Master Thesis

NEUROENTREPRENEURSHIP

Recommendations for organizational innovation to enhance entrepreneurial activity

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Abstract

Entrepreneurship research faces a crossroads and a new approach is needed to better understand entrepreneurial behavior. Incorporating neuroscience to comprehend the entrepreneurial mindset seems promising. Nevertheless, the potential of neuroscience for entrepreneurship research is only slowly being realized. Based on an extensive literature review, this thesis examines the emerging role of neuroscience with respect to entrepreneurship. Referring to the model of the entrepreneurial process, this thesis investigates how entrepreneurs discover, exploit, and finally capture opportunities. In this context, explanations regarding trait, expertise, adaptation, and mindset of the entrepreneur are relevant for further examination. Moreover, decision-making in uncertain situations is analyzed. In this context, the dynamic interplay between the reflective and reflexive system is considered. Ultimately, this thesis provides recommendations for organizational innovation to enhance entrepreneurial activity.

Keywords: Neuroentrepreneurship, entrepreneurial neuroscience, entrepreneurial mindset, entrepreneurial decision-making, intrapreneurship

Key Findings:

- Adapting to changes in a dynamic environment is crucial for entrepreneurs. In order to support metacognitive and dynamic capabilities, specific brain areas are involved in evaluating experiences, and thus strengthening rapid adaptation.
- The reflective and controlled system interacts with the reflexive and affective system. Therefore, emotional and affective processes influence rational cognition and consequently are an integral part of awareness, learning, and entrepreneurial decision-making.
- The entrepreneurial mindset is not primarily innate, but can be encouraged and learned.

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List of Abbreviations

ACC	Anterior cingulate cortex
BOLD	Blood oxygen-level dependent
BRE	Brain-driven entrepreneurship research
C-system	Reflective system
CNS	Central nervous system
dACC	Dorsal anterior cingulate cortex
DMPFC	Dorsal medial prefrontal cortex
e.g.	Exempli gratia (means: for example)
EEG	Electroencephalography
ERN	Error-related negativity
ERP	Event-related potentials
fMRI	Functional magnetic resonance imaging
fNIRS	Functional near-infrared spectroscopy
IPL	Inferior parietal lobule
LPAC	Lateral parietal cortex
LPFC	Lateral prefrontal cortex
LTC	Lateral temporal cortex
MEG	Magnetoencephalography
MPAC	Medial parietal cortex
MPFC	Medial prefrontal cortex
MTL	Medial temporal lobe
nAch	Need for achievement
NIRS	Near-infrared spectroscopy
OBE	Out-of-body experience
PCC	Posterior cingulate cortex
PET	Position emission tomography
PNS	Peripheral nervous system
rACC	Rostral anterior cingulate cortex
RAS	Reticular activating system
SCN	Social cognitive neuroscience
SME	Small and mid-sized enterprises
tDCS	Transcranial direct current stimulation
TMS	Transcranial magnetic stimulation
VMPFC	Ventromedial prefrontal cortex
X-system	Reflexive system

1. Introduction

Over the last decades, researchers tried to comprehend the uniqueness of the entrepreneurial mindset (Nicolaou et al., 2019). Today, entrepreneurs become business icons or role models and for many companies the “entrepreneurial spirit” is a key criterion for hiring employees. Companies strive to be agile, innovative, and unique. Therefore, they are looking for employees who demonstrate an entrepreneurial mindset, who are inspiring, courageous, and outstanding (Butler, 2017). This thesis examines the emerging role of neuroscience with respect to entrepreneurship and ultimately provides recommendations for organizational innovation to enhance entrepreneurial activity.

The potential of neuroscience for entrepreneurship research is only slowly being realized. In order to extend the knowledge about the entrepreneurial mindset, the notion of neuroscience needs to be addressed. Neuroscience provides a comprehensive understanding of the human behavior and therefore helps to shed light on the “small, impenetrable black box” (Sacks, 1985), which the human brain still is. Entrepreneurs have diverse backgrounds, experiences, and circumstances, but what unites them might be their particular mindset. The examination of the entrepreneurial behavior using research methodologies inherited from neuroscience advances this field of research (Pérez-Centeno, 2017a). Subsequently, entrepreneurship researchers analyzed for example the cognition (e.g. R. K. Mitchell et al., 2002), prior knowledge (Shane, 2000), mindset (Haynie et al., 2010), and the intuition (J. R. Mitchell, Friga, & Mitchell, 2005). In addition, the investigation of entrepreneurial opportunities is of great interest. What determines the probability of certain people discovering certain opportunities? Shane and Venkataraman (2000) argue that prior information is essential for identifying opportunities in addition to cognitive properties that are relevant for assessing these opportunities. Neuroentrepreneurship combines the findings of neuroscience and entrepreneurship research and ultimately enables steering the research into a new direction. This direction is

characterized by interdisciplinary research and experimental studies that seem uncommon for entrepreneurship researchers. Nevertheless, the discovery of this field is definitely worthwhile.

1.1. Problem Definition

Entrepreneurship research comprises three approaches that have evolved and can accordingly be described as epochs or eras (Pérez-Centeno, 2017a). The first approach considers the economic view of entrepreneurship. Researchers like Cantillon (1730), Menger (1871), Schumpeter (1934, 1942), or Kirzner (1973) focused on the impact on the economy when entrepreneurs operate in the market. Phenomena such as creative destruction through entrepreneurial innovation were the focus of this research. The classical economics developed further and gave rise to neoclassical theories, which are divided into the Austrian School, initiated by Carl Menger, the English School by Alfred Marshal, and the Lausanne School by Leon Walras. Due to the focus on mathematical equilibrium models, the impact of the entrepreneur was no longer considered (Hébert & Link, 2009; Pérez-Centeno, 2017a). Therefore, the second approach evolved. Entrepreneurship was further researched under the aspects of social sciences and psychology. The entrepreneur was considered as an human being who is influenced by the environment, background, and specific motivations (Stevenson & Jarillo, 1990). This approach analyzed the causes for specific entrepreneurial behavior and actions. Furthermore, researchers investigated particular personality traits of an entrepreneur, being the reason for his or her actions (Pérez-Centeno, 2017a). Due to changes in politics, technology, and economical structures, the management approach occurred. More and more smaller firms rose, as the efficiency of larger organizations was questioned. Entrepreneurship was considered as a developing process in which management is a key element (Pérez-Centeno, 2017a). The combination of these three approaches provides a solid base for Neuroentrepreneurship, as relevant questions are already reflected.

Nevertheless, entrepreneurship research faces a crossroads again. A new, fourth approach is needed, which has to bridge the research gaps resulting from methodological limitations of previous approaches (Pérez-Centeno, 2017a). Incorporating neuroscience to start opening and consequently understanding the entrepreneurial mind seems promising. In addition, several researchers stress the need for a new approach (Holan, 2014; Nicolaou & Shane, 2014; Pérez-Centeno, 2017b). To improve the understanding of entrepreneurial behavior, it is essential to have a closer look at attributes of the entrepreneurial mindset. One key element of entrepreneurship is a specific opportunity, which consequently could be the starting point of a good idea, service, or product. Opportunities need to be identified, analyzed, and finally implemented by a person (Shane & Venkataraman, 2000). Nevertheless, not everyone values the opportunity the same way and recognizes possible consequences, which might lead to a successful business idea. What distinguishes an entrepreneur from a manager? Prior knowledge, individual experiences, and available resources influence the decision-making process of entrepreneurs. How entrepreneurs recognize, evaluate, and exploit advantages of these opportunities and how they actually form decisions, is one key research question of Neuroentrepreneurship. The neurological differences between rational thinking (“cold” cognition) and emotional processing (“hot” cognition) constitute a good starting point for further research (N. Krueger & Welpe, 2014). For example, the decision-making efficiency can be measured by using functional magnetic resonance imaging (fMRI) to obtain insights into neurological mechanisms (Laureiro-Martínez et al., 2014).

Existing research fields are the combinations of neuroscience with for example leadership (Waldman, Balthazard, & Peterson, 2011), marketing (McClure et al., 2004), or organizational behavior (Becker, Cropanzano, & Sanfey, 2011). These research fields indicate methods to combine neuroscience with a business-related topic and are therefore a solid basis for a closer analysis of Neuroentrepreneurship.

1.2. Research Objectives

The research gap in the field of Neuroentrepreneurship is obvious. The purpose of this investigation is to examine the correlation between neuroscience and entrepreneurship research. As a result, neurological structures that determine entrepreneurial behavior and thinking are analyzed. This study systematically reviews data from social cognitive neuroscience and entrepreneurship and provides insights about the entrepreneurial mindset. The advanced brain-based technology is accessible through neuroscience and thus opens up a new research space for exploring and developing entrepreneurship (Day, Boardman, & Krueger, 2017). Therefore, approaches and research of some pioneers in this novel field are reflected. Finally, this thesis highlights the importance of further research in Neuroentrepreneurship.

This thesis follows the definition of entrepreneurship by Shane and Venkataraman (2000), which emphasizes the discovery, evaluation, and subsequent exploitation of opportunities. These steps are individually analyzed with the involvement of neuroscience. In fact, whether the “one entrepreneurial mindset” really exists has to be discussed hereafter. Moreover, it cannot be stated that possible differences are measurable by using neuroscience.

The following research questions guide the examination of neurological mechanisms involved in opportunity discovery and decision-making:

(1) How is the entrepreneurial mindset characterized?
(2) How does an entrepreneur identify and discover opportunities in the given environment?
(3) What characterizes and influences the entrepreneurial decision-making process?
(4) How can the entrepreneurial mindset be further promoted to enhance entrepreneurial activity and organizational innovation?

1.3. Outline of the Thesis

With the aim of finding the intersection of neuroscience and entrepreneurship, scientific papers of both branches of research were analyzed. This thesis is exploratory and inductive in nature. Moreover, it is based on qualitative data collection. The data collection for this thesis focused on secondary data. There are just a few articles purely presenting new research insights into Neuroentrepreneurship and dealing with Neuroentrepreneurship as an individual field of research. Consequently, secondary data in neuroscience and entrepreneurship literature were analyzed individually to determine whether there are possibilities of transferring empirical results and combining both research fields. Besides, related research fields such as Neuroleadership and Neuromarketing were considered.

The thesis is organized as follows:
Chapter 1: The first chapter provided a thematic introduction to the topic. Besides, this chapter highlighted the research gap and emphasized the importance of further research in Neuroentrepreneurship. This was followed by the introduction of the research questions for this thesis. Finally, the outline of the thesis is presented.

Chapter 2: The first section of this chapter examines the general brain anatomy and indicates the function of specific brain regions. Moreover, this chapter gives a brief overview of social cognitive neuroscience as a research field. Relevant terminology is explained. Additionally, this chapter covers functions, advantages, and limitations for better comprehending neuroscience methods such as fMRI or EEG.

Chapter 3: This chapter provides a holistic overview of entrepreneurship research. The discussion about a coherent definition of entrepreneurship is outlined. Three main approaches of entrepreneurship research are then presented. This chapter continues with introducing alternative, contemporary

approaches in entrepreneurship research. Finally, entrepreneurial cognitive tasks are examined and introduced.

Chapter 4: Chapter four is based on the definition of entrepreneurship by Shane and Venkataraman (2000), which highlights the discovery, assessment, and exploitation of entrepreneurial opportunities. At the beginning of this chapter, nature and source of opportunities are illustrated. Furthermore, by integrating neuroimaging into entrepreneurship research, the discovery of opportunities is discussed. In this context, the discovery is analyzed under the aspects of traits, adaptation, expertise, and mindset. The next section addresses the exploitation of entrepreneurial opportunities. Especially, the role of emotional, experiential and rational processes is examined in order to gain insights into the decision-making process of an entrepreneur. This chapter closes with analyzing how opportunities could be captured in order to implement a decision.

Chapter 5: This chapter summarizes the findings and highlights the most important topics of this thesis.

Chapter 6: Chapter six provides recommendations for organizational innovation. It opens up by laying out the theoretical dimensions of intrapreneurship and looks at specific dimensions for enhancing entrepreneurial activity.

Chapter 7: This chapter indicates the limitations of Neuroentrepreneurship research, which result in implications for future research. Furthermore, the findings of this thesis are outlined.

2. Social Cognitive Neuroscience

Neuroscience is interdisciplinary in nature and therefore also includes research results from other disciplines such as philosophy, psychology, and medicine (Holan, 2014). This chapter presents an overview of the social cognitive neuroscience approach and highlights theories, which will be used in chapter 4. Moreover, commonly used research methods are explained and discussed in terms of their usefulness and appropriateness for entrepreneurship research.

2.1. General Brain Anatomy

Neuroscience investigates behavioral, functional, evolutionary, and medical aspects of the nervous system (Brazier, 2018). Furthermore, this research field is characterized by analyzing the development, structures, and activities of the human nervous system. The nervous system itself is responsible for the perception of the environment and is subdivided into the peripheral nervous system (PNS) and the central nervous system (CNS). The CNS encompasses the spinal cord and the brain, whereas the PNS consists of ganglia (groups of neuronal cell bodies) and the nerves located outside the CNS. The brain is divided into three regions: forebrain, midbrain, and hindbrain (Sternberg & Sternberg, 2017). The following Table 1 provides an overview of major structures and functions of the three brain regions.

Table 1: Main structures and functions of the human brain

Region of the Brain	Main Structures	Functions
Forebrain	Limbic system (hippocampus, amygdala, septum)	• Involved in learning, memory, emotions, and motivation
	Thalamus	• Perception and transmission of sensory information
	Hypothalamus	• Regulation of (survival) behavior and emotions • Involved in stress system, endocrine system, and autonomic nervous system
	Cerebral Cortex	• Processing and receiving sensory information (auditory and visual information) • Cognitive processing • Planning and sending motor information
	Basal Ganglia	• Influencing the motor system
Midbrain	Reticular activating system (RAS)	• Involved in controlling consciousness, attention, and cardiorespiratory function
	Brainstem (midbrain, pons, cerebellum, medulla)	• Transmission of sensory and motor signals
Hindbrain	Cerebellum	• Controls coordination and memory
	Pons	• Involved in consciousness, neural transmissions
	Medulla oblongata	• Controls heart activity, breathing, swallowing, and digestion

Source: adapted from Sternberg & Sternberg, 2017, p. 41.

2.1.1. Forebrain

The forebrain is located in the upper and front part of the human brain. It comprises limbic system, thalamus, hypothalamus, cerebral cortex, and basal ganglia (Sternberg & Sternberg, 2017). The following explains the individual structures of the forebrain.

The **limbic system** is engaged in learning, memory, emotions, and motivation. This system processes sensory information, for example absorbed in the environment, and aligns them with individual physical needs. In this context, the limbic system is responsible for minimizing instinctive actions and impulses resulting from environmental incidents (Sternberg & Sternberg, 2017). The limbic system is composed of hippocampus, amygdala, and septum. The septum is responsible for emotions like fear and anger (Breedlove & Watson, 2013). The amygdala is associated with envy, but also with pride satisfaction (Becker et al., 2011), and especially with fear (Hsu, et al., 2005; Stanton, Day, & Welpe, 2010; Sternberg & Sternberg, 2017). Moreover, results of a study showed that differences in anatomy and networking capacity of the amygdala result in variations in action orientation (Schlüter et al., 2018). Action control means the possibility of maintaining an intention. For example, action control can be achieved by a higher level of attention or motivation or, by influencing own emotions. The aforementioned study demonstrated that people with a lower amygdala volume are more action-oriented than people having a high amygdala volume, especially during decision-making. Ultimately, people with a high amygdala volume tend to postpone the start of projects without any obvious reason (Schlüter et al., 2018). This study emphasizes that the amygdala influences risky decision-making and fear-driven behavior (Davis & Whalen, 2001). Besides, the hippocampus is responsible for building memory (e.g. Davis & Whalen, 2001; Manns & Eichenbaum, 2006; Rolls, 2019; Sternberg & Sternberg, 2017), receiving sensory information, and transmitting this to the amygdala (McDonald & Mott, 2017), which is known as supporting the fear memory (Campese et al., 2015). Through the examination of various behavioral experiments, Amadi et al. (2017) indicate how the hippocampus is

included in establishing a fear memory and how processing ambiguity by the hippocampus improves this fear memory. Additionally, the hippocampus is essential in predicting events and combining these with the real occurrence of events (Goosens, 2011). Furthermore, the hippocampus is important for flexible learning and adapting acquired knowledge (Eichenbaum, 2017). Damages occurring in the hippocampus lead to the inability of building new memories. Even if it is possible to recognize old places or situations, new information remain new and it is impossible to build latest memories (Sternberg & Sternberg, 2017). An experiment on the inactivation of hippocampal functions in the brain of primates investigated the relevance of this brain area for non-navigational spatial tasks and accordingly for spatial memory (Forcelli et al., 2014). Spatial memory is essential for perceiving where things are located and how they are physically interrelated (Howland, Harrison, Hannesson, & Phillips, 2008).

The **thalamus** receives sensory information and forwards it to the cerebral cortex. The thalamus has a filtering function and sorts out unimportant information (Sternberg & Sternberg, 2017).

The **hypothalamus** is a segment of the extended limbic system (Morgane, Galler, & Mokler, 2005) and regulates specific behavior and emotions. Body functions that are important for survival, such as feeding, fighting or mating, are controlled by the hypothalamus (Pessoa & Hof, 2015; Sternberg & Sternberg, 2017). The hypothalamus is involved in the stress system (Morgane et al., 2005). Moreover, this brain structure is part of the automatic nervous system and affects processes in the prefrontal cortex. This is especially true for the lateral prefrontal cortex, an essential part for cognitive functions (Pessoa & Hof, 2015). Furthermore, the hypothalamus regulates the hormonal balance through interacting with pituitary glands, which is significant for the endocrine system (Gazzaniga, Ivry, & Mangun, 2014; Riedl & Javor, 2012).

The **cerebral cortex** is extremely important for perception and cognition. This specific brain structure accounts for 82% of the total brain mass and is a one to three millimeter thick outer layer covering the two hemispheres of the brain (Azevedo et al., 2009). In general, the human brain consists of the right and the left cerebral hemisphere, which have distinct functions (Sternberg & Sternberg, 2017). Receptors located at the left half of the body take up sensory information from this side and transmit corresponding information to the right hemisphere and the other way around. The two hemispheres are connected by the corpus callosum, which serves to transmit impulses to the other half of the brain (Witelson, Kigar, & Walter, 2006). The left hemisphere is crucial for speaking and comprehending language. In 1861, Paul Broca studied brain lesions of corpses and concluded that the left hemisphere is responsible for articulating speech. The associated brain area is now called Broca's area and is situated in the frontal lobe in the motor cortex. The Wernicke's area is essential for comprehending language and is located in the parietal lobe in the sensory cortex (Sternberg & Sternberg, 2017; Tremblay & Dick, 2016). The cerebral cortex demonstrates a variety of different functions (see Figure 1). These functions in neural processing are associated with four lobes, namely temporal lobe, occipital lobe, parietal lobe, and frontal lobe (e.g. Gazzaniga et al., 2014; Sternberg & Sternberg, 2017). Figure 1 illustrates the functional areas of the cerebral cortex.

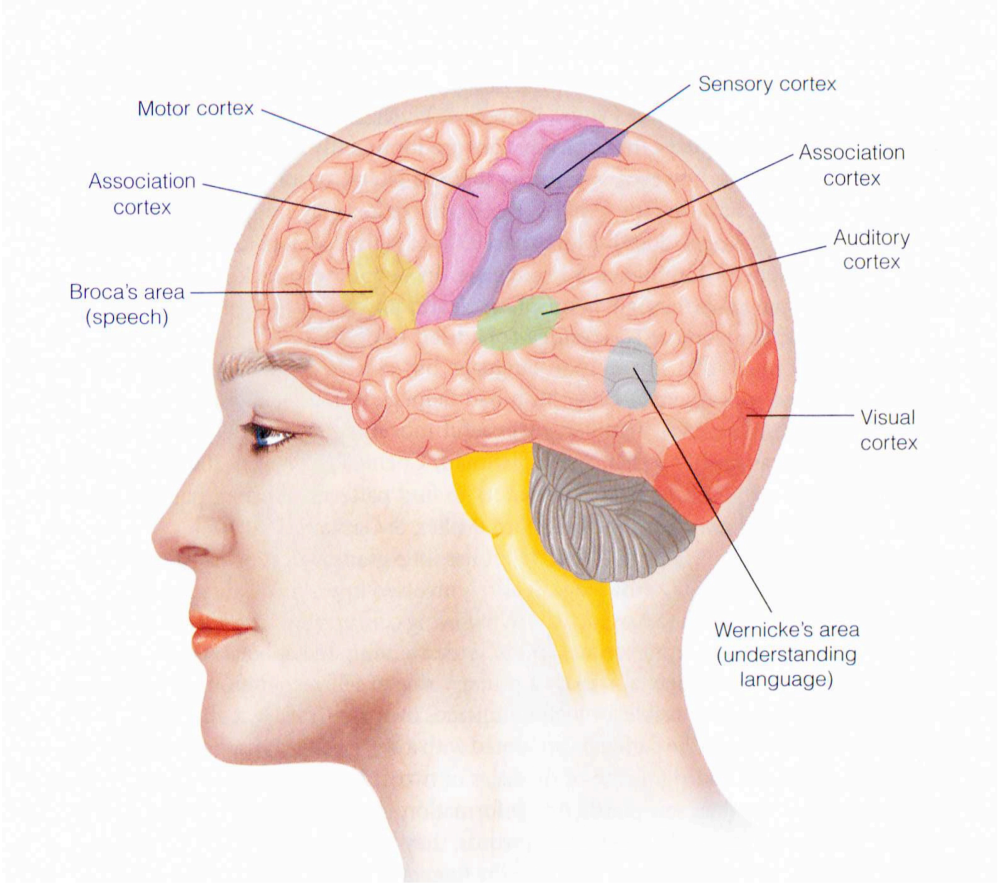

Figure 1: Functional areas of the cerebral cortex

Source: Sternberg & Sternberg, 2017, p. 45.

