig. 7 Expert distance and evaluation relationship (Boudreau et al., 2016).](image)

Given the cognitive limitations we all have (normal cognitive function assumed), as described previously, experts would then be limited in creating highly novel solutions, though they by ipsative- and normative assessment could be considered highly creative, again if the proposal is useful. This raises the question of the extent to which the degree of novelty is important for creativity – a question that will be furthered in the final chapter.

Though Amabile to some extent takes this into account in regards to highly creative responses, by arguing that experts may not be appropriate under certain circumstances, she relates this to be exclusive for very high levels of creativity (Amabile, 1996). The above
mentioned research indicates that it is relevant for a broader part of the creativity continuum. This would imply an additional revision to Amabile’s theory, as once the level of novelty reaches a certain point, domain experts function as a hindering for creativity assessment.

Interestingly, the research also showed that as the distance from the specific expert’s specialized field was increased, the higher the scores were (figure 7). These findings show that experts “systematically assign lower scores to research closer to their own area of expertise” as a function of novelty (Boudreau et al., 2016:25). This additionally stresses how the use of experts as appropriate observers, may have the opposite affect than the aim, as what by the appropriate observers is judged most creative, is actually only slightly novel in nature. If the level of creativity increases with increased novelty, then we urgently need new methods of assessment. If not, then we find highly creative solutions, that have low levels of novelty, which then suggests needed revisions of the current definitions.

This brings us back to neurocreativity through Mednick; “if a newcomer to a field has the requisite information, he is more likely to achieve a creative solution than a long-time worker in the field.” (Mednick, 1962:224). This implies; if you want creative solutions then go to the newcomer with adequate information about the domain, and not the expert whose knowledge, though very vast, is rooted in the specific domain of endeavor. Here we find some tension; I have previously described that the more associations an individual has the more possible solutions can be made according to Mednick. But there seems to be a limitation, as too many associations within a specific domain can result in a hindrance of creative efforts. The question is then how to find a balance, and if that balance is identical in other knowledge domains. In this regard, age becomes interesting to briefly mention as in order to become an expert, time is obviously needed to acquire knowledge. We might therefore find a specific amount of time used to absorb information as “optimal” for creativity given a specific rate of adoption. This would then result in a given age of an individual being at the peak of his or her creative performance. Interestingly, research on age in regards to creativity is not new. Lehman (1953), Dennis (1966) and Simonton, (1975b) have found outstanding geniuses within certain domains to be roughly the same age, though it varies between domains. Today, the average ages of Nobel Prize winners have gone up. In 1905 it was common to see major
scientific achievements from scientists before the age of 30 – today, the average age at which physicists do their Nobel Prize-winning work is 48 (LiveScience, 2011). This might be due to the vast amount of information available within the field of e.g. physics. Therefore, it takes more time to acquire and the individual therefore becomes older. This would also suggest that we have to further the notion above in regards to an optimal amount of time spent, and instead talk about the extent of domain specific knowledge, which leads to a peak in creative performance, being relative to the size of that domain. It is then not a question of time spent or age, but about acquiring a sufficient amount of knowledge relative to the size of that domain. Though food for thought, this is mostly speculatory and other researchers will have to elaborate further on this as well.

**Creativity-relevant processes**

Here I found four points of interest the result in some quite interesting suggestions for further research, some of which will be elaborated on in the discussion chapter.

7. **Focused divergent thinking as suspended judgement.**

Amabile argues for suspended judgment as a cardinal rule of brainstorming. “*In the case of the creative mind, it seems to me, the intellect has withdrawn its watchers from the gates, and the ideas rush in pell-mell, and only then does it review and inspect the multitude*” (Brill, 1938:193).

This line of thinking goes well with the intended goal of the Double Diamond process. The four main stages (Discover, Define, Develop, and Deliver) are divided into two groups where one (Discover and Develop) are aimed towards divergent thinking, while the other group (Define and Deliver) relate to convergent thinking. The point is to maintain focus on divergent thinking when developing the solution to the defined problem to let our mind seek out the more remote associations. This is where the rest of the key concepts also come into play, as reflecting upon them helps foster this focus, and thereby directly help hinder the immediate evaluation of convergent thinking.
8. **A flat associative hierarchy increases creativity.**

One of Amabile’s cognitive styles suggested for increasing creativity is using “wide” as opposed to “narrow” categories. Individuals who see relationships between apparently diverse bits of information may be more likely to produce creative works and responses (Cropley, 1967).

This view is greatly supported by neurocreativity with reference to Mednick’s flat associative hierarchy as described in the chapter on neurocreativity. In this sense, it is easier for an individual with a flat associative hierarchy to combine the diverse bits of information, as the associated strength between them are not much stronger than those more closely associated, resulting in a greater ease of response.

9. **Memory is an important part of creativity.**

Remembering accurately is another of Amabile’s cognitive styles. Cambell (1960) has proposed that those who can code, retain, and recall large amounts of detailed information will probably have an advantage in creative performance (Amabile, 1996).

This makes logical sense. The more associations an individual is able to remember, the greater the amounts of new combinations become possible. Note that I here say “remember”. I will come back to this briefly. Though Amabile references Pollert et al., (1969) for empirical support, new research also supports this claim. A study by Madore et al. (2015) showed that “...people produce more episodic details when imagining future events and solving means-end problems after receiving an episodic-specificity induction [...] than after receiving a control induction not focused on episodic retrieval” (Madore et al., 2015:1461). In this study they gave participants brief training in recollecting details and then tested them by using divergent thinking assessment methods. The study showed an increase in performance as a result of the brief training.

Though it logically makes sense that the more bits and pieces an individual is able to remember, the greater the amounts of new combinations become possible, we must not
forget that there is a difference between the potential of the memories we have, and the extent to which they can be applied (or recollected), given how our brain works. This new research then fosters the question if the use of memory palaces as used by Oddbjørn By (2006) – a former world memory champion – to some extent can function as the key concepts from neurocreativity – as a cognitive tool to increase creativity? If participants given training to remember details perform better on divergent thinking tests, then expanding on this tool to the more extreme as By (2006) has done, might take the amount of responses in a divergent thinking test far beyond what we have seen so far. This might also bring creative efforts to a whole new level, which is another questions future researchers must refine and investigate.

10. Knowledge of heuristics increases creative efforts.

Amabile views knowledge of heuristics as “a way of approaching a problem that leads to an alternating outcome” (Amabile, 1996:89). This fits quite well with the intent of neurocreativity, though it is not as much as about an alternate outcome per se, as it is about expanding the variety of possible outcomes by providing cognitive tools to increase the amount and remoteness of associations when trying to make new solutions.

Task motivation

As mentioned previously, the full and vast details related to the intrinsic motivation principle of creativity will not be elaborated in much detail, as it goes beyond the current framework of neurocreativity. However, there are two things I would like to bring in. The first relates to Amabile’s critique of some “humanists” who she argues think that creative production will flow spontaneously when the mind and body are the most relaxed and unbothered. Though I would not argue that simply relaxing makes you creative, Martindal and Hasenfus (1978) showed that students performing best on a creative task had lower levels of arousal (more relaxed). In addition, Sio et al. (2012) have demonstrated that sleep has a positive effect on problem solving, though the effect was only seen in regards to the more difficult problems,
and it was not related to incubation effects. They concluded that “sleep facilitates problem solving, most likely via spreading activation” (Sio et al., 2012:159). This would indicate that a lower level of arousal can be conducive for creativity and therefore support the “humanists” perspective to some extent.

**Brief Summary**

As seen by the above claims I found both support and critique of Amabile’s theory of creativity after having engaged it in a dialogue with neurocreativity. Most notable was the critique of the use of domain experts as appropriate observers in regards to creativity assessment, and the suggested revisions to her theory that would follow if the stated claims were to be substantiated. Some specific claims will be furthered in the discussion chapter, along with the new venues of research that open up as a result.

Initially, though, the next chapter brings in a different perspective on creativity to further the dialogue by exploring what else neurocreativity might contribute to our understanding of creativity in the context of business innovation, when focused towards creativity as social dynamics.
A Dialogue (Part 2)

Sawyer uses interaction analysis to see how the individuals in a group interact and suggests certain characteristics for groups that, if fully present, will result in greater creative outcomes. His view on (group) creativity does, therefore, not provide us with specific well-described definitions and go-to methods for assessment. However, he does cite his own work under a socio-cultural approach (Sawyer, 2012), and if we look into further detail as to how Csikszentmihalyi – who Sawyer’s work builds on – views creativity, we find his influential systems model where he argues that creativity emerges from a system containing the individual, the field (society), and the domain (knowledge and prior works), and that creativity measurement can take place in each category to function as a proxy indicator (Csikszentmihalyi, 1990b; 1988). Additionally, Csikszentmihalyi has previously made use of subjective assessment methods (e.g. Getzels & Csikszentmihalyi, 1990). It is therefore safe to assume, that Sawyer’s views on creativity assessment has its foundation in the socio-cultural domain like Amabile and Csikszentmihalyi. I will therefore not dig into further detail about this topic in regards to Sawyer, as it would essentially be repeating the arguments from the previous chapter.