The frontal lobe is fundamental for advanced cognitive processes, as for example reasoning, perception, problem solving, judgment or, planning (Cadwell et al., 2019; Geschwind & Rakic, 2013; Stuss & Floden, 2006). In addition, the frontal lobe contains the ability to speak, which is a motor action. The primary motor cortex is essential for planning and executing movements, for which information integrated over time is relevant. Moreover, the frontal lobe is important to reach an objective. Figuring out the procedures and requirements to reach a goal is not possible with a lesion in this brain area. Additionally, people with a lesion in the frontal lobe do not have the motivation to start reaching an objective or adjust their behavior towards this objective (Gazzaniga et al., 2014). The parietal lobe processes somatosensory information received from senses. This area processes visual and acoustic signals, especially with regard to spatial localization (McMullen, Wood, & Palich,

2014). Furthermore, the somatosensory cortex transfers information from the environment, the own body, and from memory. Information from senses about texture, temperature, pressure, or pain are recognized with receptors on the skin (Gazzaniga et al., 2014). In this context, people who experience a lesion in the parietal lobe have an “out-of-body” experience (OBE) as their consciousness is no longer related to their own body (Blanke et al., 2002). Additionally, the parietal lobe is crucial for the ability to concentrate on a specific task (Humphreys & Lambon Ralph, 2015; Sternberg & Sternberg, 2017). The temporal lobe transmits auditory information and is important to comprehend language (e.g. Cope et al., 2020; Han et al., 2011; Teige et al., 2019). Besides, the temporal lobe processes visual abstract concepts and influences the ability of matching new impressions with existing visual memory (Harpaintner et al., 2020; Sternberg & Sternberg, 2017). The occipital lobe processes visual information like color, location, or motion (Casillo, Luy, & Goldschmidt, 2019; Harpaintner et al., 2020; McMullen et al., 2014). The visual cortex receives signals from the eye on the right side and transmits these signals to the right hemisphere and vice versa (Gazzaniga et al., 2014).

Closely interrelated cell masses form the group of **basal ganglia**, which directly interface with the motor thalamus and are therefore important for the motor system (ten Donkelaar, 2015).

The forebrain is crucial for various functions, especially for processing cognitive and sensory information, executing the motor system, and expanding the memory.

2.1.2. Midbrain

The midbrain is located above the pons. The most important structure is the **reticular activating system** (RAS), which is also designated as "reticular formation”. Main functions of this system are to control the sleep-wake rhythm, consciousness, arousal, and attention. Consequently, the increase in attention and motivation is attributable to the RAS (Morgane et al., 2005). Essential body

functions such as breathing and heartbeat are controlled via this system. The RAS is a complex of neurons located in the brainstem and extended to the hindbrain (Sarter, Bruno, & Berntson, 2006; Sternberg & Sternberg, 2017). The **brainstem** builds the connection from the forebrain to spinal cord and comprises midbrain, pons, cerebellum, and medulla. The physical integrity of the brainstem is significant, as it transmits sensory and motor signals (Gazzaniga et al., 2014).

2.1.3. Hindbrain

The hindbrain consists of cerebellum, pons, and medulla oblongata. The last part of the brainstem is the **medulla oblongata** (Gazzaniga et al., 2014). This section of the brain is involved in digestion, swallowing and in cardiorespiratory function. Furthermore, information from the spinal court is transferred through the medulla. Information from the right side of the brain, which is processed in the left hemisphere, is directed accordingly through the medulla (Sternberg & Sternberg, 2017). The **pons** behaves as bridge transferring neural information within the brain. Furthermore, this structure of the hindbrain is part of the RAS. The **cerebellum** is important for somatosensory and visual-motor coordination (Harpaintner et al., 2020). In this context, the cerebellum is involved in learning motion sequences, of which memory function is a key aspect. Additionally, the cerebellum is crucial for coordination, movement, and balance (Sternberg & Sternberg, 2017).

In order to understand, firstly, structures and functions of cognition and, secondly, neuronal processes as a whole, it is crucial to further investigate social cognitive neuroscience (SCN) and the entrepreneurial mind.

2.2. Social Cognitive Neuroscience Approach

Cognitive neuroscience focus on human behavior in order to receive information about human cognition (Pérez-Centeno, 2017a). Moreover, this

research field examines the linkage between the nervous system and human behavior or cognitive processes (Sternberg & Sternberg, 2017). According to Liebermann: “social cognitive neuroscience uses the tools of neuroscience to study the mental mechanisms that create, frame, regulate, and respond to our experience of the social world” (Liebermann, 2010, p. 143). In other words, this field of research focuses on processes and structures in the human brain that allow individuals to empathize with others and understand their own behavior in their social environment.

SCN encompasses three analysis levels. On the contrary, the cognitive neuroscience and social psychology analyze only two of three levels (Ochsner & Lieberman, 2001). The three levels of analysis are the following:

(1) The social level analyzes social and motivational elements affecting experience and behavior.
(2) The cognitive level analyzes the ability to process information and affects the social level.
(3) The neural level analyzes brain mechanisms and affects the cognitive level.

Table 2 provides an overview of the basic neuroscience concepts. Pérez-Centeno (2017a) mentions the existence of eight disciplines in neuroscience, which are important for research on entrepreneurship: cognitive neuroscience, behavioral neuroscience, affective neuroscience, computational neuroscience, cultural neuroscience, systems neuroscience, neuroinformatics, and finally social neuroscience. In the context of this thesis, the most important ones are cognitive, behavioral, affective, and social neuroscience.

Table 2: Basic concepts of neuroscience

Conceptualization	Definition and Characteristics
Neuroscience (or neural science)	Examination of the development, structure, and action of the nervous system.
Cognitive neuroscience	Transfer of research findings on the behavior and on the brain to comprehend human cognition.
Cognitive psychology	Understand human cognition through research on behavior.
Social neuroscience	Understand biological systems and the respective implementation of social mechanisms and behavior.
Social cognitive neuroscience	Explore mental mechanisms generating, regulating, and responding to experiences in the social environment.

Source: adapted from Liebermann, 2010; Pérez-Centeno, 2017a.

2.3. Research Methods of Social Cognitive Neuroscience

Research methods of neuroscience are striving to get a closer look into the inside of the “black box”. What we truly know about the brain of humans is only a small fraction. Research methods make it feasible to measure and visualize processes in the human brain and therefore start opening the “black box” (Becker et al., 2011; Camerer, Loewenstein, & Prelec, 2005). Various brain-imaging methods as well as methods recording neuronal electric activity provide researchers with a tool to analyze functions, structures, and interrelationships within the brain. This chapter provides an overview of selected research methods helping to understand cognitive processes taking part in an entrepreneurial mindset. Four categories of research methods for entrepreneurship research are thinkable (Pérez-Centeno, 2017b). The first

category directly records electric potentials and magnetic fields related to neuronal firing. Examples for this are magnetoencephalography (MEG) or electroencephalography (EEG) (Bunge & Kahn, 2009). The tools used in the context of the second category indirectly record neuronal activities. An increase in blood circulation and metabolic activity results in an increased neuronal activity. This rise is measured by functional brain imaging methods, such as position emission tomography (PET) or functional magnetic resonance imaging (fMRI) (Bunge & Kahn, 2009). As PET is invasive and therefore not suitable for analyzing the mindset of entrepreneurs, it is not further analyzed in the context of this thesis (see also Pérez-Centeno, 2017b). Methods related to the third category modulate or influence the human brain activity and are referred as "neuromodulator" or "brain stimulator" (Banich & Compton, 2018; Lewis et al., 2016; Pérez-Centeno, 2017b). For example, neurofeedback, transcranial magnetic stimulation (TMS), and transcranial direct current stimulation (tDCS) are applied methods in this category. The fourth category considers optical imaging techniques, such as near-infrared spectroscopy (NIRS), which is non-invasive and suitable to measure light reflection through the scalp (Carter & Shieh, 2015b). In this context, functional near-infrared spectroscopy (fNIRS) is applicable as it combines functional brain imaging and NIRS (Bunge & Kahn, 2009; Pérez-Centeno, 2017b). In the following, the four categories are explained in greater detail and analyzed regarding their suitability for investigating the entrepreneurial mindset. Table 3 provides a summary of selected research methods and additionally highlights corresponding advantages and disadvantages.

2.3.1. Measurement of Physical Activity

The brain receives information in form of chemical and electrical signals. Scientists visualize this information and the corresponding reaction of the brain. Moreover, they record electrical activity of the brain with EEG and magnetic fields with MEG. These two methods allow to obtain information associated with the CNS (Colosio, Bellavitis, & Gorin, 2017). Additionally, these methods are useful to receive detailed information about modifications in neuronal activity.

This is possible because the temporal resolution of EEG and MEG is high and precise in the range of milliseconds. Nevertheless, the spatial resolution is inadequate (Bunge & Kahn, 2009).

EEG is a noninvasive functional brain imaging method that was first discovered by German psychiatrist Hans Berger in 1929. This method is still popular and widely used today, as it measures brain activities in real-time (Bunge & Kahn, 2009). Nevertheless, EEG alone does not create significant images of the human brain. Therefore it is not considered as a real brain-imaging method. Instead, in combination with other brain-imaging methods as for example fMRI, EEG produces a valuable spatial and temporal resolution of brain activity (Carter & Shieh, 2015c). Brain activity is recorded with EEG by placing numerous electrodes on the scalp (e.g. Antonio Zaro et al., 2016; Bunge & Kahn, 2009; Carter & Shieh, 2015b). The intensity and frequency of brain activities are visible as waves of different heights (intensities) and widths (frequencies). The EEG does not record electrical signals of individual cells but of entire brain areas (Sternberg & Sternberg, 2017). The EEG technique provides two forms of information. Firstly, EEG shows the condition of the brain at certain points. This approach considers frequency and time in order to get deeper insights into the signal processing and the condition of the brain. Secondly, the EEG is able to measure modifications of cortical activity induced by particular events occurring within a certain time frame (Colosio et al., 2017). This analysis of event-related potentials (ERP) provides information about the reaction to a cognitive, sensory, or motor incident (Carter & Shieh, 2015c). For example, if a person recognizes the unexpected lighting up of a visual signal, the perception can be recognized as an ERP in the EEG signal. Hence, the ERP method is particularly relevant to receive information about individuals' attention and perception (Woodman, 2010). Moreover, ERP averages out electrical activity in the brain, which is not event-related and hence irrelevant. In contrast, EEG considers and displays these "noises" (Pérez-Centeno, 2017b; Sternberg & Sternberg, 2017; Woodman, 2010). The averaging out of noises allows to identify the signal, which reveals specific neuronal activity

corresponding to cognitive, sensory, or motor incidents (Gazzaniga et al., 2014). Therefore, ERP provides information about which brain area is involved in a specific task and how this task is performed (Holan & Couffe, 2017). Holan and Couffe (2017) mention three overarching objectives of the ERP technique:

(1) Derive temporal aspects of processing and the sequence in which an event is processed.
(2) Identify the influence of (social) factors such as education, gender, or wealth on the response to an event.
(3) Understand reasons and implications of differences in response to an event.

EEG and ERP have been used to study the decision-making process of entrepreneurs, the selective attention of an opportunity and language (Pérez-Centeno, 2017b). Ortiz-Terán et al. (2013) compare non-entrepreneurs and entrepreneurs to analyze the speed of entrepreneurial decision-making. Zaro et al. (2016) use EEG to investigate the behavior of entrepreneurs during the process of identifying business opportunities. How the research method of EEG/ERP can be used for entrepreneurship research is further analyzed in chapter 4 of this thesis.

The MEG measures changes in magnetic fields created by electrical activity of neurons in the brain. The magnetic fields are measured by putting a device over the scalp (Colosio et al., 2017; Sternberg & Sternberg, 2017). This method provides information about the localization of brain activity at a given time. Additionally, MEG has a precise temporal resolution and is therefore appropriate to measure brain mechanisms (Bunge & Kahn, 2009). Nevertheless, MEG is not widely used, as it is very complex, expensive, and difficult to set up. For valuable results, a magnetically shielded room is required where no other magnetic effects could affect the MEG signal and hence the validity of the measurement (Pérez-Centeno, 2017b). In the end, the combination of MEG and other brain-imaging methods, for example fMRI, is a

promising approach to reveal intrinsic networks of the brain. Concerning entrepreneurship research, MEG could be beneficial to understand cognitive processes taking place during entrepreneurial decision-making and the interaction of emotions (Pérez-Centeno, 2017b).

2.3.1. Measurement of Neuronal Activity

An increase in neuronal activity is related to an increase in blood flow and metabolic activity (Bunge & Kahn, 2009). Brain imaging methods, as for example fMRI, make these changes in blood flow visible. fMRI is considered to be predominant in SCN and provides a good temporal resolution plus a precise spatial resolution (Ward, Reeck, & Becker, 2017).

The fMRI scanner measures differences in oxygen concentrations in specific brain areas. Cognitive, sensory, or motor incidents activate different brain areas with a different intensity. The more active a brain area is, the more oxygen-rich blood is needed. Oxygen-poor and oxygen-rich blood exhibit dissimilar magnetic resonances. These variances in oxygen concentrations are measurable and visible by using a fMRI scanner (Cerf, 2017). The surplus of oxygen is measured by the blood oxygen-level dependent (BOLD) signal (Bunge & Kahn, 2009; Pérez-Centeno, 2017a; Ward et al., 2017). With the use of fMRI, brain regions involved in coping with a task are depicted. Therefore, it is possible to link brain topography with specific brain functions (Fox & Raichle, 2007). Nevertheless, this method has a relatively poor temporal resolution, whereby no information about the timing of specific brain activity is generated (Pérez-Centeno, 2017b). Mather et al. (2013) highlight four questions, which can be answered by using fMRI:

(1) Which functions are localized in particular brain regions?
(2) What mental processes are taking place during various tasks?
(3) What stimuli and information is depicted in each area of the brain?
(4) Are two tasks associated with common or different processing mechanism?

Laureiro-Martínez et al. (2014) use fMRI methods to access attention control and decision-making efficiency by comparing entrepreneurs and managers (Pérez-Centeno, 2017a).

2.3.2. Neuromodulation

The research methods of the neuromodulation category can influence or modulate the human brain activity (Banich & Compton, 2018; Lewis et al., 2016). Examples for these brain stimulations or neuromodulations are TMS, tDCS, or neurofeedback. Without disturbing the scalp, these methods manipulate neuronal activity (Pérez-Centeno, 2017b). Moreover, neuromodulation is considered to enhance human attention, cognitive abilities, and memory (Carter & Shieh, 2015a).

When using the noninvasive TMS method, a coil is placed close to the head. This coil creates a brief (less than one millisecond) but intense magnetic field on the surface of the scalp. The current flow is transmitted to the brain and has the ability to depolarize neurons close to the scalp (Lewis et al., 2016). Depending on the brain area and intensity of this magnetic pulse, either stimulation or temporary inactivation of neuronal activity is the result (Carter & Shieh, 2015c). With this method it is possible to compare performance between activated and non-activated brain areas (Gazzaniga et al., 2014). Research on entrepreneurship has not yet been carried out using the TMS technique (Pérez-Centeno, 2017b). Nevertheless it seems appropriate using TMS to study information processing (Amassian et al., 1993), learning, memory (Pascual-Leone, Grafman, & Hallett, 1994), focusing of attention (Ashbridge, 1997), or decision-making (Van't Wout et al., 2005). This particularly favors entrepreneurial research. With regard to the ability of stimulating neurons by using TMS, it might be possible to improve entrepreneurial performance (Pérez-Centeno, 2017b).

The method of tDCS stimulates neuroplasticity in the cerebral cortex by putting two electrodes on the head. These electrodes cause an electric potential difference (Pérez-Centeno, 2017b). Compared to TMS the method of tDCS has neither an appropriate spatial resolution nor a good temporal resolution (Pérez-Centeno, 2017b). Therefore, this method is not discussed in detail in the following.

2.3.3. Optical Imaging

The cerebral surface must be exposed to allow light to pass through. A camera records reflected light rays. The reflection of light changes depending on the activity of neurons. More active neurons show different properties of blood volume, hemoglobin concentration, and oxygen supply. Consequently, the corresponding nerve tissue has different light scattering characteristics.

NIRS is considered as a noninvasive alternative, as light is reflected and recorded through the surface of the brain (Carter & Shieh, 2015c). For this reason, the spatial resolution is reduced (Bunge & Kahn, 2009), whereas the temporal resolution is high (Cutini, Moro, & Bisconti, 2012). FNIRS is a functional brain-imaging method that indirectly records neuronal activity (Bunge & Kahn, 2009). Additionally, this research method can be used to analyze nearly all cognitive functions. FNIRS is considered as a supplement to other imaging techniques, for example fMRI, because further details about specific cognitive functions are obtained (Cutini et al., 2012). According to Centeno (2017b), fNIRS is a promising research method to further analyze entrepreneurship. In particular, to study the memory (Rugg et al., 2008), emotional processing (Glotzbach et al., 2011), attention, and higher cognitive processes (Toichi et al., 2004).

The following Table 3 summarizes the methods presented above. These methods were chosen with regard to their applicability for entrepreneurial research. In addition, these methods were analyzed in terms of their advantages and disadvantages. Theories or models of Neuroentrepreneurship

that are meaningful in the context of this thesis have to be verifiable. It is essential that elements of a model or theory are not speculative. Therefore, the substantiation of a theory based on people's subjective perception is considered speculative. Hence, this thesis refers to models and theories of Neuroentrepreneurship, which can be proven with one of the methods summarized in Table 3.

Table 3: Overview of research methods of cognitive neuroscience

Research Method	**Procedure**	**Advantages**	**Disadvantages**
Electro-encephalography (EEG) in combination with event-related potential (ERP)	Detects changes in electrical potentials with electrodes on the scalp.	• Results less biased by consciousness • Good temporal resolution • Easy to use, portable, noninvasive and less expensive than other methods	• No actual brain images • Not very precise, large number of trials needed • Need to pay attention to noise control • Poor spatial resolution
Magneto-encephalography (MEG)	Measures brain activity through detecting magnetic fields.	• Very precise temporal resolution • Appropriate spatial resolution • Noninvasive	• Expensive, complex, difficult accessibility
Functional magnetic resonance imaging (fMRI)	Measures magnetic field changes due to altered oxygen concentration in the brain. Detects local differences in the BOLD signal and potential correlation with action.	• Marker of mental processes • Link brain topography with specific brain function • Noninvasive	• Stimuli must be repeated • Poor temporal resolution • No information about causal role of specific brain area

Transcranial magnetic stimulation (TMS)	Generates magnetic field through a coil placed on the scalp. Disrupt or stimulate brain area and analyze impact for cognitive functioning.	• High spatial resolution • Appropriate temporal resolution • Identify importance of neural substrate for specific behavior • Noninvasive	• Only reach brain regions on the cortical surface • Could be uncomfortable for participants (sound, pain, distraction) • When misusing potentially dangerous
Functional near-infrared spectroscopy (fNIRS)	Measures blood flow in prefrontal cortex and amount of oxygen in the blood.	• High temporal resolution • Complement to fMRI • Relatively easy to use, portable, less expensive • Noninvasive	• No information about subcortical activity & anatomy • Weaker signal than (invasive) optical imaging

Source: adapted from Colosio et al., 2017; Holan & Couffe, 2017; Pérez-Centeno, 2017b; Sternberg & Sternberg, 2017; Ward, Reeck, & Becker, 2017.

3. Entrepreneurship Research

This chapter provides an overview of entrepreneurship research. The ongoing discussion about a coherent definition is summarized. In the second part of this chapter, three main approaches of entrepreneurship research are presented. In the third part of this chapter theories, which take contemporary influences and challenges into account are discussed. Lastly, cognitive tasks, which are essential for entrepreneurs, are examined.