Sawyer has previously stated that “it is inaccurate to describe creativity as a purely mental process” (Sawyer & DeZutter, 2009:81) and starts somewhat opposite Amabile. He initiates by arguing that collaborating groups are more creative – an argument based on observations using interaction analysis. Hereafter he pulls in other theories and views to support his claims. His approach does therefore not provide a well-structured framework as Amabile, and given that neurocreativity focuses on the individual where Sawyer focusses on the interaction between individuals, we may here have to slightly stretch the framework of neurocreativity in certain aspects, which in itself is an indication of where future research might explore further. The following claims represent the specific points of interest that I generated in my analysis.
1. **Priming can both have positive and negative effects**

Sawyer argues that priming is positive as it facilitates the group process, which is one of the reasons he finds diversity in groups necessary (Sawyer, 2008). Additionally, he references psychologists Schunn & Dunbar (1996) who performed a research study with biology students asked to solve a genetics problem. The students were divided into two groups, where one had been given a problem to solve the day before that related (by analogy) to the genetics problem, whereas the other group solved one that did not. Schunn & Dunbar found that “an implicit process – priming – can make old knowledge available for current problem solving” (p. 271).

This view of priming as a positive mechanism for solving the problem is somewhat in opposition to the view from neurocreativity, where priming is explained within the context of limitation. However, neurocreativity does not suggest we avoid priming, but being attentive to its affect. So if we temporarily use the lens of neurocreativity to view priming in a positive manner, we can do so by arguing for the possibility of individuals in a team priming each other to more remote associations. But in contrast, we may find that too much priming can result in topic fixation if the team members are not aware that they are doing it. The question is then how to find the right balance so we can take advantage of the positive effects and avoid the negative. A practical example could be writing down your own ideas first, before interaction with other team members, so you use the associations you relate to the task at hand – associations that for others may be very remote. If initial ideas are written down collectively in the group first, they may prime each other towards the same (or similar) associations, thereby countering the value of diversity in the group towards topic fixation and groupthink in general as mentioned by Sawyer (2008).

In this regard Sawyer and neurocreativity can support one another, as being aware of priming can help the individual distinguish between when it is positive (facilitates more remote associations) and when it is negative (e.g. fixates the groups to specific topics). This is where neurocreativity can provide us with some new tools for further investigation, as a reflection upon how our brain works (the five key concepts) may help us find this balance. In addition, it may also foster a reflection upon confabulation, so that the students in the above mentioned
experiment become aware of the fact that their ability to solve the problem is influenced by what they, in this case, did the day before. This would also suggest that individuals would become more aware of the importance of social interaction which Sawyer so intensely argues for, while neurocreativity can provide them with tools to avoid some of the negative effects that emerge as a result of that interaction.

2. *Diversity can make teams more creative*

Sawyer argues that “*diversity makes teams more creative because the friction that results from multiple opinions drives the team to more original and complex work*” (2008:71) and references several studies to support his claim including Kurtzberg & Amabile (2001) and Guzzo & Dickson (1996).

I found support for this view from neurocreativity if we look into priming and remote associations as just mentioned above. However, this view relates to divergent thinking as the needed approach for finding the remote associations that Mednick (1962) argues are the key to high levels of creativity. However, Harvey (2014) is somewhat critical of this:

> “*Previous research has been premised on a model in which idea generation stimulated by divergent input increases the variance in ideas a group generates and therefore increases the chance that one of the group’s ideas will be a radical, breakthrough creative product*” (p. 324).

She argues that “*a group’s diverse resources are most effective for extraordinary group creativity when they are applied to developing a synthesized understanding of the problem or task, rather than to promoting divergence between group members*” (p. 325).

This means that though diversity is still relevant seen from the perspective of neurocreativity, we may need to review the focus to also include the notion of *creative synthesis* (Harvey, 2014) where the focus is towards fostering a greater understanding of the problem at hand, rather than simply functioning as a source of divergent input, which would be the current argument. Whether focused on divergent input as means to better understand the problem
or find more remote associations, neurocreativity would provide us with a framework that adds significant details to the social interaction of teams trying to generate highly creative outcomes.

3. Preparation increases the likelihood of a creative solution

Sawyer argues for preparation which “involves a period of working hard, studying the problem, and talking to everyone else working on it” (Sawyer, 2008:81). I found support for this view from neurocreativity if we look towards Mednick’s (1962) argument for massed work sessions, as has also been mentioned previously in regards to support for some of Amabile’s findings. Therefore I will not elaborate on this once more.

However, we can further this if we look into detail in regards to the opportunistic assimilation theory introduced in this thesis by Seifert et al. (1995). It states that insightful ideas can be triggered by stimuli that are serendipitously encountered at some time after repeated failures have sensitized one to an unsolved problem. Thus, this theory focuses on hints that point the problem solver towards successful solutions. Having worked hard and studied the problem can make us sensitive to it, and talking to everyone else, as Sawyer suggests, may represent the serendipitous stimuli which can end up pointing the individual towards a solution.

The question is then if only talking to those already working on the problem, which Sawyer states, could prevent some of the more remote associations from emerging? Sawyer does argue for familiarity as a condition for group flow; group members need some common ground for social interaction, but that relates to groups working together and not for interactions simply providing some associations to the given problem. The outcome of research focused on this question could provide us with insights on the extent to which associations introduced by others could foster more remote associative combinations appropriate for the task at hand, and thereby an insight relevant for the link between individual and group creativity.
4. Thinking outside the box is not enough

Weisberg & Alba (1981), whom Sawyer references, concluded that thinking outside the box is not enough to be creative; “you have to know how to think outside the box” (Sawyer, 2008:88).

Sawyer additionally references Taggar (2002) who studied 94 groups on 13 different open-ended tasks. Taggar used Amabile’s three components (task motivation, domain knowledge, creativity-relevant processes) for predictions of individual creativity, but found that in order for a group to have high levels of creativity, team creativity-relevant processes (specific intragroup interactions) were needed as well. But interestingly, one of Taggar’s conclusions is that “…aggregated individual creativity is significantly correlated with both group creativity and team creativity-relevant processes” (Taggar, 2002:325). This would indicate that the social interaction per se is not enough, but that creative individuals are prerequisite for its effectiveness. If we look into some of Sawyer’s previous empirical research (e.g. Sawyer, 2006a; 2003) it is based on musical- and theatre groups. He uses interaction analysis to see how they build upon each other’s input without looking at the individual’s level of creativity, and then argues that the emergent performance is a “group-level phenomenon, impossible to explain in terms of the individual actor’s creative impulses or inspirations” (Sawyer, 2006a:153). Though this may be correct in regards to the performance itself, Sawyer does not include high levels of individual creativity as a prerequisite for its emergence, which his theoretical source indicates is needed.

Neurocreativity, in this regard, expands on Sawyer’s method of interaction analysis. By providing an insight to the inner workings of an individual’s mind and how social interaction may influence that individual, neurocreativity provides us with a framework for furthering the research between individual and group creativity.
5. Mental processes are essential to creativity

“Successful innovators [...] don’t succeed by getting lucky and being blessed with a rare good idea. They succeed by way of many small sparks, and by drawing on collaboration over time to build those sparks into something tremendous” (Sawyer, 2008:105). In order to successfully innovate over time, Sawyer states four everyday mental processes that he argues are at the core of creativity.

With reference to analogical thinking from Gick & Holyoak (1980) Sawyer mentions conceptual transfer as one of these four, which is where an analogy from a different domain is used as part of the solution to the current problem. Sawyer argues:

“...to be creative, you need to be aware of as many potential analogies as possible; and when faced with a problem, you should try as many different analogies as possible... [but] remember[ing] the right analogy isn’t enough to be creative; the key to creativity involves noticing the right analogy.” (Sawyer, 2008:112)

According to neurocreativity, what we remember and notice is largely influenced by our cognitive inhibition which narrows our thoughts down to what we have previously found relevant for the task at hand. However, the five key concepts are specifically designed to make us reflect upon the inner workings of our brain, and thereby notice the influence of the current situation as Onarheim & Friis-Olivarius (2013) have shown works in a study on business students. In addition, I have previously suggested memory techniques, which in this case could function as a tool for remembering as many analogies as possible. This, then, means that if we combine memory techniques with neurocreativity, we may have a slightly more advanced tool that not only allows us to remember more analogies, but also allows us to reflect upon why we specifically remember the ones we do, and how the current social context plays a role in that regard. This would further the details of an analysis of social interactions and provide more insight to Sawyer’s method of exploration.

But we can further our understanding even more if we look a little broader at the field of neuroscience. Here we find that “REM sleep facilitates the use of prior information for creative problem solving” (Cai et al., 2009), and that “sleep improved analogical transfer, but
effects were not due to improvements in subjective memory or similarity recognition, but rather effects of structural generalization across problems” (Monaghan et al., 2015:25). The latter would indicate that memory and recognition is not enough and that there are more things are at play. But this only adds to the notion of how we must remain open towards additional perspectives and insights if we are to reach a fuller understanding of creativity as a complex phenomenon.