3.1. Definition of Entrepreneurship

Entrepreneurship is a multidisciplinary research field associated with various factors. Innovation (Schumpeter, 1934), growth (Drucker, 1985), or opportunities (Shane & Venkataraman, 2000; Holcombe, 2003) are attributes considered in a coherent definition of entrepreneurship. Moreover, entrepreneurs are required to react upon valuable opportunities towards achieving desired results (McMullen & Shepherd, 2006). Formation of new processes or products (Schumpeter, 1934), the establishment of new enterprises (Gartner, 1985; Low & MacMillan, 1988), and new market entries (Lumpkin & Dess, 1996) are examples for entrepreneurial activities. The debate on a common definition of entrepreneurship and its theoretical background influences current and future research. Table 4 summarizes proposed definitions of entrepreneurship.

Table 4: Selection of contributions regarding definitions of entrepreneurship

Author(s)	Suggested Definitions of Entrepreneurship
(Knight, 1921)	• Entrepreneur is decision-maker in uncertain environment • Differentiation between risk (measurable as probabilities of outcome are familiar) and uncertainty (not measurable, probabilities unknown)
(Schumpeter, 1934)	• Entrepreneur is innovator and change agent • New combinations as a form of innovation: introduction of new goods, opening of new market, new method of production, new organization of any industry, new source of supply
(Kirzner, 1973)	• Entrepreneur is competitor • Perceive new opportunities through entrepreneurial alertness and achieve market equilibrium
(Drucker, 1985)	• Entrepreneur is innovator • Sources of entrepreneurial opportunities can be either within industry / company or outside company in environment
(Low & MacMillan, 1988)	• Entrepreneur is creator of new ventures • Focusing on “psychological traits” of entrepreneur is not successful because many factors are overlooked
(Gartner, 1985)	• Entrepreneur is creator of new ventures • Focus on process of creating new enterprises
(Stevenson & Jarillo, 1990)	• Entrepreneur is pursuer of opportunities without considering current resources • Pursue opportunities either alone or within company • Entrepreneurship as process requires specific skills, which mostly are teachable
(Lumpkin & Dess, 1996)	• Entrepreneur is newcomer in the market • New entry into established or new markets with new or available services or goods
(Timmons, 1999)	• Entrepreneur is value creator • Combining factors as opportunity, resources and team for business planning

(Shane & Venkataraman, 2000)	• Entrepreneur is explorer, evaluator and exploiter of opportunities • Explore opportunities through individual knowledge and distinctive cognitive traits

Concepts and theories derived from various disciplines are used in order to contribute to entrepreneurial research. The flexible usage of entrepreneurial terminology and theories can be seen as a significant deficit (Shepherd, 2015). Because knowledge is collected from various disciplines, the elaboration of a coherent definition of entrepreneurship is hampered. On the other hand, this is an advantage as entrepreneurship research continues to be relevant and crucial (Wiklund, Wright, & Zahra, 2019).

Friedrich A. Hayek (1937, 1945, 1948) and Ludwig von Mises (1949) supported the idea, that the economic equilibrium is not a prevailing condition. According to this, Schumpeter and other scientists of the Austrian school of economics rejected and criticized the neoclassical theories, which justify static economic equilibrium. The formation of new processes or products refers to the Schumpeterian entrepreneurship. Schumpeter suggested the evolutionary perspective indicating that the economy is dynamic. Consequently, the economy never achieves the same market equilibrium again. Entrepreneurs initiate a creative destruction and therefore continuously disrupt the market equilibrium. Through new and unfamiliar combinations, radical innovations are achieved. Radical innovations by entrepreneurs relocate the status quo whereas the economy reaches a new equilibrium (Schumpeter, 1934, 1942). If this is successful, the risk-adjusted yields are exceeded by entrepreneurial profits (Henrekson & Sanandaji, 2019). The economic theory of evolution refers to the biological evolutionary theory and to the associated mutation, selection, and retention.

Low and MacMillan (1988) proposed the creation of new ventures as starting point for a consistent definition of entrepreneurship. According to them, entrepreneurship research should investigate the process of setting up new

businesses and the respective impact on the economy. Therefore, the activities and behavior of entrepreneurs should be analyzed instead of their individual personalities (Gartner, 1985).

Additionally, entrepreneurship research encompasses the evaluation of opportunities arising from entering new or existing markets. Market entries differentiate entrepreneurial performance from activities that are essential to exploit an opportunity (Lumpkin & Dess, 1996). Besides, Lumpkin and Dess highlighted that entrepreneurship is considered a process. Accordingly, the creation of new ventures (e.g. Gartner, 1985) is not absolutely necessarily, as new entry is rather a comprehensive action where a new business is created either by a start-up company, by an existing company, or by intrapreneurship (Lumpkin & Dess, 1996).

Instead of defining entrepreneurship by outcomes and an entrepreneur's behavior, Shane and Venkataraman include the examination of entrepreneurial opportunities within their definition.

> *"Entrepreneurship is an activity that involves the discovery, evaluation and exploitation of opportunities to introduce new goods and services, ways of organizing, markets, processes, and raw materials through organizing efforts that previously had not existed (Venkataraman, 1997; Shane and Venkataraman, 2000)"* (Shane, 2003, p. 4).

The definition proposed by Shane and Venkataraman is considered as the conceptual definition of entrepreneurship for this thesis. Therefore, the process how entrepreneurs identify, evaluate, and ultimately exploit opportunities is of particular interest regarding entrepreneurship research. Moreover, Shane and Venkataraman suggest the following research questions, which will be further analyzed in the future chapters of this thesis:

> *"(1) why, when, and how opportunities for the creation of goods and services come into existence; (2) why, when, and how some people and not others discover and exploit these opportunities; and (3) why, when,*

and how different modes of action are used to exploit entrepreneurial opportunities" (Shane & Venkataraman, 2000, p. 173).

The main emphasis of this explanation lies on entrepreneurial opportunities. Shane defines entrepreneurial opportunities as following:

"I define an entrepreneurial opportunity as a situation in which a person can create a new means-end framework for recombining resources that the entrepreneur believes will yield a profit" (Shane, 2003, p. 18).

The following Figure 2 represents a version of the entrepreneurial process proposed by Shane. The activities of identifying, discovering, exploiting, and executing entrepreneurial opportunities are influenced by individual, industrial, and macroeconomic factors (Shane, 2003). Moreover, this process includes both, opportunities and individuals, whereas venture creation is complementary but not required for entrepreneurship (Gartner, 2001; Shane & Venkataraman, 2000). This thesis analyzes how the model of the entrepreneurial process proposed by Shane could be extended.

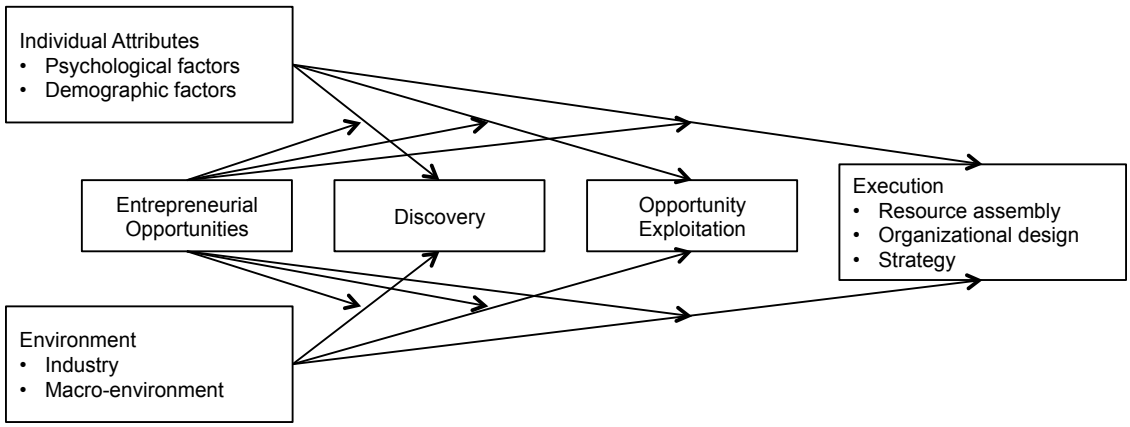

Figure 2: Model of entrepreneurial process
Source: Shane, 2003, p. 11.

3.2. Three Approaches of Entrepreneurship Research

The field of entrepreneurship is multidisciplinary and includes, or even unites, theoretical approaches from other research fields. Therefore, it is essential to

fully understand these approaches and theories in order to make precious contributions to entrepreneurship research (Lohrke & Landström, 2010). This thesis presents the following three main disciplines, which are relevant for entrepreneurship research: economics, social or psychological sciences, and management studies (Stevenson & Jarillo, 1990). Lohrke and Landström categorize these disciplines based on time periods and refer to as “eras of entrepreneurship research” (Lohrke & Landström, 2010, p. 3). According to this categorization, the “economics era” is dated between the years 1870 and 1940. The period between 1940 and 1970 is known as the “social sciences era”. The “management studies era” began in 1970 and continues until nowadays (Lohrke & Landström, 2010). Instead of a time-based categorization, this thesis will focus on content and contribution of these three disciplines and accordingly will use the term “disciplines” instead of “eras”. Thus, scientific contributions that were not published in the corresponding period of a category but were published at a later date can be included. Table 5 summarizes the three influencing disciplines and their respective contributions to entrepreneurship research. Details about these contributions are presented in the following sections.

Table 5: Contributions of three disciplines to entrepreneurship research

Discipline	Economics	Psychology	Management
Main research question	*What* can happen when entrepreneurs act?	*Why* do entrepreneurs act?	*How* do entrepreneurs act?
Focus of research	Entrepreneurship as function of the market Perception of opportunities Creative destruction through innovation	Entrepreneur as an individual with specific traits	Entrepreneurship as process
Research subject	Effects	Causes	Behavior
Investigation level	Economy	Individual	Firm

Source: adapted from (Landström, 2004; Stevenson & Jarillo, 1990, pp. 156–161).

3.2.1. Economics

The discipline of economics investigates *what* happens on the market when entrepreneurs act. Entrepreneurs perceive and exploit opportunities while creating instability and creative destruction. As a result of entrepreneurial behavior, net effects on the macroeconomic system can be identified. The focus of attention lies on, how specific entrepreneurial performance develops the market and shifts the economic equilibrium (Stevenson & Jarillo, 1990).

The origin of the classical economic theory is attributed to Adam Smith. In his work *Inquiry into the Nature and Causes of the Wealth of Nations*, published in 1776, Smith mentioned that capitalists are central actors in the economy. Moreover, he drew no distinction between an entrepreneur who makes decisions and the capitalist who provides monetary flow (Landström, 2004).

One of the first researchers who analyzed the role of entrepreneurs in the market is Richard Cantillon. The idea about the entrepreneur as a person, who has to make risky decisions with uncertain outcomes, is written in the paper *Essai sur la Nature du Commerce en Généra*l (Cantillon, 1730). Moreover, Cantillon emphasized that the willingness to take risk describes an entrepreneur and distinguishes him or her from hired employees (Lumpkin & Dess, 1996; McMullen & Shepherd, 2006). Besides, Cantillon stressed the importance of opportunities, which arise based on the inconsistency of demand and supply side in a market. Accordingly, a market equilibrium can be reached as entrepreneurs pay lower prices for resources, but charge higher prices in the market (Landström, 2004).

Carl Menger initiated with his work *Grundsätze der Volkswirtschaftslehre* the subjectivist perspective of economy (Menger, 1871). This subjectivist perspective states relations between people instead of relations between objects as the main focus of economic phenomena (Landström, 2004). Besides the pure economic concept, this perspective includes cultural and social aspects, which determine entrepreneurial behavior of individuals (Landström, 2004). With his work, Menger is referred to the founder of the Austrian School of Economics. Economical theories and approaches discussed in Europe were recognized and further developed in the United States. Frank Knight for example, was interested in the differences between risk and uncertainty (see Table 4). Correspondingly, uncertainty characterizes entrepreneurship because the probability of an outcome is not familiar. Furthermore, entrepreneurs are risk-takers and the received benefit is considered as incentive and compensation for accepting uncertainty (Knight, 1921).

Similar to Knight, Schumpeter was not convinced of the static view of neoclassical theories. Therefore, Schumpeter established the *Theory of Economic Development*, which considers the entrepreneur of particular importance and refuses the idea that a market equilibrium is the perfect idea for economic systems (Landström, 2004; Oakey, 2015; Schumpeter, 1934).

Instead, new combinations, which Schumpeter called innovations, are the reason for spontaneous and discontinuous changes. These changes disturb the current market equilibrium. Schumpeter distinguished five different forms of new combinations, which will be further discussed in chapter 4. Entrepreneurial innovations change existing circumstances, as the market rewards innovation and thus forces other market participants to adapt. By implementing new combinations, the pioneering entrepreneur paves the way for follow-up innovations. Consequently, a swarm of other entrepreneurs will follow this example. Therefore, successful entrepreneurs exploit the monopoly that is limited in time and take advantage in form of extra rewards before the swarm of entrepreneurs starts imitating and adapting. This process of adaptation leads to creative destruction and market movements, which create a new equilibrium (Andersen, 2012; Landström, 2005).

In the discussion of Schumpeter's theories of the innovative entrepreneur, a distinction is recognizable between the "Schumpeter Mark I" and the "Schumpeter Mark II" model of innovative activities (Stephan, 2013). This conceptual distinction was introduced by Nelson and Winter (1982) as well as by Kamien and Schwartz (1982), who recognized divergences of the second book from the first one. The model of Schumpeter Mark I focuses on the individual entrepreneur as a driving force for economic development. Correspondingly, economic development is the result of an innovative entrepreneur interacting with a routine-based enterprise (Andersen, 2012). Through new combinations an entrepreneur causes disruption and a discontinuous development of the economy (Stephan, 2013). The corporatized innovation is emphasized in Schumpeter Mark II. This model is also referred as "the Schumpeterian hypothesis" (Nelson & Winter, 1982, p. 278) and explains that innovations are made by powerful large organizations due to their environment and context. Therefore, the economic development is the result of an oligopolistic competition among large organizations (Andersen, 2012). This thesis focuses on Schumpeter Mark I, as it highlights and analyzes the innovative entrepreneur as an individual. Schumpeter's view of constant change

and the practice of creative destruction ultimately contests the idea of a static equilibrium (Schumpeter, 1942). The description of the entrepreneur in Schumpeter Mark I model is characterized by radical innovations that initiate discontinuous changes and often a paradigm shift in the industry. As a result, Schumpeter is regarded as the founder of evolutionary economics, which is considered paradigmatic in business and economic innovation theory (Stephan, 2013).

Hayek (1945) and Mises (1949) supported Schumpeter's opinion that the economy is not in equilibrium. Hayek remarked that the phenomenon of imperfect knowledge is missing in Schumpeter's theory (Hayek, 1945). Individuals do not have equal knowledge at the same point in time. As a consequence, specialized and asymmetric information is the reason why not everyone is able to recognize an opportunity (Shane & Venkataraman, 2000). Mises added that entrepreneurs are the economic drivers and consequently outline the market processes through their actions (Mises, 1949).

Inspired by his mentor Mises, Kirzner further developed the existing ideas about entrepreneurship and added recent findings. Kirzner introduced the terminologies "entrepreneurial alertness" (Kirzner, 1973) and "entrepreneurial discovery" (Kirzner, 1997). Entrepreneurial alertness implies open-mindedness towards existing opportunities. Therefore, entrepreneurs are always attentive and spontaneously seeking for new and unexploited opportunities in their environment. Nevertheless, entrepreneurs are constantly looking for new inspirations and discoveries without conscious searching (Kirzner, 1997). Entrepreneurs who have specific knowledge and attributes to recognize a profitable opportunity exert influence on the development of the market (McMullen & Shepherd, 2006). In contrast to Schumpeter, who referred to opportunities that bring the market into disequilibrium, Kirzner stressed the equilibrating function of opportunities. According to Kirzner, the entrepreneur operates in a competitive market and changes the price or output data in order to reach an economic equilibrium (Douhan, Eliasson, & Henrekson, 2007;

Kirzner, 1997). The Kirznerian entrepreneur performs as an arbitrageur who recognizes opportunities due to incongruities in demand and supply. These incongruities arise due to different prices in different markets (Douhan et al., 2007; Kirzner, 2009; McMullen & Shepherd, 2006).

The contributions of the economic discipline characterize the entrepreneurship research up to present days. In summary, two prevailing explanations describe the impact of entrepreneurial behavior on the economy. One group considers that entrepreneurs, by exploiting opportunities or introducing new innovations, disrupt and imbalance the economic market (Schumpeter, 1934). The antithesis constitutes that entrepreneurs reach the equilibrium in the market due to their ability to identify opportunities (Hayek, 1945; Kirzner, 1973; Mises, 1949).

3.2.2. Psychology

In scientific literature, the psychological approach is also referred to as the social science approach. This approach was introduced by McClelland in 1961 as well as Collins and Moore in 1964 to underline the importance of analyzing the entrepreneur as an human being who is influenced by his or her environment, background, and specific motivations (Stevenson & Jarillo, 1990). Moreover, the discipline of social sciences investigates *why* entrepreneurs act the way they do. This discipline is called the “entrepreneurship from its causes approach” (Stevenson & Jarillo, 1990, p. 160) and puts entrepreneurs as individuals in the center of attention. Trait-related theories and cognitive theories are two main research fields analyzed by psychologists in the context of this discipline.

Trait-related theories assume specific personality traits and characteristics as the cause of entrepreneurship. This approach is intended to describe the entrepreneurial personality as the most crucial element in the creation of new businesses (R. K. Mitchell et al., 2002). The contribution of McClelland is pioneering in this context. According to his book *The Achieving Society*, an individual’s motivation determines his or her respective entrepreneurial

behavior. Additionally, an individual's environment determines motivation. Therefore, McClelland analyzed and compared various societies regarding their social and economic growth (Landström, 2004; McClelland, 1961; Stevenson & Jarillo, 1990). He found out that the development of a society is strongly influenced by prevailing norms and values, as for example the need for achievement (nAch). A higher nAch in the society leads to a stronger economic development, which simultaneously reflates the market (Brockhaus, 1980; Perry et al., 1986; Timmons, 1990). Besides, the nAch is a catalyst for entrepreneurial behavior, leading to economic growth (McClelland, 1961). Accordingly, people having a higher nAch are more interested in challenging jobs where cognitive skills are required (Lee & Liu, 2009). Furthermore, people with a high nAch are prepared to take risk, future-oriented, and success-oriented. These characteristics are similar to those relevant to successful entrepreneurship (Rubin, 2011). In general, entrepreneurs are considered moderate risk-takers. Nevertheless, the difference between entrepreneurs and managers, according to their risk-taking propensity, is not statistically significant (Brockhaus, 1980; Busenitz & Barney, 1997). Further, locus of control is one trait considered in entrepreneurship (Brockhaus, 1980; Hull, Bosley, & Udell, 1980). According to locus of control, internal and external characteristics are possible. Internal locus of control means that the behavior of a person is responsible for what happens and thus controls fate. People with external locus of control cannot influence the things affecting them (Wolk & DuCette, 1973). Moreover, entrepreneurs are recognized to be decision-makers accepting ambiguity or uncertainty (Huettel et al., 2006; Schwenk, 1982).

The probability of discovering entrepreneurial opportunities is increased by two factors. Firstly, by access to information that is required to identify opportunities, and secondly, by cognitive properties in order to value and exploit the opportunity (Shane & Venkataraman, 2000). For the purpose of exploiting opportunities it is irrelevant whether entrepreneurs are risk carriers or not (D. K. Sarasvathy, Simon, & Lave, 1998). Rather, it is important to investigate how entrepreneurs deal with risk and make decisions in an uncertain environment.

Unique cognitive properties assist entrepreneurs to value opportunities in circumstances in which other businesspeople see risks and uncertainty (D. K. Sarasvathy et al., 1998). Besides, entrepreneurs rarely utilize counterfactual thinking, failing to envision possible hypothetical outcomes and ultimately not regretting missed opportunities. Additionally, successful entrepreneurs benefit more from their previous mistakes, as they use counterfactual thinking to develop enhanced strategies (Baron, 2004). Entrepreneurs make use of heuristics and analytical thinking which correspondingly support better decision-making and overcoming obstacles (Busenitz & Barney, 1997). Prior entrepreneurial exposure affects intentions, attitudes, and behavior towards the feasibility of new businesses (N. Krueger, 1993).

Entrepreneurial cognition is essential in environments that are characterized by high levels of uncertainty and information overload, novelty, time pressure, or emotions (R. K. Mitchell et al., 2002). In the psychological approach entrepreneurs are analyzed as individual human beings with specific values, motivations, and backgrounds. This approach provides information on how the entrepreneur operates in particular situations, for example in uncertain environments.

3.2.3. Management

The approach of analyzing management studies and the corresponding impact on entrepreneurship research is used to examine *how* entrepreneurs act. The level of investigation is limited to the firm level. In particular, entrepreneurial behavior is analyzed in this approach.

Entrepreneurship is perceived to be a process with various stages of development (Pérez-Centeno, 2017a). Gartner (1985) introduced a framework, which describes the creation of new companies (see Figure 3). Four dimensions interact with each other. This framework accentuates the importance of entrepreneurial behavior. Simultaneously, new firms are organizational entities

developing over time and interacting within their environment in order to search for adequate resources and to stay competitive.

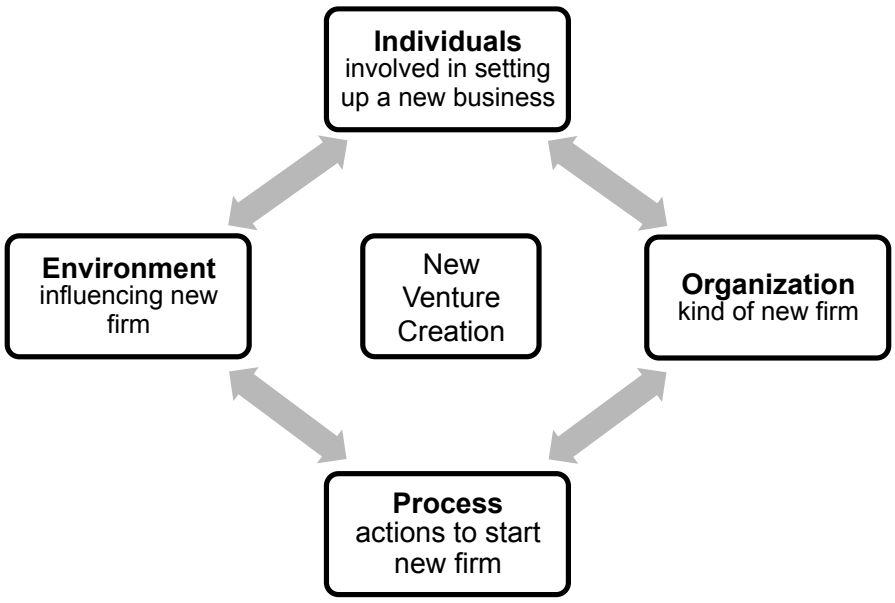

Figure 3: Framework for describing new venture creation
Source: adapted from Gartner, 1985, p. 698.

Due to technological progress and changes in the global economy since the 1970s, smaller firms are considered more efficient than larger companies (Carlsson, 1992). Consequently, new innovations, entrepreneurship, and the creation of new firms were encouraged (Landström, 2004). Researchers focused on entrepreneurial behavior and corresponding success factors during the start-up period of a company (e.g. Carlsson, 1992; Low & MacMillan, 1988). The behavior of entrepreneurs and related establishment of new firms is analyzed and measured along various success factors. Examples for success factors are profitability, managerial decisions, available resources, sales growth, venture strategy, and business environment (Dess, Lumpkin, & Covin, 1997; McDougall, Robinson, & DeNisi, 1992; Mintzberg & McHugh, 1985; Penrose, 1995; Quinn & Cameron, 1983). Researchers analyzed how entrepreneurs are able to achieve their objectives, whereby understanding and improving the entrepreneur's management practice was essential.

In detail, this approach enables to recognize differences between successful firms or entrepreneurs and non-successful ones. Finally, entrepreneurship is recognized as a process in which several variables interact with each other.

3.3. Advancement of Entrepreneurship Research

The behavior of entrepreneurs has changed and adapted to new developments in the economy. Dynamic capabilities, adaptability, innovativeness, and a rapid response to a changing environment are necessary for being competitive in the global economy. Entrepreneurship has allowed the region Silicon Valley to seize opportunities offered by globalization rather than failing to do so. Hence, the Silicon Valley Model is one example for the advancement of entrepreneurship research.

3.3.1. Silicon Valley Model

Radically innovative companies are emerging more frequently and are particularly distinctive for the Silicon Valley. Consequently, as attention is given to extraordinary cases, this region attracted the attention of researchers relatively early. This is also because business cases and data sets were available (Herrmann, 2019). Nevertheless, to empirically prove the characteristics of entrepreneurship is challenging (Fairlie & Chatterji, 2013). The study of specific clusters, where numerous start-ups are founded and entrepreneurs pursue ideas and innovations, is also exemplary for other regions. What makes these regions unique? How do entrepreneurs in these regions differ from others? Why do so many new enterprises emerge in these regions? These research questions are examples for the study of the Silicon Valley. Findings of this examination extend the scope of a coherent definition of entrepreneurship. Besides, the Silicon Valley Model is not only applicable to this specific region and the information technology industry. Additionally, according to the topic of this thesis, it is interesting to derive findings on entrepreneurial behavior and cognitive tasks.

Previously, natural properties, infrastructure, allocation of human capital, and ongoing efforts determined the economic success. This has changed over time as intellectual capital became essential for growth, location, and innovation (Walshok, 2019). The Silicon Valley is considered to be one of the most significant geographical cluster regions that generated numerous successful start-ups. For example, Bill Gates (Microsoft), Mark Zuckerberg (Facebook), and Steve Jobs (Apple) established ventures disrupting the market with new business ideas (Audretsch, 2007, 2019).

The Silicon Valley Model of entrepreneurship particularly focuses on innovation and growth. Moreover, it analyzes radical innovations implemented by high technology firms. These innovations disrupt markets and are therefore considered radical instead of incremental (Audretsch, 2019). Typically, these entrepreneurial opportunities arise due to extensive research and development, for example in the context of research organizations such as universities (Audretsch, 2019).

Three factors are examined within the Silicon Valley framework (Aldrich & Ruef, 2018). The first factor considers firms with high-growth rates (e.g. Aldrich & Ruef, 2018; Engelhardt, 2004; Welter, Baker, & Wirsching, 2019). This leads to economic growth and higher employment rates in the Silicon Valley region. The second factor is about innovative activity. In this context, entrepreneurs are characterized by creativity and inventiveness. Entrepreneurs face resource constraints, as they might have limited access to preferably needed resources. Consequently, entrepreneurs need creative thinking and improvisation in order to find the most appropriate solution to cope with this challenge. This principle of bricolage is essential for entrepreneurs, since they are able to reach the desired goal in a creative way with appropriate resources (Aldrich & Ruef, 2018; Baker & Nelson, 2005). The third factor examines opportunity recognition. Besides high growth rates, creativity, and inventiveness, the focus on recognizing opportunities is essential for successful entrepreneurs (Aldrich & Ruef, 2018). Various researchers, for instance Kirzner, Shane or

Venkataraman, mentioned this aspect in their work. For example, entrepreneurial alertness (Kirzner, 1973) is necessary to discover relevant information and exploit business opportunities.

Furthermore, entrepreneurship, in accordance to the Silicon Valley Model, focuses on technology-driven ventures or entrepreneurs. These ventures characteristically obtain financing through risk capital, as for example venture capital (J. Lerner, Leamon, & Hardymon, 2012). Through venture capital, young and fast-growing companies receive additional (monetary) opportunities, as they are not only dependent on their revenue or bank loans (Engelhardt, 2004). Entrepreneurs compete in the market with radical innovations. On the one hand, these firms are growing rapidly, but on the other hand there is a risk of failure (Herrmann, 2019). The Silicon Valley Model is synonymously referred to as Entrepreneurial Business Model and the start-up business as new technology-based firm or entrepreneurial company (Engelhardt, 2004).

3.3.2. Entrepreneurial Bricolage

Bricolage is getting more important in the contemporary entrepreneurship research. Implementing radical innovations and thereby disrupting an existing business model is partially and in some industries not possible (Beckett, 2016). Nevertheless, entrepreneurial orientation and thus innovativeness and adaptability are crucial for sustainably successful companies. Therefore, exploiting and recombining existing opportunities might be more suitable, especially for small and mid-sized enterprises (SME) (Beckett, 2016). This concept has been described as entrepreneurial bricolage.

Bricolage is derived from French and means “tinkering” or “do handicraft”. This behavior was first described by Lévi-Strauss (1966) and further analyzed by various researchers. Entrepreneurial bricolage explains the process of doing things to identify and exploit opportunities from available resources (Beckett, 2016; Hooi et al., 2016). The resources at hand are combined in a novel way to encourage product or process innovation (Beckett, 2016). Bricolage is

particularly suitable for industries, businesses, and situations, which are confronted with resource scarcity and a deficiency of new resources (Gundry et al., 2011). For this reason, bricolage is recognized as a form of creative improvisation (Baker, Miner, & Eesley, 2003). Moreover, this concept coincides with Schumpeter's view (1934) of seeing new combinations as a form of innovation (Beckett, 2016).

Beckett (2016) suggests a model for the entrepreneurial bricolage process. In Figure 4, five key elements influenced by specific factors are highlighted. The starting point for an entrepreneurial bricolage process is the presence of accessible resources, which mark an opportunity or a need for innovation. The type of innovation imperative influences the resource configuration. Possible imperatives are either urgent changes or changes due to the necessity of the operational environment. An evolutionary combination of resources results in a recombination for a novel purpose, as for example a new technology, process, or business model. An instant combination of available resources satisfies the transient need (make do). Additionally, a subsequent analysis examines what worked and what did not work. Due to that analysis, the resource configuration can be improved (Beckett, 2016).

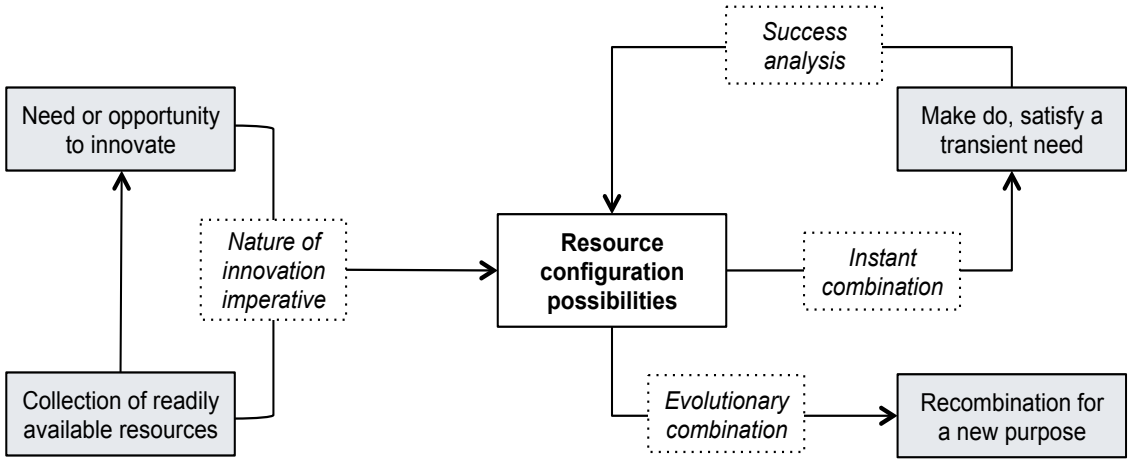

Figure 4: Model of entrepreneurial bricolage process
Source: adapted from Beckett, 2016, p. 3.

Bricolage constitutes a good alternative to radical innovation, which is not always suitable and doable for organizations. Moreover, this concept is considered to be important for future research on entrepreneurial processes (Baker et al., 2003). In particular, for social entrepreneurship, bricolage is an interesting concept as this specific environment is often characterized by limited resources and uncertainty (Gundry et al., 2011).

3.3.3. Contextualization in Entrepreneurship Research

Generally, entrepreneurship is considered as a broad and diverse research field with no coherent definition or framework (S. D. Sarasvathy & Venkataraman, 2011). Contextualization in entrepreneurship fosters the interaction of existing theories and frameworks (Welter et al., 2019; Zahra, Wright, & Abdelgawad, 2014). Furthermore, contextualization is suitable to point out effects of the situation, environment, fortunate coincidence, and the individual person on entrepreneurship. Additionally, fostering contextualization is beneficial in the discussion of opportunity exploitation and opportunity recognition. This approach helps to understand why specific opportunities are recognized, or why certain settings are more conducive to promote entrepreneurship (Zahra et al., 2014). In this context, it is important to investigate varieties and differences, for example in entrepreneurs, locations, industries, or available resources (Welter et al., 2019).

Contextualization is relevant for examining why, when, and how entrepreneurship occurs and who is involved in the entrepreneurial process (Welter, 2011). Zahra et al. (2014) identify five dimensions of entrepreneurial context, which are represented in Figure 5. Completeness and representativeness are assured through including the aspect of various institutions. Either formal or informal institutions overlay the five dimensions of entrepreneurial context and show interactions with each other. Moreover, these five dimensions are interrelated with individual entrepreneurial behaviors. The temporal dimension has been overlooked in past entrepreneurial research (Welter, 2011; Zahra et al., 2014). Besides, path dependency is a crucial

concept in entrepreneurship, as ventures change over time and different actions are required. In this respect, it is worthwhile to analyze how actions taken at the present time influence entrepreneurial decisions in the future. Both, experience and learning influence the behavior and decision-making of entrepreneurs (Baker & Welter, 2018; Welter, 2011; Zahra et al., 2014). Industries at a micro level and markets at a macro level are investigated in the second dimension of contextualization. Crucial for successful ventures is to remain competitive while being a pioneer or becoming internationally active. The consequences of market entry or market exit in a dynamic environment need to be further analyzed in future research (Zahra, 2007; Zahra et al., 2014). The third dimension analyzes the spatial context, such as geography, location, stakeholders, or the assembly of resources. Regarding local availability of resources, entrepreneurs might have limited opportunities, especially in rural areas (Müller & Korsgaard, 2018). Moreover, entrepreneurial mobility influences the internationalization of business. Digitalization limits physical distance, which simultaneously influences the transfer of ideas, capital, and innovations. Additionally, limited physical distance increases cultural exchange, as entrepreneurs receive the opportunity to learn about different cultures and organizations. This experience is recognized as a benefit regarding enlarged knowledge about specific businesses or markets (Zahra et al., 2014). The spatial dimension is strongly interrelated with the social dimension. This dimension analyzes the entrepreneurial ecosystem and network important for competitive advantages (Siqueira & Bruton, 2010; Wiklund et al., 2019). The fifth dimension considers organization, ownership, and governance. These aspects influence decision-making, access to resources, and the exploitation of opportunities (Zahra et al., 2014).

Contextualization in entrepreneurship is relevant for further research. The analysis of the dynamic interplay of different dimensions is crucial for further studies on entrepreneurship. Furthermore, the investigation of the interrelations between environment, timing and structures on the one hand and motivation,

learning and attitude on the other hand is essential to advance entrepreneurship research (Bamberger, 2008).

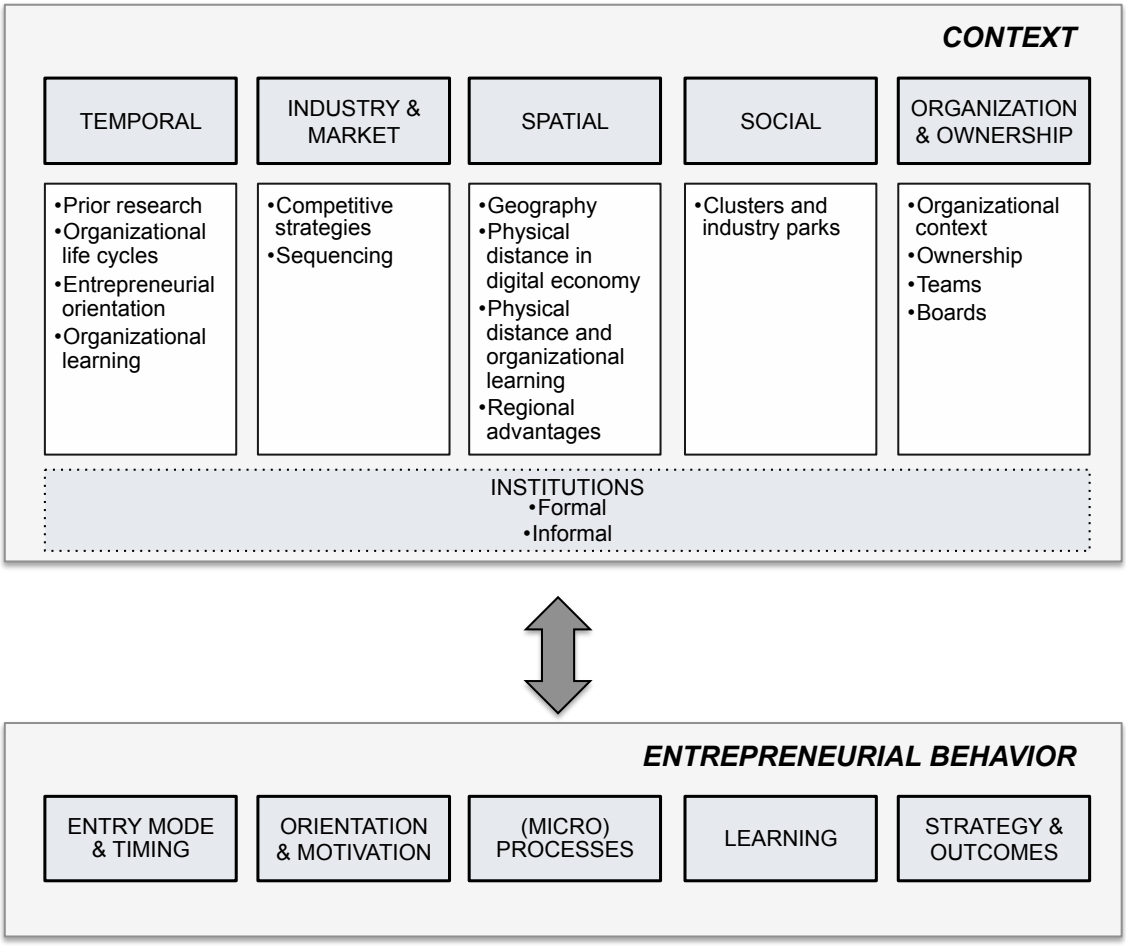

Figure 5: Contextualization in entrepreneurship
Source: adapted from Zahra et al., 2014, p. 483.

3.4. Entrepreneurial Cognitive Tasks

The entrepreneurial mindset is defined by Ireland as: “a growth-oriented perspective through which individuals promote flexibility, creativity, continuous innovation, and renewal” (Ireland, 2003, p. 968). Cognitive abilities allow entrepreneurs to take decisions and exploit opportunities even under uncertainty and ambiguity (Alvarez & Barney, 2002; Ireland, 2003). In the following chapter, three categories exemplify entrepreneurial cognitive tasks.

These categories and further aspects of entrepreneurial cognitive tasks are examined in more detail in chapter 4 of this thesis.

3.4.1. Opportunity Identification and Evaluation

Opportunity evaluation is a cognitive phenomenon and therefore affected by diverse cognitive processes (Keh, Foo, & Lim, 2002; N. F. Krueger, 2000). Additionally, new means-ends relationships occur based on changes in the ecosystem. Hence, it is essential for successful entrepreneurs to have cognitive properties in order to perceive and identify such means-ends relationships to ultimately discover opportunities. These cognitive properties differ between people, which results in different abilities to combine current approaches and information to generate new ideas (Shane & Venkataraman, 2000). Research methods, for instance EEG, are suitable to test differences in cognitive abilities. A reflection of the brain and the cognitive processes involved demonstrates differences between the investigation groups (Holan & Couffe, 2017).

Entrepreneurial alertness is closely related to opportunity identification. Specific skills to process and perceive information are considered as driving forces for identifying entrepreneurial opportunities (Gaglio & Katz, 2001). Moreover, the ability to recognize patterns is a crucial research element. In detail, entrepreneurs identify links between complex changes, events, or trends. Subsequently, they recognize that these links constitute a pattern (Baron, 2007). The Flanker task is a visual exercise that measures the ability of participants to process information and perceive patterns. Two conditions are used in order to conduct a Flanker task. The first condition is a congruent or compatible condition, which can be an arrow directing to the target. In contrast, the incongruent spatial cue is an arrow facing in the reverse direction. This test is examined with the EEG technique and can be combined with ERP (Holan & Couffe, 2017). The Flanker task allows comparing entrepreneurs and non-entrepreneurs regarding their performance, because it is possible to use opportunity-related stimuli as congruent or incongruent conditions. In this way, researchers can use electrophysiological and behavioral methods to determine

whether entrepreneurs have an advantage in terms of readiness or alertness (Holan & Couffe, 2017).

The role of prior knowledge for identifying and evaluating entrepreneurial opportunities is partly unclear. Nevertheless, Shane (2000) states that differences in prior knowledge influence the opportunity discovery. The proactive interference theory can be combined with ERP in order to find out how existing knowledge influences or even impedes learning and information processing of entrepreneurs (Holan & Couffe, 2017).

3.4.2. Acceptance of Ambiguity and Risk

Researchers are interested in comprehending the cognitive neuroscience of entrepreneurial risk-taking behavior. In order to receive valuable research outcomes, the following four research-design criteria are particularly important (Shaver et al., 2017):

(1) Attention to differences between uncertainty, ambiguity, and risk.
(2) Maximization of the opportunity to receive significant results.
(3) Selection of unambiguous concepts.
(4) Avoidance of methodological confusion.