**Brief Summary**

As with the analysis of Amabile’s framework I have with Sawyer also found both support and critique. Most interesting has been the deeper analysis of Sawyer’s sources, which indicate that high levels of individual creativity are needed if the conditions and social interactions Sawyer suggests are to result in group genius. In addition, I found that neurocreativity and its five key concepts may be the tool needed to increase individual creativity to the extent needed for group genius to emerge, while also providing details to the link between individual and group creativity. This, along with some of the other findings, will be discussed in the following.
Discussion

In my analysis, I found that the current literature on creativity in the context of business innovation has several limitations, when considered in relation to new insights emerging from neurocreativity research. These limitations include the use of experts in regards to creativity assessment and producers of creative responses; how novelty as an essential element of the definition of creativity may not be needed to the extent used in contemporary research and practice; how managers focusing on creativity as social dynamics may benefit from including an individual perspective, as well as a focus towards the management of other’s creativity rather than individuals actively partaking in the responsibility. In the following, I will link these findings back to business innovation in practice, and also provide an illustrative example of how breakthrough innovation has occurred, and how these findings may help us understand the dynamics leading to such advances.

Most prevailing in regards to creativity from an individual perspective has been the critique that neurocreativity research prompts us to make regarding the use of experts as appropriate observers to judge creative efforts. This goes somewhat in opposition to what we experience in a contemporary organizational setting, where the greater challenges with higher demand for innovation correlate with seniority and expertise, which this thesis challenges. The findings indicate that though experts themselves can be regarded as highly creative by ipsative- and normative assessment criteria, they are biased in favor of low levels of novelty, which was supported by a study by Boudreau et al. (2016). This is argued due to their expert knowledge, which limits them in regards to finding remote associations relative to the domain of endeavor, given the cognitive functionality of our brain. This means that expert’s ability to evaluate and suggest solutions, may be limited to lower levels of creativity, indicating that they would be best suited for developing and evaluating incremental product progressions, rather than those that greatly depart from previous efforts, unless the bias is somehow countered. This critique is consistent with previous research; e.g. Wiley (1998) who found that “subjects with the most domain-related knowledge were least able to solve problems correctly” (p. 726). Wiley discovered that when the solution required her subjects to extend beyond the obvious search space, high-knowledge individuals were less adept at solving the
problem. Though this thesis is exploratory in nature and not based on a large empirical study as Wiley, is does, however, suggest that neurocreativity as a research perspective can add additional insights and details to the understanding of why this occurs, and how we might be able to counter the negative effect in a practical business setting.

If we rely on appropriate observers (as defined by Amabile) as the way in which we measure creative efforts, we would be missing out on highly novel solutions. The question is then to what extent the degree of novelty is required or relevant in regards to creativity, which is a question that was raised in the first analysis chapter (p. 51). Given the current definitions of creativity, where it is viewed on a continuum, a solution would not need to be highly novel in order for it to be considered creative. However, creativity assessment still consists of two essential requirements; novelty and usefulness. This, therefore, matters because if we look at the previously introduced scholars focusing on breakthrough innovation, we find that breakthroughs are highly novel in nature (Harryson, 2006) and that these come about by brokering knowledge across domains (Hargadon, 2003), which means a high level of departure from previous efforts, which is how novelty is defined (Boudreau et al., 2016). This would suggest that novelty is a very important factor in regards to breakthrough innovation, which would be considered highly creative. Yet the predominant assessment method used for creativity is biased against it. Amabile has somewhat mitigated this critique by arguing that appropriate observers may not be adept at judging extreme levels of creativity (assumed to also include high levels of novelty). The findings indicate that this must be expanded to a broader part of the creativity continuum, and not just in regards to the extreme levels of creativity. Additionally, as long as experts are biased in favor of low levels of novelty in regards to proposals within their own domain of expertise, they may be of limited use as gatekeepers in the innovation process. If so, we are unlikely to find the breakthrough ideas that Amabile argues they cannot evaluate, because they would have already been filtered out – it is a Catch 22. This would indicate a need for separating novelty from creativity assessment, so that we initially look at the novelty of a proposal. If it is more than slightly novel in nature, we would need to search for evaluators who are not experts in the domain within which that proposal resides. But this is an adaptation of the method based on normative assessment criteria, whereas Neurocreativity provides us with an alternative.
The findings indicate that neurocreativity is better suited for assessing creativity, given that it provides us with a framework for objective creativity assessment without having to rely on an outcome. But this approach focuses on a different object compared to the normative assessment method. Neurocreativity focuses on the individual, while the latter is on the product, which would suggest that though neurocreativity may be better suited for (individual) creativity assessment, it does not extend to innovation as some kind of market acceptance or response is required. This would indicate that the framework from neurocreativity can be used to measure individual creativity, whereas appropriate observers could be used in regards to assessing creativity relative to other creative responses in relation to innovation. This distinction is important, because if we are to increase individual’s creative efforts we must also provide an assessment method relative to the individuals themselves, and not their responses relative to other responses judged by observers biased towards low levels of novelty.