Entrepreneurs are frequently taking decisions with ambiguous results. It is interesting to find out what encourages entrepreneurs to accept ambiguity and uncertainty and consequently take risky decisions. In this context, the conception of reward plays a major role. The Columbia Card Task, a task to test risky decision-making, is appropriate for measuring the willingness to take risk. There is a “hot” and a “cold” version available. The hot version is dynamic, as risk increases during the task. The cold version allows only one selectable decision with a delayed feedback. During this task, activated brain regions are for example the prefrontal cortex and the anterior insula. The study of the Columbia Card Task revealed that the willingness to take risk is not an outcome of a particular personality trait. In fact, various aspects influence risk taking,

which is why it is not recommendable to make conclusions from a single situation (Figner & Weber, 2011; Shaver et al., 2017).

3.4.3. Decision Making

Many researchers focused on entrepreneurial decisions being the result of judging under uncertainty (e.g. Cantillon, Keynes, Marshall, Menger). Nevertheless, McMullen and Shepherd mention that “a decision is a necessary but insufficient condition for the occurrence of entrepreneurship” (McMullen & Shepherd, 2006, p. 134). Krueger and Welpe (2014) emphasize the need for research investigating the entrepreneurial decision to exploit an emerging opportunity rather than analyzing the static character of entrepreneurship. Pursuing opportunities is considered as an evolutionary process, because entrepreneurs make selective decisions after they discovered an opportunity. In addition to that, entrepreneurial motivation plays a key role in human decision-making (Shane, Locke, & Collins, 2003).

The comparison of decision-making efficiency between managers and entrepreneurs and the related neurobiological mechanisms is possible with the fMRI technique. Laureiro-Martínez et al. (2014) examined neural bases in decision-making efficiency. Making quick decisions is essential to react upon occurring changes in the environment (Pérez-Centeno, 2017a). Moreover, Laureiro-Martínez et al. (2014) highlight the importance of switching between exploration and exploitation. This is linked to an activation of brain areas associated with cognitive and attentional control. Additionally, the comparison between managers and entrepreneurs indicated that entrepreneurs indeed achieve the same results as managers, but in less time. This result emphasizes greater decision-making efficiency of entrepreneurs and accordingly, an increase in the frontopolar cortex (Pérez-Centeno, 2017a).

With the technique of EEG, in combination with the Stroop reaction time task, Ortiz-Terán et al. (2013) analyzed personality characteristics of entrepreneurial decision-makers. The Stroop task comprises words in different colors (red, blue,

green) displayed on a computer screen in colors other than the word itself (for example, the word "red" is written in blue). Furthermore, for the purpose of studying entrepreneurial decision-making, scientists studied the relationship between personality characteristics and neurophysiologic characteristics of founder entrepreneurs and non-entrepreneurs. With the help of the reaction time task, it was possible to observe that entrepreneurs make decisions more quickly, both physiologically and behaviorally, than non-entrepreneurs (Ortiz-Terán et al., 2013; Pérez-Centeno, 2017a).

In addition, the decision to exploit an opportunity is based on the consideration of successful outcomes and rewards (Holan & Couffe, 2017). Criteria for deciding and judging a situation are opportunity novelty, worst-case scenarios, and resource efficiency. This concept of rule-based thinking is proposed by Wood and Williams (2014).

4. Neuroentrepreneurship

Neuroscience provides the technology and methodology to further investigate underlying structures that characterize entrepreneurial behavior and thinking (Day et al., 2017). This approach will prove useful in expanding the understanding of the entrepreneurial cognition and emotion (Pérez-Centeno, 2017a).

The first step of entrepreneurship is the identification of an opportunity. Shane (2003) highlights two factors that influence the capability of identifying entrepreneurial opportunities: absorptive capacity and cognitive processes. Successful entrepreneurs evaluate the opportunity, whether it is promising and advantageous to exploit. The second step is the exploitation of opportunities. Entrepreneurial decisions are often marked by uncertainty. The study of entrepreneurial decision-making is important for both, theory and practice. Additionally, the combination of entrepreneurship with neuroscience is promising because research is already accessible (Baron & Henry, 2011; Shepherd, Williams, & Patzelt, 2015; Ward et al., 2017). The third step of the entrepreneurial process is the opportunity capture, which is influenced by individual attributes. Risk and reward play an important role during this stage.

4.1. Nature of Opportunities

Shane (2003) emphasizes the importance of opportunities for the holistic understanding of entrepreneurship. According to his understanding, entrepreneurial opportunities are new means-end frameworks. These new means-ends are a recombination of resources, for example goods, services, and organizing methods to provide a profit for the entrepreneur. Opportunities play a particularly important role in the understanding of Neuroentrepreneurship. The following chapter examines various sources of entrepreneurial opportunities. However, research techniques like fMRI or EEG are not suitable to study the nature of entrepreneurial opportunities. Hence, this

chapter has limitations regarding the value for Neuroentrepreneurship. Nonetheless, in order to fully analyze how entrepreneurs identify, evaluate, and exploit opportunities it is important to clarify where entrepreneurial opportunities arise

Analyzing the source and origin of opportunities is the basic requirement for evaluating the entire entrepreneurial process. The comparison of the two predominant approaches of opportunities examines how various opportunities vary regarding their value, form, and their derived entrepreneurial actions (Shane, 2003). In addition to that, seven sources from Drucker (1985) and three categories from Shane (2003) are presented.

4.1.1. Comparison of Schumpeterian and Kirznerian Opportunities

The Schumpeterian and the Kirznerian opportunities constitute two predominant perspectives of entrepreneurial opportunities. These approaches mainly differ in terms of the need for new information to perceive and exploit opportunities. Schumpeter (1934) clearly supported the view that new information forms the basis for entrepreneurial opportunities. Political, technical, regulatory, social, and macro-economic changes constitute new information for entrepreneurs. Entrepreneurs make use of this information to consequently discover new ways of recombining resources and creating valuable outcomes. Through recombining resources, new information modifies the value of resources and thus increases their equilibrium price. The available information enables people to buy resources for a lower price and, after recombination, sell the valuable result to potentially make profit. Information is generally not perfectly distributed and shows differences in its temporal distribution. Consequently, individuals receiving information about resources in advance have the option to exploit these opportunities, buy resources for a lower price, and ultimately make an entrepreneurial profit (Schumpeter, 1934; Shane, 2003; Shane & Venkataraman, 2000). On the other hand, Kirzner (1973, 1997) promotes the opinion that new information is not required for creating entrepreneurial opportunities. Instead of new information, entrepreneurial opportunities require

variations in access to available information. In detail, market players make use of available information to speculate about the value of resources. Individuals make decisions based on assumptions, intuition, correct information, and inaccurate information. This process probably leads to wrong decisions. These incorrect decisions cause surpluses, shortages, or incorrectly allocated resources. As a consequence, individuals have the opportunity to buy resources at a low price, recombine them and sell them at an increased profit value (Craig & Johnson, 2006; Kirzner, 1973, 1997; Shane, 2003; Shane & Venkataraman, 2000). Moreover, the Kirznerian and Schumpeterian idea of opportunities differ regarding the impact on the economy. The Kirznerian opportunity brings the market into equilibrium, whereas the Schumpeterian opportunity results in disequilibrium in the market. According to the Schumpeterian perspective, innovations disrupt the market. In contrast, the Kirznerian perspective is less innovative and strengthens established practices. Due to the very innovative nature, Schumpeterian opportunities occur less often than Kirznerian opportunities (Chiles, Bluedorn, & Gupta, 2007; Shane, 2003).

Nevertheless, Shane and Venkataraman (2000) support the idea that both, Schumpeterian and Kirznerian opportunities are simultaneously available in the market. As Kirznerian opportunities are less innovative and occur more often than Schumpeterian opportunities, they are considered to pose lower risks. In addition to that, entrepreneurs exploiting Schumpeterian opportunities are characterized as decision-makers who are capable of breaking away from the routine and recurring work of the well-known possibilities (Craig & Johnson, 2006; Shane, 2003). This kind of decision-making can be associated with various characteristics, for instance with overconfidence, goal-orientation, or optimistic thinking (Bernardo & Welch, 2001; McMullen et al., 2014).

4.1.2. Sources of Entrepreneurial Opportunities

In the following section, seven sources of entrepreneurial opportunities mentioned by Drucker (1985, 2002) are presented. These sources are divided into two sections. Four sources arise within an industry or company and three

sources arise in the environment due to intellectual or social changes. Sources arising *inside* an industry or company are the following: unexpected occurrences, incongruities in demand and supply, process needs, and industry and market changes. In addition to that, sources arising in the environment and therefore *outside* of an industry or company are the following: demographic changes, changes in perception, and new knowledge (Drucker, 1985).

Shane and Venkataraman (2000, p. 175) summarize these seven sources in the following three categories:

(1) “The creation of new information”: inventing new technologies results in new information.
(2) “The exploitation of market inefficiencies”: information asymmetry resulting from differences in time and location leads to market inefficiencies. Exploiting these inefficiencies can be beneficial for individuals.
(3) “The reaction to shifts in the relative costs and benefits of alternative uses for resources”: due to changes in politics, regulation, or demography, the individual entrepreneur can use resources in a different way and profit from modifications in relative costs.

Shane (2003) emphasizes that there is much more knowledge about Schumpeterian opportunities than there is about Kirznerian opportunities. This is justified by the argument that Kirznerian opportunities arise due to wrong decisions by other market players. These wrong decisions occur frequently and everywhere, which increases the complexity for researchers to analyze their actual sources. Therefore, Shane (2003) focused on Schumpeterian opportunities and derived three different categories of sources. As this thesis adopts the definitions of opportunities and entrepreneurship proposed by Shane, the three categories are considered as reliable basis. Moreover, the aforementioned sources are still relevant even in an increasingly digitalized world. Additionally, it is possible to adopt and extend the scope of categories

and include individual sources for a specific industry or company. These three sources of entrepreneurial opportunities stated by Shane (2003) are political/regulatory changes, technological changes, and social/demographic changes.

Opportunities arising from technological changes enable the development of new goods and services. Entrepreneurs combine resources, information and competences in a new and more effective way. Thus, entrepreneurs discover new opportunities, detect the needs of market participants, and the need of potential customers (Companys & McMullen, 2007; Shane, 2003). Opportunities from technological changes result, for example, in product innovations (Ahuja & Katila, 2004; Beckman et al., 2012; Henderson & Clark, 1990), or in general improvements in technology, process, and knowledge (Shane & Venkataraman, 2000; Toms, Wilson, & Wright, 2020). Nevertheless, the availability of opportunities arising from technological changes may vary depending on the industry, company, or country (Shane, 2003).

Political and regulatory changes allow entrepreneurs to reallocate available resources and consequently, to discover new procedures, techniques, and usages. Regulations or deregulations create opportunities for entrepreneurs to enter a new market, a new industry, and to get access to new capital (Shane, 2003; Toms et al., 2020). Additionally, political changes influence the entrepreneurial opportunity process. For instance revolutions, lobbying, governance structures, and sifts in demand have influence on the existence of entrepreneurial opportunities (Companys & McMullen, 2007; Shane, 2003).

Lastly, social and demographic changes are an essential source for opportunities. These changes generate the opportunity for economies of scale through generating additional demand. For example, urbanization, educational infrastructure, and population dynamics are sources in this category (McMullen, Plummer, & Acs, 2007; Shane, 2003).

4.2. Opportunity Discovery

Referring to the entrepreneurial process model proposed by Shane, entrepreneurship research examines how entrepreneurs discover opportunities and accordingly identify and evaluate them. The following discusses which factors (e.g. experiences, traits, individual capabilities, and cognitive processes) empower the entrepreneur to perceive opportunities in the environment (Ward et al., 2017). McMullen et al. (2014) determine four paradigms that are included in the opportunity identification system (see Figure 6). This system has two dimensions. The first dimension indicates the locus of origin and analyzes whether the stimulus is internal or external. The second dimension analyzes whether characteristics in entrepreneurial reasoning, thinking, and behavior are of temporary or permanent nature. The four paradigms are not exclusively relevant for the discovery and evaluation of opportunities, but also for the phases of opportunity exploitation and opportunity capture in the entrepreneurial process model.

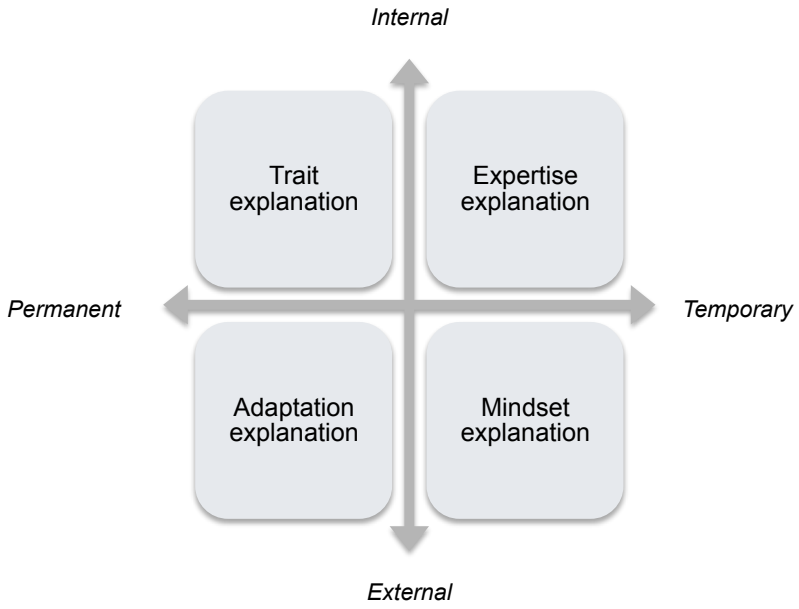

Figure 6: System for opportunity identification and theories of the mind
Source: Holan & Couffe, 2017, p. 112.

4.2.1. Trait Explanation

The trait explanation is the internal-permanent paradigm and therefore analyzes internal attitudes as genetics or personality traits. Related research questions mentioned by McMullen et al. are: “Who is an entrepreneur? What personality traits make entrepreneurs unique? Do particular personality traits encourage individuals to become entrepreneurs? Are these traits responsible for entrepreneurial success?” (McMullen et al., 2014, p. 19)

The trait explanation is one of the earliest attempts in explaining the phenomenon of entrepreneurs. The existence of personality traits associated with entrepreneurial action and in this context, the existence of an “entrepreneurial gene” has been discussed in past research (e.g. Leutner et al., 2014; Nicolaou & Shane, 2014; Rauch & Frese, 2007; Zhao & Seibert, 2006). Critical is the fact that personality traits are difficult to prove by using research methods as fMRI or EEG. Moreover, specific traits are not considered to be exclusively relevant for entrepreneurial behavior and action (Shaver et al., 2017). Aldrich predicted the “empirical dead end” for research on entrepreneurial traits (Aldrich, 1999, p. 76). Nevertheless, studies, for instance about the Big Five personality dimensions, are still considered and extended in order to make personality traits provable (Obschonka & Stuetzer, 2017; Zhao & Seibert, 2006). In this context, McMullen et al. (2014) suggest to examine how, when, and why personality traits influence entrepreneurial behavior and thus the discovery of opportunities. Moreover, empirical experiments need to be established in order to set linkages between personality traits and cognition and therefore analyze entrepreneurial action. Two populations are formed, whereby one group indicates high values in a specific personality trait and one group indicates low values in this personality trait. Neuroscience supports this approach by comparing people with and without specific personality traits and by detecting brain regions that are active during entrepreneurial activities. Based on the premise that personality traits are associated with diverse cognitive tasks, neuroscience supports this comparison. A specific brain structure, detected with research methods, could be more susceptible to the

discovery of opportunities. Comparing these two populations suggests that differences in brain activity are related to certain personality traits and thus result in different entrepreneurial actions (McMullen et al., 2014).

Personality neuroscience attempts to comprehend sources of traits in the human brain and to reconstruct corresponding cerebral processes back to their origin (DeYoung & Gray, 2009). The Big Five personality dimension is a framework relating entrepreneurial performance to personality traits. Hence, this framework is suitable to find out and examine these traits (Shaver et al., 2017). These five personality dimensions are: extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience (McCrae & Costa, 1985, 2004). Previous research indicates a correlation between entrepreneurial cognition and the Big Five personality dimensions (Bajwa, Shahzad, & Aslam, 2017; Botha & Morallane, 2019). Studies that investigated the Big Five personality traits of entrepreneurs consider, for example, venture survival (Ciavarella et al., 2004), or entrepreneurial statues (Zhao & Seibert, 2006). Zhao and Seibert (2006) compared managers and entrepreneurs and discovered that, on average, entrepreneurs show higher values in openness to experience and in conscientiousness. Additionally, entrepreneurs show lower values in agreeableness and neuroticism (Shaver et al., 2017). This study could be a base for applying research methods and relate these finding to specific brain areas. Research studies using fMRI show that extraversion is linked with an increase in the activity of, for example, the amygdala (Canli et al., 2002; Cohen, et al. 2005), the temporal cortex in the right hemisphere (Canli et al., 2001), and the orbitofrontal cortex (Cohen et al., 2005). Applying these findings on entrepreneurship research would propose that people with high values in extraversion show higher activities in brain regions supporting rewarding (Cohen et al., 2005). Therefore, these people will more likely discover opportunities as they are hoping for a reward and accept risky decisions (DeYoung et al., 2010; McMullen et al., 2014). Moreover, the personality trait conscientiousness is relevant for decision-making and exploitation of opportunities. This trait motivates the person to plan ahead (McMullen et al.,

2014). Glucose, as the source of energy for the brain, is essential for conscientiousness. The prefrontal cortex is inter alia responsible for decision-making and effortful processes as cognition and learning (Gailliot & Baumeister, 2007; Gailliot et al., 2007). The amount of glucose in blood can be measured by using fMRI. Therefore, brain regions that are more active during conscious activity are identified. People with constant supply of glucose are more conscientious and consequently more likely to exploit opportunities successfully. In contrast, consciousness has a negative impact on impulsivity, which limits the probability of discovering opportunities

Particularly, by combining research findings on entrepreneur's personality traits and brain structures associated with specific personality traits, entrepreneurial cognition can be further analyzed. Research elements of the trait explanation must be verifiable with experiments such as fMRI in order to justify scientific validity for Neuroentrepreneurship

4.2.2. Adaptation Explanation

The adaptation explanation is the external-permanent paradigm of the opportunity identification system by McMullen et al. (2014). Research questions deal with examining cognitive skills required for identifying entrepreneurial opportunities and adapting to changing requirements (McMullen et al., 2014).

Research suggests that entrepreneurs are able to perceive patterns and connections between environmental changes through their cognitive framework. This pattern recognition plays an important role in interpreting perceived information from the environment and in identifying opportunities (Baron, 2006; Shane, 2000). Processing perceived information and accordingly evaluating and visualizing the meaning of this information influences the interpretative judgment (McMullen, 2010; Mcmullen et al., 2014; Mitchell et al., 2000). Entrepreneurs are attentive and decide which change is most promising (J. R. Mitchell & Shepherd, 2010; Shepherd, McMullen, & Jennings, 2007). Dynamic and metacognitive capabilities are essential in adapting to changes, learning

quickly, and reorganizing current knowledge in order to cope with new challenges (Haynie et al., 2010; Lecler & Kinghorn, 2014). These capabilities support the identification and evaluation of entrepreneurial opportunities. In addition, activities based on these capabilities activate particular brain areas, which are detectable by neuroscience.

The anterior cingulate cortex (ACC) is associated with effortful processing, attention, action selection, and conflict monitoring (Botvinick, Cohen, & Carter, 2004; Segalowitz & Dywan, 2009; Shenhav, Botvinick, & Cohen, 2013). Therefore, this brain structure plays a major role in discovering and evaluating entrepreneurial opportunities. ACC signals the emergence of conflicts in processing information. Compensatory adjustments in cognitive control are initiated by this conflict (Botvinick et al., 2004). Error-related negativity (ERN) is a component of ERP studies and reveals differences in error processing between non-entrepreneurs and entrepreneurs. ERP studies inspect the attitude that successful entrepreneurs learn from mistakes to improve their performance. The ERN-signal appears when the participant commits an error, even if he or she is not aware of it. Through a motor response participants give feedback to the appearing event. The ERN of entrepreneurs indicates shorter latencies or higher peaks (Holan & Couffe, 2017; Segalowitz & Dywan, 2009). Through the usage of EEG, the ERN-signal confirms that occurring errors are perceived in the ACC. Moreover, this extends the scope of entrepreneurial alertness (Kirzner, 1973). Changes in the environment distort previous assumptions about valuable means-ends. Based on that, an individual makes wrong decisions. The sensitive ACC detects wrong behavior and helps adapting to changes through dynamic cognitive capabilities. Additionally, the ACC supports the transformation of intentions. Through choosing the appropriate action plan ACC reinforces the achievement of set objectives (McMullen et al., 2014). Using fMRI is also useful to analyze the activities in the ACC (Amiez et al., 2012). Moreover, the Flanker task can be combined with ERN and is frequently used to get insights in the neuronal response to error commission (Botvinick et al., 2004). The Flanker task supports comparing entrepreneurs and

non-entrepreneurs concerning their performance, as it is possible to use opportunity-related stimuli as congruent or incongruent conditions (Holan & Couffe, 2017). Activation in the ACC has been observed when incongruent conditions occurred. This condition replicated a conflict between the error response and the correct response (Botvinick et al., 2004).

4.2.3. Expertise Explanation

The third paradigm explains internal-temporary expertise. This considers questions about the role of knowledge, expertise, and day-to-day learning in opportunity discovery and later in opportunity exploitation (McMullen et al., 2014). In general, experience and knowledge influence considerations of an opportunity (Haynie et al., 2010; N. F. Krueger, 2000; J. R. Mitchell & Shepherd, 2010). Differences in knowledge about technology and the market differentiate individuals and thus their competencies to discover and evaluate an opportunity (Wood & Williams, 2014). Proactive interference and the effect of prior knowledge (Shane, 2000) on the detection of discrepancies is not clear and still in discussion. Proactive interference analyzes processing and learning of new information based on pre-existing knowledge. By using the ERP method, it is possible to compare entrepreneurs and non-entrepreneurs (Holan & Couffe, 2017).

Of particular relevance for the opportunity identification is the default-mode network. The default-mode network is a brain region, which shows increased activity during phases of reflection and resting. In contrast, the activity of this particular brain area decreases while people are active and engaged in tasks. However, Ward et al. (2017) mention that entrepreneurship research has not fully inspected brain activity of the default-mode network at rest. Research has focused more on analyzing what happens when entrepreneurs are active. Further examination of default-mode network by using fMRI provides insights into proceedings before an opportunity is identified. Besides, processes in the entrepreneurial mind during resting can be further analyzed (Ward et al., 2017). In anatomical terms, this brain region comprises the posterior cingulate cortex

(PCC), inferior parietal lobe (IPL), ventromedial prefrontal cortex (VMPFC), lateral temporal cortex (LTC), and dorsal medial prefrontal cortex (DMPFC) (Buckner, Andrews-Hanna, & Schacter, 2008). The VMPFC is responsible for emotional decision-making and the related evaluation of likely rewards for future behavior (Ward et al., 2017). The analysis of the activation of the VMPFC from entrepreneurs at rest provides insights into the thinking about opportunities. In addition, it is possible to reveal differences between entrepreneurs and non-entrepreneurs. The fMRI study could provide details why entrepreneurs take an opportunity despite the risk of failure. Alternatively, it would be possible to analyze cognitive processes of entrepreneurs in dealing with uncertainty and risk (Ward et al., 2017). The default-mode network is considered to be important for reviewing the past and pondering the future (Andrews-Hanna et al., 2010; Raichle & Snyder, 2007). Additionally, Ward et al. describe the default-mode network as “introspective, stimulus-independent, self-directed thinking” (Ward et al., 2017, p. 131). The default-mode network is elementary to understand processes happening before an opportunity is identified. Therefore, the entrepreneur considers possible future events influencing the decision-making. The possibility of comparing activations of the default-mode network of various populations could show the importance of this brain structure for entrepreneurship research. The comparison of entrepreneurs, non-entrepreneurs, successful entrepreneurs, company founders, the impact of gender, ethnicity, status, and education can be pursued (Ward et al., 2017).

4.2.4. Mindset Explanation

The fourth paradigm is the external-temporary mindset explanation, which states that entrepreneurs differentiate because of their “entrepreneurial mindset” (Haynie et al., 2010). The mindset explanation answers research questions considering the unique mindset of entrepreneurs, which encourages them to identify, evaluate, and exploit opportunities. Moreover, this paradigm considers influences and circumstances forming the entrepreneurial mindset (McMullen et al., 2014). The pronounced distinctive mindset enables to comprehend and act quickly, even under uncertain circumstances (Ireland, Hitt,

& Sirmon, 2003). Further, this unique mental attitude allows to interpret new information (McMullen et al., 2014). Entrepreneurs are considered to be self-confident, success-oriented, and optimistic about their future achievements (Hayward, Shepherd, & Griffin, 2006; McMullen & Kier, 2016). Thus, “enterprising individuals” (Shane, 2003) demonstrate factors that differentiate them from other populations and ultimately influence the entrepreneurial process.

In order to explain the entrepreneurial mindset, it is essential to analyze risky decision-making processes and consequently brain areas relevant for such decisions. Additionally, differences between risky decisions for gains and risky decisions for losses are considered and analyzed with the use of fMRI. This analysis highlighted that the VMPFC and the striatum, which is part of the subcortical basal ganglia, are both involved in risky losses and gains. Nevertheless, these structures are involved to varying degrees in decision-making processes for profits and losses (Levin et al., 2012). The involved striatum and the amygdala are associated with firstly automatic reactions approaching positive stimuli and secondly automatic reactions avoiding negative stimuli (Cunningham et al., 2010; Ernst & Fudge, 2009; Schlund & Cataldo, 2010). Particularly, the amygdala is associated with individual variations in action orientation, risky decision-making, and fear-driven behavior (Davis & Whalen, 2001; Schlüter et al., 2018). Nonetheless, no subcortical structure processes only negative or positive stimuli (Carretié et al., 2009). The prefrontal cortex controls approach-avoidance reactions (Ernst & Fudge, 2009). Both systems, the prefrontal cortex for approach-avoidance and the amygdala for action orientation, cooperate complementarily and therefore enable successful opportunity identification and exploitation (McMullen et al., 2014).

4.3. Opportunity Exploitation

In accordance with the entrepreneurial process model by Shane (2003), the discovery of opportunities is followed by the exploitation. Many decisions are

made during this stage. The entrepreneurial decision-making process is characterized by the interaction between characteristics of the decision-maker and particularities of the situation he or she is confronted with. The situation in which entrepreneurs imagine to find themselves is determined by factors that they consider being relevant (Lucas, Vermeulen, & Curseu, 2008). Figure 7 represents this interplay between environment and decision-maker. Further, it becomes evident which decisions are relevant in the entrepreneurial process. As uncertainty plays a major role in entrepreneurial decision-making, heuristics and biases influence this process and increase the efficiency and effectiveness of decision-making (Busenitz & Barney, 1997).

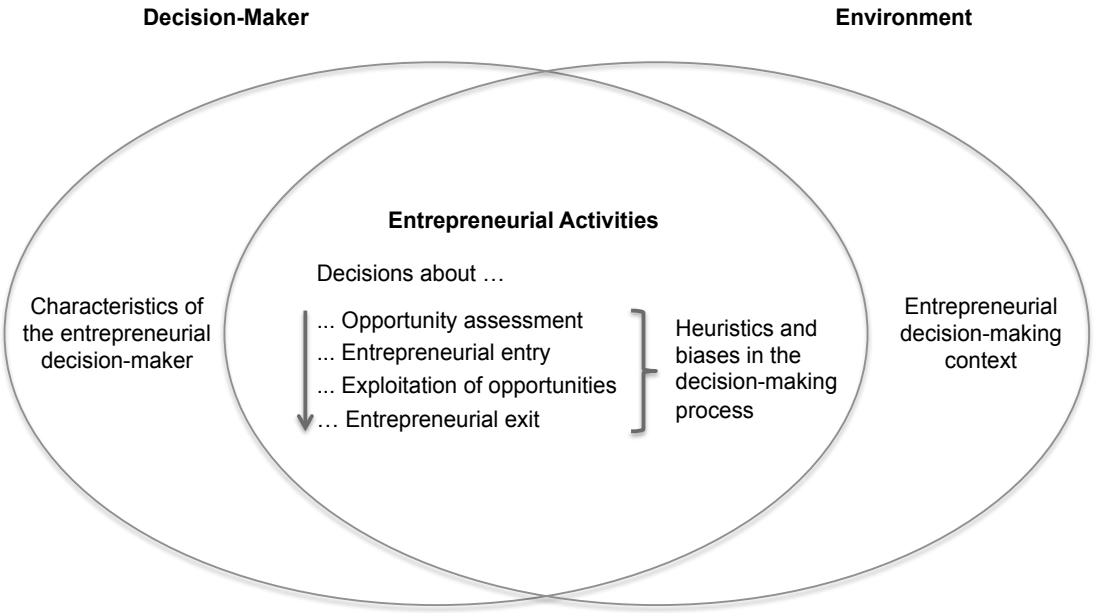

Figure 7: Entrepreneurial activities associated with decision-making
Source: Shepherd et al., 2015, p. 14.

4.3.1. The Role of Affect in the Decision-Making Process

Affect has an influence on decision-making, especially in uncertain situations (J. S. Lerner & Keltner, 2001). Entrepreneurs face these uncertain situations regularly, for example when making decisions about new ventures, market entry or exit, and the exploitation of opportunities (Shepherd et al., 2015). Two forms of affect are particularly considered in the respective literature. The first form is dispositional affect. Due to individual traits people constantly experience

positive or negative feelings. The second form is the event-related affect. This is a temporary state of feelings and moods (Baron, 2007; Baron & Henry, 2011). In the following section of this chapter, reference is made to the term affect, whether the origin of affect is stable or event-specific. In addition, a distinction is made between affect and emotions. Emotions are longer lasting, more intense, and show a broader spectrum (Baron, 2007).

As affect impacts cognition and behavior, it is reasonable that affect has also consequences for entrepreneurship. There are two reasons for doing so. Firstly, entrepreneurs operate in a rapid changing environment, which consequently encourages the impact of affect on behavior and cognition (Lichtenstein, Dooley, & Lumpkin, 2006). Secondly, affect influences behavior regarding entrepreneurial tasks. In detail, affect influences entrepreneurial creativity, and therefore opportunity recognition. Further, affect influences the establishment of business relations, persuasion, acquisition of resources, judgment, decision-making, and business strategies (Baron, 2007, 2008; Baron & Henry, 2011; Ireland et al., 2003). Additionally, Baron (2007) identified potentially negative and beneficial impacts on the entrepreneurial affect. In particular, important under the aspect of decision-making are the following impacts. Firstly, positive affect results in being enthusiastic, expressing enthusiasm, and getting attention of others. This in turn has a positive influences on the procurement of resources (e.g. Civettini & Redlawsk, 2009). Secondly, entrepreneurship is often characterized by making decisions under uncertainty and high pressure. Individuals who show a high level of positive affect perceive satisfaction faster. This causes people to make quicker and more efficient decisions in limited time and without having all information. Finally, affective states influence entrepreneurial behavior and decision-making. Combining the existing knowledge about affective states with cognitive frameworks provides a more holistic understanding of entrepreneurial opportunity exploitation. In addition, aspects such as pattern recognition, flexible thinking, and creativity resulting from positive affect strengthen the process of discovering opportunities (Bechara & Damasio, 2005; Camerer et al., 2005; Hayton & Cholakova, 2012).

Applying neuroscience on this research field reveals new correlations, insights about decision-making processes, and the entrepreneurial performances (Ward et al., 2017). The use of fMRI made it possible to examine affective states and cognitive processes involved during the “ultimatum game”. This simulates economic decision-making and therefore underlines the game theory (Sanfey et al., 2003). In this game two participants have to share any amount of money (e.g. ten dollars). Person A, the proposer, receives the entire amount and is allowed to decide how much he or she gives to person B. Person B, the responder, can either reject or accept the offer. If the responder declines the proposal, neither of the two participants receives any money and the game is over. With a rational choice of the responder, he or she would accept every positive offer, since any amount of money is better than none (Baron, 2007; Hayton & Cholakova, 2012; Sanfey et al., 2003). Nevertheless, observations showed that a significant percentage of respondents reject any proposal below five dollars and most reject proposals below three dollars. This experiment shows that there are conditions in which individuals are encouraged to actively renounce financial rewards (Sanfey et al., 2003). Furthermore, this experiment and the application of neuroscience emphasize the correlation between refusal of offers and the emotional brain area. By using fMRI, scientists compared the reactions of responders to fair (equal division of the money) and unfair (proposed amount is less than 50%) situations. Unfair offers cause a collision between emotional ("reject") and cognitive ("accept") motives in the responder. Additionally, affective processes invalidate rational cognitive processes (Hayton & Cholakova, 2012; Nicolaou et al., 2019). In the case of unfair offers, brain regions that are connected with cognitive (e.g. the dorsolateral prefrontal cortex) as well as emotional (e.g. the limbic system) processes are activated. Furthermore, the probability that the responder will decline the offer will increase when a brains’ emotion-processing areas are active (Baron, 2007). The activation during unfair offers increases in the ACC, dorsolateral prefrontal cortex, and in the bilateral anterior insula. The bilateral anterior insula is considered to be relevant for negative emotions such as pain, hunger, anger, and autonomic arousal. Hence, an unfair proposal correlates with the activation

of anterior insula and arouses negative emotions, which ultimately lead to the rejection of this specific offer (Hodgson et al., 2012; Sanfey et al., 2003). The prefrontal cortex is associated with reflection on actions of other people and makes assumptions about future actions (Hodgson et al., 2012). Moreover, the prefrontal cortex is relevant for cognitive tasks such as achievement of objectives and implementation control. Consequently, the prefrontal cortex' activation may also be associated with cognitive processes during the game to increase profit. The acceptance of an offer results from a higher activation in the prefrontal cortex compared to the anterior insula. The rejection of an offer is caused by higher activation in the anterior insula and lower activation rate in the prefrontal cortex. To sum up, these findings support the hypothesis that there is competition between emotional and cognitive processes or, regarding brain areas, between the anterior insula and the prefrontal cortex during decision-making (Sanfey et al., 2003).

Further, analyzing and expanding the existing research on Neuroeconomics, which applies neuroscience on business decision-making, provides valuable analogies for entrepreneurial decision-making. The ultimatum game is equally relevant for entrepreneurship, as this game theory examines the decisions that an entrepreneur has to deal with. Besides, this theory emphasizes the influence of affect. The results of this game theory provide further insights into an entrepreneur's decision to exploit an opportunity. The entrepreneur has to evaluate offerings and consequently think about his or her profit and benefit. The involved cognitive and emotional processes are similar to those explained in the game theory. The possibility to analyze affective decision-making through the use of neuroimaging contributes to analyze the influence of affect on entrepreneurial decisions, such as entering new markets, creating a venture, and acquiring resources (Ward et al., 2017).

4.3.2. Experiential and Rational Processes in Decision-Making

Drawing conclusions from the available and emerging information requires a special system of reasoning, decision-making, and judgment. Entrepreneurs

discover opportunities and either decide to exploit them or not. This process comprises two complementing systems, explained by the dual-process theory (Sternberg & Sternberg, 2017). The dual-process theory is also described as System 1 and System 2 (Stanovich & West, 2000), or metaphorically as “two minds in one brain” (Evans, 2003, p. 454). Depending on which system is currently active, the interpretation and perception of reality varies. In this context, it is interesting to find out whether entrepreneurs use System 1 and System 2 differently in a decision-making process than non-entrepreneurs. The accomplishment of an fMRI study to analyze parallels between the two systems and activated neural networks could be beneficial in answering these and related questions (Ward et al., 2017). In particular, as entrepreneurs are regularly confronted with uncertain situations, it is relevant to find out how and with which system they interpret circumstances.

System 1 is the associative system that is characterized as intuitive, experiential, and automatic information processing. Moreover, System 1 combines characteristics of heuristic processing and automatism. Therefore, it is unconscious and requires less cognitive skills. Further, the associative system is operating quickly but also less flexible (Evans, 2003; Hodgkinson & Sadler-Smith, 2018; Stanovich & West, 2000). This system enables individuals to compare new patterns with those already stored in their memory. People may focus more on distinctive features than on describing the characteristic of the pattern. Thereby, preference is given to patterns that complement the patterns already learned better (Sternberg & Sternberg, 2017). The counterpart is System 2, which is the rule-based system. This system is responsible for analytical, rational, and controlled processing. Although this system demands more cognitive capacity, the information processing is relatively slow (Hodgkinson & Sadler-Smith, 2018; Stanovich & West, 2000). In addition, this system supports fast learning and consciousness but sometimes reveals laborious mechanisms to reach conclusions (Sadler-Smith, 2016; Sternberg & Sternberg, 2017). Besides, system 2 enables individuals to analyze features and square them with rules and constraints kept in memory (Sternberg &

Sternberg, 2017). The direct comparison of System 1 and System 2 allows highlighting differences in understanding and performing a task, which is also relevant for entrepreneurship research. The controlled processes of System 2 allow perceiving a problem independently of context and person. Hence, it is possible to apply rules and principles to a specific situation. System 2 is active, for example, in examining logical arguments, categorizing, recognizing impossibilities, and improbabilities. In contrast, System 1 contextualizes, personalizes, and socializes the task or the problem (Stanovich & West, 2000; Sternberg & Sternberg, 2017). System 2 is considered to be slower and to have less capacity. Nevertheless, it is crucial for decision-making. Of great importance are decisions based on abstract “hypothetical thinking”. Humans are able to construct and simulate future scenarios and make decisions. This human facility is not possible while using System 1, as this system is more intuitive and experience-based (Evans, 2003).

Brain imaging enables the examination of brain functions, which are active during entrepreneurial decision-making. Therefore, it is possible to identify the system that is more relevant in a given situation or the scope of interaction between the two systems. Liebermann (2007) referred to System 1 as reflexive system or X-system and to System 2 as reflective system or C-system. Furthermore, the X-system is in accordance with the automatic social cognition processes, while the C-system is analogous to the controlled processes. The X-system is associated with basal ganglia, amygdala, VMPFC, dorsal anterior cingulate cortex (dACC), and with LTC (Lieberman, 2007). The basal ganglia show activity during emotional processing and the processing of motor information (Lieberman, 2007; ten Donkelaar, 2015). Moreover, this brain region supports intuition and is relevant for predicting rewards, as well as associative learning (Hodgkinson & Sadler-Smith, 2018). The amygdala is particularly relevant for decision-making under uncertainty and risk, as the amygdala is associated with fear-motivated attitude (Hsu et al., 2005; Stanton & Welpe, 2010; Sternberg & Sternberg, 2017). Besides, the amygdala directs the choice of actions by choosing preferable behaviors based on previous

experiences and restraining behaviors that may lead to negative outcomes (Schlüter et al., 2018). Hence, System 1, or the reflexive, automatic X-system is appropriate. The VMPFC shows increased activity during emotional decision-making and the evaluation of potential rewards in the future (Ward et al., 2017). Further, the VMPFC is active in automatic social cognition, as fair plays, trust, and cooperation (Lieberman, 2007). The LTC is part of the automatic nervous system (Pessoa & Hof, 2015), which supports the affiliation to the X-system. Additionally, this brain structure belongs to the default mode network and is therefore relevant for the opportunity evaluation (Buckner et al., 2008). Consequently, the LTC is crucial for evaluating the past and pondering the future (Andrews-Hanna et al., 2010; Raichle & Snyder, 2007). Experiences in the past play a major role. The C-system is associated with the medial prefrontal cortex (MPFC), lateral prefrontal cortex (LPFC), medial parietal cortex (MPAC), lateral parietal cortex (LPAC), rostral anterior cingulate cortex (rACC), and medial temporal lobe (MTL) (Lieberman, 2007). The MPFC is also a segment of the default mode network and important, for example, to reflect on situations and make judgments (Buckner et al., 2008). The LPFC is significant for cognitive functions and indicates a functional connection to the amygdala. Greater activity in LPFC regions leads to control and reduce the activity of the amygdala and thus also the anxiety-motivated attitude (Lieberman, 2007; Pessoa & Hof, 2015). In addition, the LPFC maintains the present objective in the working memory (Lieberman, 2007). The MTL, among other brain regions, controls social cognition (Lieberman, 2007). Furthermore, the temporal lobe is involved in auditory perception and hence essential for the comprehension of language (Cope et al., 2020; Han et al., 2011; Teige et al., 2019). Moreover, the MTL combines new impressions, for example auditory information, with existing memory (Harpaintner et al., 2020; Sternberg & Sternberg, 2017). This supports the property of System 2, which is active when verbal information processing occurs (Ward et al., 2017). The ACC is relevant for detecting errors in received information and consequently initiates compensations and adaptations in cognitive control. Additionally, this brain region is vital for cognitive processing and attention (Botvinick et al., 2004; Shenhav et al., 2013).