This thesis would suggest that we instead use novelty as an approach to inspiration – finding remote ideas relative to the domain of endeavor – which the referenced research on breakthrough innovation along with other scholars (e.g. Uzzi et al, 2013; Fleming 2001; Levinthal, 1997) have shown to be effective. Based on neurocreativity, we can argue that novelty relative to other responses is not a needed requirement and question if the novelty element has been added as a result of the normative assessment method. The current predominant view is that there is no objective method for assessing creativity (Amabile, 1996; 1983), which is perhaps why we see creative assessments of the product used as equivalence to the level of individual creativity. But given the emergence of neurocreativity we can challenge that view. This also leads to questions relating to the use of creativity assessment in general and the influence is has on innovation. This goes beyond the scope of this thesis, tough it still functions as an indication of the questions neurocreativity allows us to ask.

In a business context; we may have to reevaluate who we see as experts and thereby who we give most responsibility to. This is based on a theoretical limitation related to an individual’s potential for creativity that I found through my analysis, which relates to the network of possible wonderings (Newell & Simon, 1972) as mentioned by Amabile. Based on current
literature, it is argued that the more numerous the set of possible responses, the greater the amount of new combinations could be made. Though this may be true, this thesis finds that it is missing a central point which neurocreativity provides; namely that it is not as much about the potential per se, but the extent to which that potential can be put to use. This would indicate that expertise in a given domain should not only be based upon years of experience and education per se, but also on the extent to which the individual can access and take advantage of that experience. In a practical setting; we may find two employees where one has seniority given more experience in the field, but where the other can make use of the lesser experience to an extent that surpasses her more senior colleague. In this sense, the less experienced individual could be considered more of an expert than her senior colleague, which is a new perspective that has become available for further research given the introduction of neurocreativity.

Managers using an approach that builds on Sawyer’s work may benefit by extending their focus to individual creativity as well. If we look towards creativity as social dynamics I found a critical limitation in regards to Sawyer’s theory. The essence of his argument relates to group genius emerging in a group setting when certain conditions and interactions are present. However, he bases his argument on a theoretical source that shows a high correlation between individuals with high levels of creativity and groups with high levels of creativity (Taggar, 2002) but does not mention it. This would indicate that highly creative individuals are a prerequisite for group genius to emerge. Though this critique came about by investigating Sawyer’s theoretical sources and not directly as a result of the “conversation” between his claims and neurocreativity, it did foster a question that neurocreativity has allowed us to ask: Can introducing the five key concepts to any normally cognitively functioning individual, increase his or her creative ability to such an extent, that Sawyer’s conditions and social interactions result in group genius? In a practical business setting, Sawyer’s approach to only focus on the interactions may be slightly misguided if we are to rely on the interpretation of the findings here. However, this is where neurocreativity may come to the rescue. If the key concepts function to the extent just described, then Sawyer’s approach would be at the premise of the individuals receiving creativity training if they are not highly creative already. But his approach would work with a broad spectrum of people nonetheless, which the
critique raised in the thesis suggests, based on Sawyer’s own theoretical source, is currently not possible. Neurocreativity, in this case, raises a critical issue with Sawyer’s theory, while also providing a cognitive tool which may help assist countering this critique.

We could also interpret this finding differently and view the emergent group genius relative to the participating individuals. The group may reach the point of flow and thereby perform at their peak, but, unless the individuals are highly creative on an individual basis, the group would not reach high levels of creativity either. This would indicate that there is a correlation between the level of genius and the level of creativity of the individuals in that group, which would then suggest that we should also view group genius on a continuum. This would provide an explanation for Taggar’s (2002) findings, but be counter to the discourse of Sawyer’s work; indicating that anyone can produce a highly creative outcome if only the right conditions and circumstances are present in a group setting.

Whether the former or most recent interpretation prevails (or something completely different), neurocreativity has nonetheless provided us with a framework displaying insights as to how individuals may influence one another through social interaction. This adds to the link between individual and group creativity, while also providing us with a mental toolbox that has been shown to increase creativity at an individual level. This also fosters an additional perspective for the implications for business practice: Most of the current creativity research related to business innovation is aimed towards managers to give them insights on the conditions under which their employees must work, and how they must interact to be more creative. Whether this is based on creativity from an individual perspective, as social dynamics or something third, it is still primarily aimed towards someone managing the creativity of others. The findings in this thesis would suggests that the individual team members could play a more active role, and thereby indicate a subtle move towards individual responsibility in regards to creative processes, rather than it being viewed as something only managers implement or set the conditions for. Though I will not disregard the importance of management, the suggestion of not only relying on the management of creativity brings back a multiplicity perspective that may result in a greater creative outcome.
As a final point in this discussion, I will bring in a specific innovation process. This is based on a number of insights, all of which are highly subjective in nature as they arise from my own experience. Throughout this thesis I have mentioned Harryson (2006) in relation to breakthrough innovation. As mentioned in the introduction, I have worked at his consultancy as an intern, which inspired me to write this thesis. Based on this experience along with having attended his lectures at Copenhagen Business School and having read much of his literature related to innovation, I will outline his innovation process. The point is not to provide a detailed description of every element, nor do I argue that my insights can be seen as a full overview of what goes on. But I wish provide an illustrative example of how I see some of the findings in this thesis relate to his successful approach – an approach that has yet to be understood as only limited empirical studies (mostly by students) have been conducted. Therefore, most of how to make this process work still resides with Harryson himself.