The X-system and the C-system interact in a “dynamic interplay” (Hodgkinson & Healey, 2011, p. 1503). Therefore, both, reflective and reflexive processes affect decision-making and reasoning. The dynamic interplay emphasizes that the reflexive-system reinforces or inhibits the reflective processes and thus consciously support complex reasoning and decision-making (Hodgkinson & Healey, 2011). Thus, the dual-process theory is of particular relevance for entrepreneurship research and for examining entrepreneurial decisions to exploit opportunities. The role of affect is considered with regards to System 1 and plays a major role in intuitive decision-making (Sadler-Smith, 2016). Neuroscience confirms that effective decision-making, especially in risky and uncertain situations, is characterized by the interplay of emotional and higher cortical brain regions. The ACC has an impact on both, the X- and the C-system. In the X- system the ACC signals that it is not possible to adequately and automatically assign the stimulus to an existing pattern, which activates processing by the C-system (Hodgkinson & Sadler-Smith, 2018). Additionally, the amygdala and the VMPFC are essential for making economic and effective decisions and therefore have high importance for entrepreneurial decisions. Somatic makers are significant for complex decisions, as situations are associated with previous experiences and emotions. These somatic makers represent intuitive affect, because they take place expeditiously, involuntarily, and prior to System 2 processing (Sadler-Smith, 2016). Hence, entrepreneurs intuitively make use of their affective processing during decision-making. Nevertheless, rational analytical processing influences decision-making, but with some delay. Sadler-Smith (2016) suggests that emerging opportunities, which are accompanied by a negative somatic condition, are assessed as high risk and limited benefit. In contrast, opportunities combined with a positive somatic condition are considered less risky and beneficial for exploitation. The nature of opportunities as well as the individual entrepreneur who is influenced by experiences, memory, and somatic markers, are to a certain extend unknown variables in this analysis. Various variables generally influence the decision-making. Additionally, the characteristics and dominance of these systems are different for each individual entrepreneur. Neuroscience confirmed

the interplay between experiential and rational, or unconscious and conscious processes, which then determines entrepreneurial decision-making (Hodgkinson & Sadler-Smith, 2018). Entrepreneurs make decisions with the influence of cognitive capabilities and emotions and are consequently “always boundedly rational, but manifestly driven by emotion” (Hodgkinson & Healey, 2011, p. 1512). Table 6 summarizes the properties of the experiential and rational processes as well as indicates the related brain areas.

Table 6: Properties related to experiential and rational processes

	Experiential Processes	**Rational Processes**
Model / System	System1 Reflexive System X- System	System 2 Reflective System C- System
Properties	Associative Heuristic Automatic Affective Fast operating Slow learning Parallel processing Undemanding of cognitive capacity – effortless Nonreflective consciousness Behavior unaffected by cognitive load Sensory Outputs seen as reality	Rule-based Analytic Intentional / Controlled Rational Slow operating Fast learning Serial processing Demanding of cognitive capacity – effortful Reflective consciousness Behavior altered by cognitive load Linguistic Outputs seen as self-generated
Related Brain Areas	Lateral temporal cortex Amygdala Ventromedial prefrontal cortex Basal ganglia	Lateral prefrontal cortex Lateral parietal cortex Medial prefrontal cortex Rostral anterior cingulate cortex

	Dorsal anterior cingulate cortex	Medial parietal cortex Medial temporal lobe

Source: adapted from Hodgkinson & Sadler-Smith, 2018; Lieberman, 2007; Stanovich & West, 2000.

4.4. Opportunity Capture

The execution of opportunities finalizes the holistic understanding of the entrepreneurial process, proposed by Shane (2003). Making efficient decisions plays again an important role. For example, decisions regarding the allocation of resources, business partners, and suitable business strategies are necessary to execute the entrepreneurial opportunity. Moreover, the environment of entrepreneurs is changing regularly. Thus, entrepreneurs have to stay flexible and adapt quickly to changes. Continuous learning and dynamic capabilities are relevant in this setting. Another reason why this section highlights the efficiency of risk-based decisions is that insights from neuroscience are available. Neuroscientific research was carried out with fMRI or EEG, for example.

4.4.1. Efficiency of Decision-Making

The capability to manage risks positively influences the probability of starting a new venture (Shepherd et al., 2015). Moreover, the willingness to implement a risk-based decision is influenced by the reward anticipation. Entrepreneurs subtract the costs of the action from the possible reward and thus make their decision (Holan & Couffe, 2017). The performance and efficiency of the decision depends on the expected reward that the individual entrepreneur receives as a result of the decision (Laureiro-Martínez et al., 2014). By using fMRI, Laureiro-Martínez et al. (2014) examined differences in cognitive processes during exploitation and exploration. Further, they analyzed the additional influence of attentional control and reward seeking. Since the efficiency of decision-making determines how and whether opportunities are implemented and captured, the results of this study are relevant. Exploitative decisions appeal for greater activation in dopaminergic regions, associated with

the expectation of a reward, than exploratory decisions. Therefore, the fMRI detected increased activity in the hippocampus and medial prefrontal cortex during exploitative decisions (Laureiro-Martínez et al., 2014). Finally, the VMPFC is more active, the more likely a reward appears (Tobler et al., 2007).

4.4.2. Neuronal Differences in Reward- and Risk- Processing

As reward is not identical with risk but often co-occurs, it is challenging to disentangling their neural features (Shaver et al., 2017). Preuschoff et al. (2006; 2008) performed an experiment that analyzed independent elements of reward and risk. Participants played a card game while fMRI recorded their brain activities. In this card game, participants draw two out of ten cards and stated their guess whether the next card will have a higher or lower value than the first one. At first, the first card is turned up. With a short delay the other card is turned up, revealing whether the participant has lost or won. This game structure permits to independently change the value of the result and likelihood of its occurrence. The expected reward and value rise linearly with the likelihood of winning. The fMRI records independently the value of each round and the inherent risk. Hence, it is achievable to identify neural signals, which are associated with risk or reward (Preuschoff et al., 2006, 2008; Shaver et al., 2017). This study state, that the anterior insula is activated during behavior associated with risk processing (Preuschoff et al., 2008; Shaver et al., 2017). Additionally, the anterior insula is relevant for decision-making and motivation, but also for responding to negative outcomes and for example rejecting unfair offers (Preuschoff et al., 2008; Sanfey et al., 2003). Moreover, the insula is important for affective processing and indicates negative emotions (Laureiro-Martínez et al., 2014). In contrast, the ventral striatum is linked to reward processing, but correlates negatively with risk (Hsu et al., 2005; Preuschoff et al., 2006; Shaver et al., 2017). This experiment emphasizes that there is a difference in neural representation for reward-related and risk-related behavior. During decision-making, entrepreneurs also have to deal with positively and negatively skewed outcomes. Positively skewed outcomes are for example characterized by a high probability for low-value results and by a low probability

for high-quality results. As an example, the likelihood that the new venture will become the future tech-star company can be mentioned (Shaver et al., 2017). Positively skewed decisions reveal increased activity in the nucleus accumbens, which is a part of the ventral striatum (Wu, Bossaerts, & Knutson, 2011). Negatively skewed outcomes show a low probability for high-value results and a large likelihood of low-value results (Shaver et al., 2017). Negatively skewed decisions result in higher risk awareness and cause negative arousal (Wu et al., 2011). Results like these are important to further investigate differences in behavior and neural characteristics in risk tolerance between entrepreneurs and managers.

Research concerning how an entrepreneur deals with risk reveals more about the actual implementation of the opportunity. The success of capturing opportunities relies on the nature of opportunities. Therefore, the related uncertainty and risk as well as the predicted potential reward are influencing the efficiency of entrepreneurial decisions.

5. Summary

In summary, this thesis investigated the specifications, influences, and effects of the entrepreneurial mindset. With the aim of broadening the knowledge spectrum, findings from neuroscience and entrepreneurial research were individually analyzed. Finally, this thesis transferred research results and determined an intersection of neuroscience and entrepreneurship research – Neuroentrepreneurship.

The in-depth analysis of neuroscience research highlighted that numerous brain structures are involved in entrepreneurial activities. For example, the limbic system is engaged in processing sensory information, learning, and emotional behavior. The cerebral cortex exhibits individual structures that indicate the significance for perception and cognition. The fMRI is a neuroimaging tool that identifies brain regions which are active for example during decision-making and is therefore suitable for answering questions of “where” activations take place (Pérez-Centeno, 2017b). Nevertheless, it might be challenging to construct tasks that are appropriate for data collection by fMRI (Ward et al., 2017). Compared to all other neuroimaging methods, the EEG has the best temporal resolution. Particularly, in combination with ERP, the EEG method is suitable to test entrepreneurship-related properties (Holan & Couffe, 2017). The EEG is meaningful to find out “how” the activation is characterized, but due to its poor spatial resolution, it is not suitable to locate the signal (Bunge & Kahn, 2009; Pérez-Centeno, 2017b).

The concept of entrepreneurship used in this thesis is based on the definition by Shane and Venkataraman (2000). The discovery of opportunities was described by four paradigms (McMullen et al., 2014). In this context, the role and existence of personality traits related to entrepreneurial activity was discussed as first paradigm. A critical point was the difficulty to prove the “entrepreneurial gene” by using research methods as fMRI or EEG (e.g. Leutner et al., 2014; Nicolaou & Shane, 2014). The second paradigm considered adaptation, which

is associated with cognitive skills relevant to perceive and evaluate information. In that respect, the ACC signals the occurrence of errors in information processing. This leads to the initiation of compensatory measures in cognitive control (Botvinick et al., 2004). The third paradigm analyzed the influence of expertise and investigated the importance of knowledge and learning for making entrepreneurial decisions. In this aspect, the default-mode network, which is needed to reflect on the past and think about the future is crucial (Andrews-Hanna et al., 2010; Raichle & Snyder, 2007). These specific brain regions are active during resting phases and provide indications as to why an entrepreneur makes a particular decision. The fourth paradigm considered the entrepreneurial mindset. The prefrontal cortex is relevant for approach-avoidance and the amygdala for action orientation. Both regions cooperate complementarily and therefore enable successful opportunity identification and exploitation.

In the phase of exploiting opportunities, the entrepreneurial decision-making was analyzed. Findings of the ultimatum game supported the hypothesis that emotional and cognitive processes compete with each other in decision-making. In relation to brain areas, this means that the anterior insula and the prefrontal cortex are rival structures (Sanfey et al., 2003). The dual-process theory analyzed which segments of the brain are active during entrepreneurial decision-making. Results of neuroimaging indicated that the reflective and reflexive system interact in a dynamic interplay, which supports complex considerations and decisions (Hodgkinson & Healey, 2011).

The capture of opportunities addressed some previous neurological processes once again. The efficiency of entrepreneurial decision-making depends on the expected reward. By using fMRI it is possible to assign certain brain areas to a specific function and examine neuronal differences for risk-processing and reward-related behavior. For example, the anterior insula shows activity during risk processing and decision-making (Preuschoff et al., 2008; Shaver et al.,

2017). The anterior insula is active in affective processing and reveals the occurrence of negative emotions (Laureiro-Martínez et al., 2014).

The relevance of Neuroentrepreneurship was clearly stated by the findings of this thesis. The combination of neuroscience, cognitive science, and entrepreneurship holds the potential to further examine the entrepreneurial mindset. Finally, this is beneficial for encouraging intrapreneurship and consequently for promoting organizational innovations.

6. Recommendations for Organizational Innovation

Companies are facing increasing global competition. Organizational performance, success, and business growth depend on adapting and further developing the current business strategy. Through optimizing existing products and processes, exploiting new markets, or disrupting the market with new innovations, companies are perfectly equipped for sustainable business growth in the future. These activities depend on people who have an entrepreneurial mindset within the company. The following chapter discusses and emphasizes the importance of intrapreneurship and derives recommendations for organizations to enhance their entrepreneurial activities and support employees having an entrepreneurial mindset. These recommendations are based on the findings of Neuroentrepreneurship and therefore provide novel insights into intrapreneurship. Ultimately, intrapreneurship should become an integral part of the corporate culture.

6.1. Entrepreneurship versus Intrapreneurship

Entrepreneurship within an established venture is considered a suitable definition for intrapreneurship (J. Antoncic & Antoncic, 2011). Intrapreneurship is a research subfield of entrepreneurship and thus showing similarities, but also differences (B. Antoncic & Hisrich, 2003). The literature also refers to intrapreneurship as corporate venturing or corporate entrepreneurship.

There are three focal areas of research in the field of intrapreneurship (B. Antoncic & Hisrich, 2003). The first area considers the individual intrapreneur. This area focuses on individual characteristics and behavior of intrapreneurs. Derived from these evaluations, organizations receive insights into the most appropriate form of support for intrapreneurs. Moreover, they can examine how to recognize employees who have this specific entrepreneurial mindset. The second area of research analyzes the establishment of a corporate start-up company. In this area, researchers are interested in differences and similarities

of various types of new corporate ventures. Additionally, these types are analyzed regarding their adaptability to the existing corporation and how the existing corporation creates an internal corporate environment. The third area inspects the entrepreneurial organization. This research field considers features of the entrepreneurial organization and examines respective success factors for enhancing intrapreneurship.

In general, employees within the existing company behave and act as entrepreneurs. Through intrapreneurship, existing companies receive support regarding their innovations and foster their business growth. Nevertheless, it is not a compulsory requirement that intrapreneurs generate new ideas (Sinha & Srivastava, 2013). Entrepreneurial activities and behavior associated with intrapreneurship refer to the innovation concept by Schumpeter. These activities and related behaviors are the following (B. Antoncic & Hisrich, 2003; J. Antoncic & Antoncic, 2011):

(1) New ventures and new businesses: the creation of new businesses considering intrapreneurship results in new ventures within the existing organization. These new ventures are related to existing markets or products. Depending on the degree of autonomy, examples are internal venture teams (Dushnitsky & Lavie, 2010; Woo, 2018), internal start-ups (Macmillan, Block, & Narasimha, 1986), and autonomous business units (Vesper, 1990).
(2) Product and service innovativeness: this dimension includes product improvements and new product developments (B. Antoncic & Hisrich, 2003; Schollhammer, 1982).
(3) Process and technology innovativeness: innovations in production procedures, techniques, technologies, and methods are considered in this dimension (J. Antoncic & Antoncic, 2011; Schollhammer, 1982).
(4) Self-renewal: by renewing key ideas that constitute the company, it continues to develop. This dimension addresses organizational and strategic changes resulting in a reorganization or redefinition of the

existing company (B. Antoncic & Hisrich, 2003; J. Antoncic & Antoncic, 2011; Vesper, 1990).

The search for business opportunities by a person within an existing organization, but without considering formal channels is termed intrapreneurship. In contrast to an entrepreneur, an intrapreneur has to consider possible organizational constraints and boundaries, as for example business hierarchy, internal decision-makers, and the internal business environment (Aguilar, Vengrouskie, & Lloyd, 2019). As the established company may act as a financier, the intrapreneur has a smaller financial risk than the entrepreneur (Sinha & Srivastava, 2015). Nevertheless, there are various similarities between intrapreneurs and entrepreneurs regarding their mindset, process of decision-making, and behavior. Therefore, several of the findings of Neuroentrepreneurship can be transferred to extend the scope of intrapreneurship research and ultimately, to enhance entrepreneurial activities within established organizations.

6.2. Finding and Recognizing Intrapreneurs

Recognizing employees who actually have the entrepreneurial mindset might be difficult. The process of identifying such intrapreneurs begins in the recruitment phase and continues within the company. Who is an intrapreneur and how can she or he be recognized? This is a crucial and complex issue. The one correct answer to this question does not seem to exist. The following discussion does not primarily focus on the place where an intrapreneur can be found. Rather, the focus lies on how to recognize an intrapreneur and whether or not the potential intrapreneur is already an employee. Recruitment strategies are not analyzed. For this purpose, certain starting points and characteristics from the research of Neuroentrepreneurship are helpful.

Aguilar et al. (2019) recognize that intrapreneurs usually work at the middle operational or management level. Therefore, it might be more difficult to

recognize their impacts, developments, and improvements regarding products, processes, and techniques. Prior knowledge and past experiences influence the opportunity identification of intrapreneurs. Moreover, by obtaining the assistance of staff and management, intrapreneurs receive support in the allocation of resources, which makes the realization achievable (Aguilar et al., 2019).

As it is often the case in practice, people are evaluated on the basis of their personality and working methods. However, conflicts regarding the objective validity might arise. This fact must be conscious, because everyone interprets and evaluates personalities differently. In order to avoid this, it is recommendable to think about how to test and evaluate personality traits of employees. Besides, it is essential to remember that certain personality traits such as extraversion are a sufficient but not necessary condition for successful entrepreneurship and intrapreneurship. Nevertheless, research studies suggest that specific personality traits have a positive impact on intrapreneurship (e.g.: Canli et al., 2001; Obschonka & Stuetzer, 2017; Woo, 2018; Zhao & Seibert, 2006). An increased level of openness, extraversion, and conscientiousness indicate an increased probability for entrepreneurial behavior and entrepreneurial performance (Obschonka & Stuetzer, 2017; Zhao, Seibert, & Lumpkin, 2010). The correlation between intrapreneurship and personality could be derived from correlations between entrepreneurship and personality (Woo, 2018). Hence, the deeper analysis of HEXACO model reveals beneficial personality traits for intrapreneurs. The HEXACO personality model assumes three dimensions that demonstrate altruism (honesty, agreeableness, and emotionality) and three dimensions that indicate engagement (extraversion, openness to experience, and conscientiousness). This extension of the Big Five personality model revealed that conscientiousness, extraversion, and openness indicate positive interactions with intrapreneurship (Ashton & Lee, 2007; Vries, Reinout E., Wawoe, & Holtrop, 2016). Furthermore, and with regard to the topic of this thesis, it is relevant to investigate possible combinations with neuroscience. By applying fMRI research, people who have an increased level

of extraversion reveal an increased activity in the amygdala (Canli et al., 2002; Cohen, et al. 2005), the nucleus accumbens, the orbitofrontal cortex (Cohen et al., 2005), and the temporal cortex in the right hemisphere (Canli et al., 2001). These findings support the results of research into the analysis of personality traits of entrepreneurs. The amygdala is relevant for decision-making in uncertain and risky circumstances (Hsu et al., 2005; Stanton & Welpe, 2010). Additionally, the amygdala supports the choice of preferred behavior based on previous experiences (Schlüter et al., 2018). In combination with the amygdala and nucleus accumbens, the orbitofrontal cortex is part of the neural reward system (Cohen et al., 2005). These findings imply that reward-sensitive brain areas of people with high values in extraversion are more active during rewarding events, which regularly occur in entrepreneurial activities (Cohen et al., 2005). Therefore, these individuals are more likely to realize opportunities as they are expecting a reward and consequently make riskier decisions (DeYoung et al., 2010; McMullen et al., 2014). The temporal cortex is partly associated with experiential processing (System 1) and therefore with properties like affective, associative, and fast operating (Lieberman, 2007). These properties are also related to extraversion. The LTC, a part of the temporal cortex, is additionally a component of the automatic nervous system (Pessoa & Hof, 2015) and the default mode network, which is relevant to think about the future and reflect the past (Andrews-Hanna et al., 2010; Raichle & Snyder, 2007). These elements constitute that personality traits such as extraversion, openness, and consciousness are sufficient conditions for intrapreneurship and can be demonstrated by applying neuroscience. Particularly for the identification of intrapreneurs, the consideration of relevant personality traits is helpful. These personality traits can be tested by specific tasks demanding for example risk tolerance, reward orientation, and fast operating, which would suggest that this person is likely to be extrovert and consequently, more likely to pursuit entrepreneurial activities.

In order to identify intrapreneurs, it makes sense to analyze how intrapreneurs behave and act before they identify an opportunity. Thus, the examination of the

default-mode network is relevant (Ward et al., 2017). Preparing an assessment task to get an insight into the decision-making process of individuals might be beneficial. Particularly, to identify young intrapreneurs, a specific task as part of an assessment center, is suitable. Neuroscience revealed that the default-mode network is relevant among other things for dealing with risk and uncertainty. This risk tolerance is explainable because people think about the future and the related reward. Therefore, a specific task could be designed to examine the risk tolerance. The announcement of potential rewards is an additional motivation for potential intrapreneurs.

In summary, identifying intrapreneurs is an essential but also difficult part of implementing entrepreneurial activities in the organization. In particular, since it is not conceivable in practice to check the activity of certain brain activities when performing certain tasks by means of EEG or fMRI.

6.3. Organizational Conditions

Organizational conditions should support, motivate, and encourage intrapreneurs to contribute their own ideas. This working environment catalyzes the development of organizational innovations and consequently contributes to sustainable business growth and competitive advantage for the organization (Aguilar et al., 2019). The overarching goal to enhance intrapreneurial activities is to establish a culture of innovation. In this context, leaders and managers support their employees and value their impacts. Moreover, the organization actively encourages employees to further develop their own capabilities and explore new methods. Intrapreneurship requires individuals to leave their comfort zone and accept risk and uncertainty (Rigtering, Weitzel, & Muehlfeld, 2019). By trying out new things, successful ideas can be generated. On the other hand, the probability of failing increases. Risk avoidance results in avoiding the exploitation of intrapreneurial opportunities. Therefore, it is essential to tolerate failures as a part of innovation. In addition, it would be recommendable to create an atmosphere of exchange in which employees can

learn from each other. An organization that fosters intrapreneurial activities should provide its employees with the opportunity to share failures and thus minimize the likelihood of the same failure happening again (Aguilar et al., 2019). The benefits of implementing dynamic capabilities or routines for sharing experiences will be further discussed in the next section. Further, to share best practice examples and experiences, specific knowledge is beneficial for intrapreneurial behavior. Through a personal exchange about experiences new intrapreneurial opportunities might be identified. Therefore, it is important to promote these exchanges and bring together people with different expertise, skills and experience. In addition, increasing decentralization has a positive impact on lateral and horizontal collaboration of employees. This consequently encourages cooperation, creativity, and the elaboration of new innovations (Ireland, Kuratko, & Morris, 2006). Moreover, it promotes the “out of the box thinking”, which is crucial for intrapreneurial activities. Apart from that, learning and experiences, own or from others, influence the entrepreneurial decision-making process (Baker & Welter, 2018; Welter, 2011; Zahra et al., 2014). With regards to the human brain, phases of learning activate the hippocampus. The hippocampus is relevant for flexible learning and building memories based on experiences, situations, and knowledge (Eichenbaum, 2017; Sternberg & Sternberg, 2017). Hence, the conscious activation of the hippocampus, which is part of the limbic system, leads to memory formation and thus to prevent the repetition of mistakes. Besides, learning from others additionally addresses emotions, which results in an additional activation in the limbic system. In this context, appropriate communication motivates people to actively reach objectives and start with their projects (Rigtering et al., 2019). This motivation of reaching goals is generated in the frontal lobe (Gazzaniga et al., 2014). The existence of entrepreneurial motivation is crucial in decision-making and therefore encourages employees to exploit opportunities they discovered previously (Shane et al., 2003).