This essence of his approach is based on University-Industry competitions, where a company (the client) hires Harryson Consulting Group (HCG) to take on an innovation challenge they have deemed impossible to solve. There are two overall elements to this approach; ideation and implementation/execution. Though I will focus on the prior as this relates to my thesis, the latter should not been seen as the lessor of the two. I also acknowledge that more than “simply” ideation and implementation/execution is at play when producing a breakthrough.

The process starts with the client very precisely defining the goals of the competition (e.g. specific solution requirements). HCG then compiles University teams to compete and simultaneously collaborate towards a solution. After an initial gathering, the teams return to their respective Universities to tackle the issue on their own. Later, they gather again and must share all details of what they have discovered and produced. Hereby ideas and concepts consolidate. Throughout the process teams have access to the clients leading researchers who are available for support and insights. The process is also iterative, so teams continuously share and build upon each other’s concepts. Midway through, 5-15 initial concepts are selected as the basis for further exploration. Later, as further consolidation has taken place, the concepts are completed and now represent 3-6 business cases that are handed over to the client.
This is just a simplified outline of the process, but if we try to understand this from the perspective of neurocreativity, we find a few very interesting things. Firstly, the teams do not consist of members who are experts in the domain within which the challenge is defined – most are not experts at all. This relates well with the critique of experts as judges and producers of creative solutions, which neurocreativity has prompted. The experts are the client’s researchers, who despite vast resources have been unable to solve the problem. The university teams typically consist of a professor who can be seen as an expert in a domain, but the teams also typically consist of a few Ph.D. students and a handful of Master students in their final year, which brings us back to Mednick; “if a newcomer to a field has the requisite information, he is more likely to achieve a creative solution than a long-time worker in the field.” (1962:224).

Secondly, given the variance in expertise between teams, we find diversity, which is increased when they share the details of their initial concepts. This also fosters even more remote associations. Each team provides different bits and pieces of information stretching far beyond the domain within which we find the problem, which interestingly resembles Sawyer’s argument of “combining distant concepts” as “one of the most creative types of conceptual creativity” (Sawyer. 2008:124). It is here we find the high degrees of novelty. This thesis has argued that expert’s bias in favor of low levels of novelty may be detrimental to creative efforts. Here, in this illustrative example, we see how non-experts outperform experts, and that novelty plays an important role in doing so.

Finally, the teams do not work side-by-side throughout the duration of the challenge, but independently and for long periods of time (massed work sessions). This may prevent priming towards topic fixation as previously discussed, and ensure that the different teams work towards their own solutions before being influenced by what the other teams have discovered.

Though this example is only an outline of an innovation process (and a very subjective one at that), it provides a glimpse of the potential of neurocreativity, and when combined with the findings in this thesis, it also provides new perspectives that can function as a starting point for further creativity research in the context of business innovation.
Conclusion

Through an explorative study I brought the emerging field of neurocreativity in to a dialogue with well-established theories of creativity in the context of business innovation, to analyze how and what it might contribute to our current understanding. I did so by method of comparative analysis and primarily relied on the work of Teresa Amabile and Keith Sawyer as a frame of reference for representing creativity from an individual perspective as well as from a social dynamics perspective, respectively. Through my analysis, I found support for some of the current literature, as well as having discovered certain areas where the current theoretical perspectives on creativity produce limitations for an understanding of this complex phenomenon, and I have suggested that introducing neurocreativity as a research perspective may help us address these limitations. But I also found certain aspects where I had to stretch the framework of neurocreativity to speak with current theory, indicating that this new field of research is still in its early stages and therefore also needs further investigation.

In regards to creativity from an individual perspective I found support for viewing creativity on a continuum instead of an either/or approach as well as how individual creativity can be increased through training, which is the context within which neurocreativity was initially introduced to a business audience. I also found support for the positive effect of individuals being deeply engaged in their work through massed work sessions, while time away from it can prove beneficial, as it functions as an incubation effect. Lastly, I found support for the importance of memory in regards to creativity. In this latter instance I dove into further detail through Amabile’s sources, as the insights neurocreativity provides us with not only relate to memory per se, but also to what we remember given the cognitive functionality of our brain. This raised some critique which will be elaborated below.

In regards to creativity as social dynamics I found support for preparation which relates to massed work sessions as also mentioned above. Being deeply involved with the task at hand sensitizes us to the problem so we inadvertently look for solutions in our other activities, while this neural activation also spreads to other parts of our brain and activates additional concepts. Additionally, I found support for team diversity as in can foster the more remote
associations which relates to Mednick’s definition of creativity. Hereto, also the importance of mental processes which is the essence of neurocreativity and, finally, I found support for priming which was argued facilitating the spreading of ideas in a group setting, but here I also found a limitation, as priming can have a negative effect if we are not consciously aware that it is taking place.

If we look towards areas of disagreement, the findings critique the use of experts as appropriate observers to judge creativity, and also as gatekeepers in an innovation context which prompted a deeper analysis. The critique is based on experts being biased in favor of low levels of novelty, which is an integral part of current definitions of creativity. Further research was suggested to explore this phenomenon and its influence on innovation in practice. Hereto it was also suggested to include the five key concepts from neurocreativity to see if they provide adequate metacognition for experts to counter the novelty bias. This latter notion is of great interest as the research studies referenced in the thesis, have been unable to provide an explanation for why this bias occurs. Additionally, I found critique regarding viewing an individual’s potential for creativity as based on the network of possible wonderings, which does not take the cognitive inhibition of our brain into account. This fostered a distinction between our potential for making new combinations and the extent to which that potential can be used productively, which is a distinction future research may benefit from including.

Critique was raised in regards to creativity as social dynamics relating to group genius emerging in a group context. A deeper analysis revealed a specific source, referenced by Sawyer, showing a correlation between high levels of group creativity and high levels of individual creativity, which is counter to the discourse of Sawyer’s writings, where it is indicated that any group can produce group genius, if only the right conditions are present. It was therefore suggested that future research should investigate the extent to which conscious creativity training (as neurocreativity) improves creative abilities in comparison to individuals who subconsciously make use of these mental processes “naturally” as a result of personality trait, and the extent to which (if any) conscious training leads to a subconscious change. The results would help us understand if any normally cognitively functioning
individual can gain high levels of creative abilities, which were found to be prerequisite for group genius to emerge. If so, it would also support Sawyer in regards to above mentioned critique.

Neurocreativity contributes with a wealth of new opportunities for further creativity research at the intersection of this emerging theory and prior creativity studies. This thesis indicates that neurocreativity is better suited for measuring individual creativity as it provides a framework for objective assessment, though it does not extend to innovation. This would imply that future research could move beyond the predominant normative assessment method and view creativity in a new light, thereby laying the ground for revisiting established theories and approaches. This thesis finds that neurocreativity also suggests a range of implications for business practice, which include the use of experts as counter to creative efforts if the problem is defined within the expert’s knowledge domain, just as managers using an approach based on Sawyer’s work may benefit from including a focus on individual creativity as well.

Though this thesis has made several claims relating to how we might look differently at business innovation in practice it is, however, explorative in nature, and the stated claims should therefore be viewed as a starting point for further research where scholars can investigate and see if additional support can be found in order to substantiate the claims. The referenced research, though argued adequately representing the two views of creativity, are both limited in regards to their own framework, as they have not been used in their entirety, along with the extent to which they represent all research that relates to their respective field. Similarly, having used an interpretivist approach, the findings are also biased towards the subjectivity of me as the researcher, though this has been reflected upon throughout the process. This thesis can therefore not stand alone as support for the claims, but provides a first look as to which questions are made possible to ask given the emergence of neurocreativity, along with what the implications for business innovation in practice might be.
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Internet links


Appendix

Appendix 1: SCOPUS search on most cited articles related to creativity (only top citations shown).

Appendix 2: SCOPUS search on R. K. Sawyer (only top citations shown).
Appendix 3: SCOPUS search on T. Amabile (only top citations shown).

Appendix 4: Google Scholar citations for research by R. K. Sawyer (only top citations shown).
**Appendix 5:** The visual mapping of the key concepts from neurocreativity. The post-its represent the theoretical and empirical sources related to the concepts.

![Neurocreativity diagram]

**Appendix 6:** The visual mapping of Teresa Amabile’s componential framework. The post-its represent related sources and brief notes.

![Amabile framework diagram]
Appendix 7: The visual mapping of Keith Sawyer’s framework. The post-its represent related sources and brief notes.