The organization should give attention to the ideal “risk/reward trade-off” (Aguilar et al., 2019, p. 27). The anticipation of rewards is elementary for

successful intrapreneurship. The VMPFC is responsible for emotional decision-making and the associated evaluation of the probable reward (Ward et al., 2017). Again, the neural reward system (consisting of amygdala, nucleus accumbens, and orbitofrontal cortex), is relevant for accepting risk and exploiting opportunities (Cohen et al., 2005). People with higher activation on the neural reward system will more likely identify opportunities. They hope for a reward and therefore make risky decisions more easily (DeYoung et al., 2010; McMullen et al., 2014).

The leader or manager of intrapreneurs is responsible for maintaining the ideal risk/reward trade-off. Based on two principles, David Rock introduced the SCARF model, which is a Neuroleadership model. Firstly, social behavior is determined by the organizational concept of maximizing rewards and minimizing threats. Secondly, social needs are processed within the brain in the same way as the desire for water and food (Rock, 2008). This model includes five areas of social experience: Status, Certainty, Autonomy, Relatedness, and Fairness. These areas can either pose a threat thus people try to minimize this threat or a reward that motivates people to adjust their behavior accordingly. Figure 8 presents the five areas of this model. Additionally, examples of causing a threat or reward are mentioned. For instance, giving advice might suggest for the addressee being ineffective, which could lead to a status threat. Therefore, the employee adapts his or her behavior in such a way that there is no threat of losing status. The amygdala has a central function in deciding whether an action should be tackled or avoided. As stimuli are processed before they reach consciousness, the approach-avoidance decision is unconscious, automatic, and fast. Regarding the SCARF model of Neuroleadership, this means that a leader who causes the perception of threat by his or her employee simultaneously minimizes the cognitive performance of the respective employee (Rock, 2011). This is explained by the negative correlation between the perception of a threat and the available amount of glucose and oxygen, which are important for cognitive functions and memory processing in the prefrontal cortex (Rock, 2011). In case the employee is a potential intrapreneur, the threat

minimizes the prospects of success for an organizational innovation. Hence, it is crucial for successful leaders to trigger the reward anticipation of intrapreneurs.

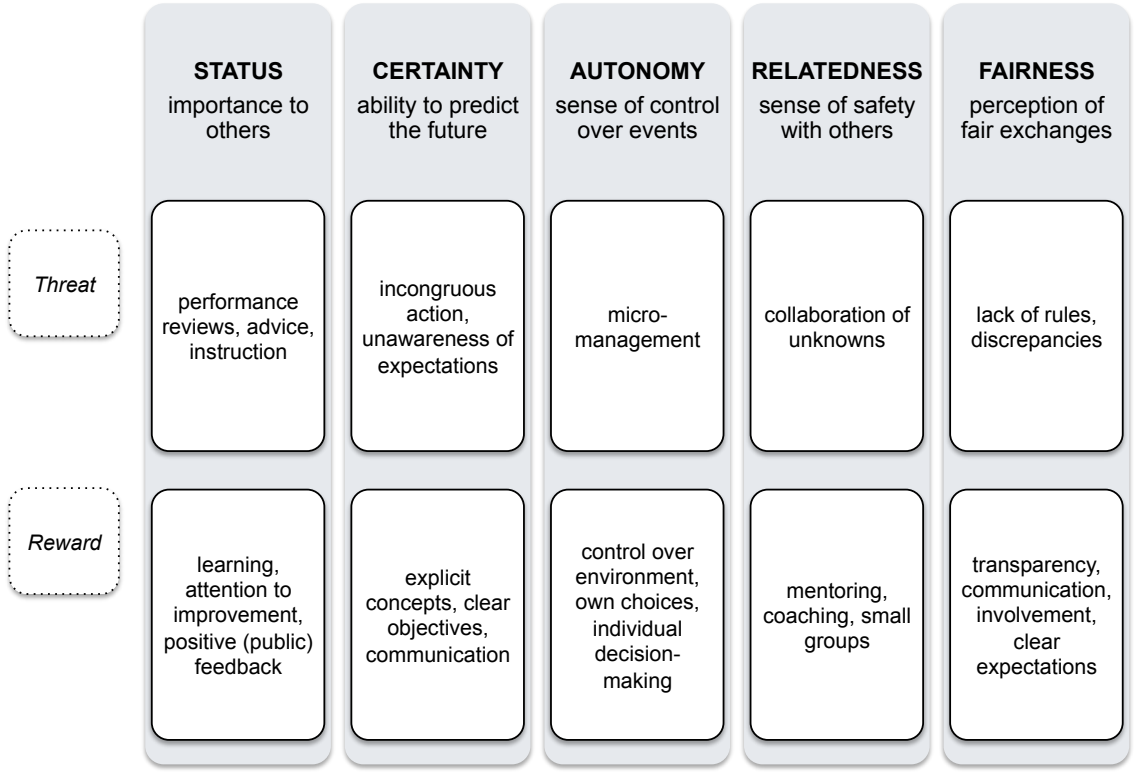

Figure 8: The SCARF model of Neuroleadership
Source: adapted from Rock, 2008, pp. 1–6.

The SCARF model provides implications for successful collaboration and leadership based on findings of neuroscience. Consequently, implications for Neuroentrepreneurship or in this case intrapreneurship, can be derived from this model. The factor autonomy is of particular relevance. Intrapreneurs are interested in an increase of autonomy as a reward. This provides them with more decision-making power and the ability to pursue their own objectives, which might lead to successful organizational innovation. Particularly, supportive leaders have a positive influence on the performance of employees and therefore on intrapreneurship. Moreover, supportive leaders can increase the job satisfaction of employees (Staub, Nart, & Dayan, 2019). This might enhance the employee's willingness to have a positive influence on the organization, for example with a product innovation. Supportive leaders are

mentors and coaches for employees. This reward anticipation linked to the relatedness factor of the SCARF model encourages employees, as they are expecting a reward. For example, intrapreneurs expect public feedback or additional autonomy.

In summary, appropriate organizational conditions are crucial for the success of intrapreneurs. Creating a culture of innovation, in which learning is actively promoted and failure is tolerated, enhances intrapreneurial activities. The anticipation for receiving a reward is motivating and enhances the cognitive abilities of intrapreneurs. Lastly, supportive leadership encourages employees to exploit opportunities.

6.4. Dynamic Capabilities

Dynamic capabilities are essential to stay competitive by extending, creating, and protecting the unique asset base of the organization (Teece, 2007). For organizations it is relevant to adapt to changes and shape the environment repetitively. Intrapreneurship is a valuable resource for organizations to increase the likelihood of identifying and consequently exploiting opportunities that arise in the changing business environment. Teece examines three dynamic capabilities being fundamental for the economic and evolutionary fitness of the organization:

(1) “to sense and shape opportunities and threats
(2) to seize opportunities, and
(3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise’s intangible and tangible assets” (Teece, 2007, p. 1319).

The intrapreneur plays an important role in all three stages and can additionally sustainably support the strategic orientation of the organization. Organizations being aware of dynamic capabilities and actively supporting intrapreneurs will

achieve a competitive advantage. Moreover, these organizations will not only react upon changes in the environment, but also actively shape it. By enhancing and promoting intrapreneurial activities, the organization achieves success, for example through process improvements, product innovations, and expansion into new markets.

The identification of opportunities and threats requires exploring the business environment and recognizing changes. Intrapreneurs combine their prior knowledge with new experiences. During this phase, intrapreneurs can be actively supported by appropriate organizational conditions. Successful seizure requires interdependent decisions, for example on business models or investment options (Hodgkinson & Healey, 2011). In this phase, details about the change or innovation are worked out to overcome people's resistance and finally integrate the new solution into the company. In the third phase of reconfiguration, the organization continuously transforms according to technological and market changes (Hodgkinson & Healey, 2011). Intrapreneurs are interested in maintaining competitiveness and therefore might initiate an additional change. The ability of adapting to the dynamic environment and related changes is important for successful intrapreneurs. Besides, these dynamic capabilities are based on both emotional and cognitive functions. Therefore, the reflective system and reflexive system act in a dynamic interplay. The reflexive, automatic, affective, and experiential systems are responsible for social cognition, for example empathizing with others, automatic categorization, and implicit stereotyping. In contrast, the reflective and controlled systems allow for advanced forms of cognition such as planning, logical reasoning, and hypothetical thinking. Dynamic capabilities are based on the interaction of both systems. Thus, the reflexive system inhibits and facilitates the reflective system, which makes an impact on decision-making and effortful reasoning. Overall, this interplay highlights the importance of emotional and affective processes for intrapreneurial decision-making. Emotions and affect are an integral part of reasoning, awareness, learning, acting, and decision-making (Hodgkinson & Healey, 2011; Lieberman, 2007). Opportunities associated with a negative

somatic condition are assessed as having a high level of risk and a limited utility. In contrast, opportunities revealing a positive somatic condition are perceived as less risky and more beneficial (Sadler-Smith, 2016). Fear, for example, restricts attention, while a too optimistic attitude can cause certain signals to be neglected. Moreover, affect is fundamental to effective perception, because it motivates cognitive adaptation (Hodgkinson & Healey, 2011).

Supporting intrapreneurs and their development of dynamic capabilities requires organizations to create a learning climate. This learning atmosphere should value affective and intuitive cognitions as well as allows for careful, deliberate processing where necessary (Hodgkinson & Healey, 2011). In this context, dynamic repetitive routines are recommendable. These routines are a source of inspiration, exchange, and idea generation. Intrapreneurs receive the opportunity to get new insights, for example into other departments, structures, and processes. Further, it is important to realize that routines designed for finding solutions, overcoming hurdles, and anticipating negative consequences are associated with negative affect. This might lead to an intrapreneur's decision to avoid the desired behavior or action. Instead, positive affect should be evoked. Routines for the positive perception of opportunities and the reduction of negative affects increase the ability to respond to events by expanding the range of perception and attention (Hodgkinson & Healey, 2011). Intrapreneurs are characterized by the ability to perceive patterns and interpret relations between changes (Baron, 2006; Shane, 2000). Intrapreneurs are attentive to changes in the environment and evaluate the meaning and potential of these changes. Based on that, they decide whether it is valuable to exploit the opportunity or not (J. R. Mitchell & Shepherd, 2010; Shepherd et al., 2007). Dynamic and metacognitive capabilities enable to adapt quickly, learn, and combine prior knowledge with new experiences and challenges (Haynie et al., 2010; Lecler & Kinghorn, 2014). The ACC is of particular importance in this context. This cortex is responsible for effortful processing, attention, action selection, and conflict monitoring (Botvinick et al., 2004; Segalowitz & Dywan, 2009; Shenhav et al., 2013). This brain region initiates dynamic cognitive

capabilities when conflicts occur during information processing (Botvinick et al., 2004). Therefore, the activation of the ACC is important for intrapreneurs. This brain region discovers wrong behavior and consequently initiates compensatory adaptations. Besides, the ACC supports the intrapreneur in adapting to new challenges, transforming initial intentions into achievable objectives, and planning ahead (McMullen et al., 2014).

Intrapreneurs show an increased level of career adaptability (Woo, 2018). This indicates that intrapreneurs have fewer problems adapting to new and uncertain challenges. Moreover, this adaptability is correlated with entrepreneurial self-efficacy, which consequently fosters intrapreneurial intentions. Intrapreneurs set challenging objectives, plan ahead, and include constructive feedback (Woo, 2018). In conclusion, as it is possible to train career adaptability, thinking about how to implement such developments within the organization is a valuable starting point (Koen, Klehe, & Van Vianen, 2012).

7. Conclusion and Limitations

In recent decades, researchers focused on examining entrepreneurship itself. Nevertheless, entrepreneurship research again faces a crossroads. A new approach is needed. Resulting from the limitations of previous entrepreneurship approaches, this new approach has to bridge current research gaps (Pérez-Centeno, 2017a). The potential of combining this field of research with neuroscience is only gradually being realized. The integration of neuroscience to open up the entrepreneurial mindset seems auspicious (Holan, 2014; Nicolaou & Shane, 2014; Pérez-Centeno, 2017b).

The purpose of this study was to examine the characteristics of the entrepreneurial mindset. Concerning this matter, the process of entrepreneurial opportunities suggested by Shane (2003) was further analyzed and raised to a new level. Neuroscience findings were included at all levels in order to finally create a uniform understanding of Neuroentrepreneurship. The entrepreneurial mindset is recognized as an essential factor influencing the identification, evaluation, exploitation, and capture of entrepreneurial opportunities. This mindset encourages entrepreneurs, for example to make decisions in risky situations, to interpret new information and associated circumstances, and evaluate possible outcomes and performance in the future (Ireland et al., 2003; McMullen et al., 2014). This thesis concludes that it is possible to promote and learn an entrepreneurial mindset and therefore it is not primarily innate. However, certain (innate) character traits can shape the entrepreneurial mindset. Particular characteristics can positively influence the entrepreneurial mindset and have an optimizing effect on the decision-making process. This is a sufficient, but not a necessary condition to be a successful entrepreneur. For example, extraversion and openness positively influence entrepreneurship and intrapreneurship. The examination with fMRI indicated a higher level of activity in the amygdala, nucleus accumbens, and the orbitofrontal cortex for people showing a distinct level of extraversion (Canli et al., 2002, 2001; Cohen et al., 2005). These brain regions play an essential role in entrepreneurial decision-

making in uncertain situations. Furthermore, in the course of time, experiences, situations, and knowledge can influence entrepreneurial behavior.

The second purpose of this thesis was to investigate factors, which empower entrepreneurs to identify and discover opportunities in the environment. Based on the opportunity identification system proposed by McMullen et al. (2014), four paradigms were analyzed in terms of their significance and their contribution to identify entrepreneurial opportunities. Particularly the adaptation explanation and expertise explanation are relevant for Neuroentrepreneurship. The entrepreneur is able to perceive patterns based on changes in the environment. Dynamic and metacognitive capabilities support this process and consequently initiate rapid learning, adaptation, and interpretation. Meanwhile, particular brain areas show an increased activity. For example, ACC signals incongruent conditions based on conflicts between the error response and the correct response. This activation causes the entrepreneur to adapt to changes. The default-mode network also features an important function in identifying opportunities. Moreover, this brain region provides a valuable research assignment to further investigate how the entrepreneur thinks about opportunities, reflects on the past, and predicts the future.

The third research question considered the characteristics and influences of the entrepreneurial decision-making process. This thesis emphasized the importance of affect. Particularly, as entrepreneurs operate in uncertain situations, affect is a major driver in the entrepreneurial process. In entrepreneurial decision-making affect interacts continuously with cognition. Nevertheless, affect can also have a negative impact on business decisions. Actions based on affect can overshadow rational decisions and base them on pure emotions, which could result in wrong decisions. Therefore, organizations need to recognize this area of conflict in order to guide and support their intrapreneurs accordingly.

The fourth aim of this research was to derive recommendations for organizational innovation to further promote the entrepreneurial mindset and consequently enhance entrepreneurial activities. All factors mentioned above are important. The intrapreneurs pursue a long-term vision, have an intrinsic motivation to change the status quo, and anticipate rewards. As decision-making is characterized by the interplay between experiential and rational or, unconscious and conscious processes, organizations should address both systems. Hence, organizational conditions allowing intrapreneurs to learn, experience, and exploit new ideas are valuable. Dynamic routines, as for example the possibility to work one day per week on own ideas, collaborate with colleagues in other departments, and to share experiences positively influence opportunity exploitation. Further, the reward for intrapreneurial activities is important. However, this does not refer to a monetary reward. Rewards for intrapreneurs taking risks and seizing opportunities are increased autonomy, resources for their projects, and the appreciation of their business ideas.

During the research for this thesis, it was noticeable that Neuroentrepreneurship is a nascent field of research and so far, just a few publications or studies are available. In fact, only a small number of experimental studies examined Neuroentrepreneurship. One reason for this limitation might be that the application of neuroscience methods requires a tradeoff in interpretation (Guillory, Boardman, & Day, 2017). For example, fMRI enables precise spatial localization in the entire brain, but is not accurate enough in measuring electrical signals. Whereas the EEG measures electrical activities, but is limited to locate these signals. Consequently, a variety of methods are required to comprehend Neuroentrepreneurship at a whole. One method alone is not appropriate to capture the entire brain on the level of specific neurons. Furthermore, the usage of neuroscience methods is very expensive and not accessible to all researchers. Additionally, the experimental conditions of neuroscience studies are frequently restrictive and artificial, because participants execute tasks in an idealized experimental setting (Nicolaou et al.,

2019). Moreover, some research methods (e.g. fMRI) make it difficult to visualize neuronal activity during personal interaction. This limitation should be considered, as personal interaction is relevant to entrepreneurship. An additional limitation of Neuroentrepreneurship is the reverse inference problem. A specific mental state or behavior is associated with activating a region of the brain. It is difficult to infer the existence of the aforementioned mental state at a later stage when a comparable pattern of cerebral activation is observed (Nicolaou & Shane, 2014; Theodoridis & Nelson, 2012). Furthermore, the pure examination of brain activity may not provide a holistic understanding of entrepreneurial decision-making. The entrepreneurial behavior also depends on other physical structures such as other individuals, the body, and the environment. The scientific examination of these structures might be critical, but is nevertheless important to advance entrepreneurship research (Nicolaou et al., 2019). Despite these limitations, the potential of the research field of Neuroentrepreneurship is significant.

This thesis proposes a trade-off between already existing attributes and capabilities learned over time that encourage entrepreneurship. In fact, it demonstrates the potential of Neuroentrepreneurship as being relevant for both, theory and practice. This thesis enhances the understanding of Neuroentrepreneurship and recognizes the importance of combining findings from neuroscience and entrepreneurship. Consequently, this thesis steers the research into a new direction. In addition, this research provides a valuable input for scholars to further examine Neuroentrepreneurship by conducting experimental studies. Both, entrepreneurs and intrapreneurs show the ability to adapt quickly to change. Further research could exactly examine this adaptability and conduct studies about related brain processes. In particular, the fact that the globalized world is characterized by increased transformation needs to be considered. For example, the financial crisis in 2008 gave rise to various disruptive innovations and new brands (e.g. Instagram, WhatsApp, Airbnb, Uber, Dropbox). Entrepreneurs perceive change quickly, evaluate significance, plan ahead, and adapt to this changing environment. Accordingly,

the Corona crisis of the year 2020 provides an opportunity for entrepreneurs and intrapreneurs. The evaluation of how to support this adaptability of entrepreneurs is a valuable research topic to further explore Neuroentrepreneurship. Prior to analyzing the enhancement and training of cognitive capabilities and entrepreneurial behavior, entrepreneurial decision-making needs to be fully understood (Guillory et al., 2017). Consequently, it is essential to include the interfaces between affect and cognition into future research on entrepreneurial cognition. In this context, analyzing the affective and cognitive processes prior to decision-making seems relevant. The further investigation of the default-mode network is beneficial in this context. Moreover, the influence of different experiences, gender, ethnicities, and socioeconomic statuses on entrepreneurial behavior can be further analyzed by studying the default-mode network. Besides, this could expose a universal neural mechanism that is the same for all entrepreneurs (N. Krueger & Welpe, 2014; Ward et al., 2017).

Over the last decades, entrepreneurship research has developed continuously. It is the time to integrate a whole new aspect into entrepreneurship research, namely neuroscience. This fourth approach has the potential to elevate the understanding of entrepreneurial opportunities to an unprecedented level. In conclusion, Neuroentrepreneurship has the latent potential to advance, if not complete, the seemingly endless discussion of a coherent definition of entrepreneurship. Because it is time to rise.

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Statutory Declaration

I hereby certify this thesis is my own work and contains no material that has been submitted previously, in whole or in part, in respect of any other academic award or any other degree. To the best of my knowledge all used sources, information and quotations are referenced as such.

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