Brain-driven entrepreneurship research a review and research agenda

Introduction

Since the 1980s entrepreneurship research has been a focus of interest in society as well as in education and academic research (Landström, 2004). While there is a significant knowledge base for entrepreneurship, thereare still challenging research gaps that cannot be addressed more deeply with existing approaches. In the interest of moving this research forward, technologies and methods from the field of neurosciences are beginningto resonate within the minds of several entrepreneurship scholars (Blair, 2010; de Holan, 2014; McMullen et al., 2014; Nicolaou and Shane, 2014; Smith, 2010). Although entrepreneurship researchers seem to love the mind and its workings, many of the concepts within entrepreneurship research can be explained only very poorly with the instruments used now(de Holan, 2014). Work done on entrepreneurial cognition is the major intellectual driver toward this new era. Research includes entrepreneurs' cognition[1] (R.K. Mitchell et al., 2002), knowledge (Shane, 2000), intuition(J.R. Mitchell et al., 2005), and mindsets (Haynie et al., 2010), among many other phenomena taking place within the human mind (de Holan, 2014).

Instead of focusing on what entrepreneurs think, how they think, why they think the way they do, and how they came to think that way,a majority of scholars are still assessing what entrepreneurs are or have (attributes), or what they do (behaviors) (de Holan, 2014). This omission is surprising, given that the focus of entrepreneurship research lies inhow entrepreneurs think and make decisions (de Holan, 2014). In this sense, de Holan (2014) highlights the relevance of neurosciences, arguing that we have not yet begun to explore what neuroscience can do for entrepreneurship, and we only know how little we know. This research gapshould be addressed and the field must come to incorporate neuroscience theory and methods (Nicolaou and Shane, 2014).

To address these concerns conceptually, the aim of this chapter is to assess the contribution of neurosciences to entrepreneurship research.This chapter strives to accomplish that through a review and research agenda for entrepreneurship research from a neurosciences angle, buildingupon existing research and knowledge of the entrepreneurial phenomenonthrough the lenses of neuroscience. The review and research agenda are developed in three steps.

First, I build on entrepreneurship research undertaken using neurosciences and highlight the conceptualization of a brain-driven approach. Second, I discuss entrepreneurship research relevant to understanding the use of neurosciences in this field. Third, to better identify avenues for future entrepreneurship research, I assess the manner and extent to which entrepreneurship research leverages the potential fora brain-based approach. Through content analysis of existing articles incorporating a neuroscience method in their studies, I depict the current state of knowledge with regard to a brain-driven research perspective. I show that for all its achievements, research has yet to leverage the full potential of applying such an approach into entrepreneurship research. I build on these observations to formalize the research agenda. I suggest a definition of brain-driven entrepreneurship research and propose a series of strategies to address and expand this approach in more in-depth ways.

Conceptualizing Brain-Driven Entrepreneurship Research

I start with the use of neurosciences in entrepreneurship research and discuss key conceptualizations advocated in that spectrum. Towards the end of this section the advances in entrepreneurial cognition research are also discussed: those that are likely to be essential for understand-ing the roots of using neurosciences in the field of entrepreneurship.The application of neurosciences to entrepreneurship research is new; thus, it is imperative to frame the scope of it within this chapter. Just as new technologies are a primary source of innovation and opportunityin entrepreneurship (Drucker, 2014; Schumpeter, 1934), the same might also be said of science (Sanders, 2007). Neuroscience did not exist even 20 years ago, but thanks to technological advances it has become one of the fastest-growing areas of the biological sciences, and a revolutionizing force across social sciences that challenges disciplines ranging from economics to sociology and psychology (McMullen et al., 2014). Taking into account that entrepreneurship draws on many of these disciplines,the field is unlikely to be immune to neuroscience's transformative impact(McMullen et al., 2014). In simple terms, neuroscience entails the studyof how the nervous system develops, its structure, and what it does (Nordqvist, 2014). It is an interdisciplinary science that liaises closely with other disciplines, such as mathematics, linguistics, engineering, computer science, chemistry, philosophy, psychology, and medicine (Nordqvist,2014).

In addition to the set of basic concepts (Table 1), there are eight branches of neuroscience that are of special interest to the field of entre- preneurship: cognitive neuroscience, affective neuroscience, behavioral neuroscience, cultural neuroscience, computational neuroscience, neu- roinformatics, systems neuroscience, and social neuroscience. Nordqvist (2014) succinctly defines these branches: cognitive neurosciences study the higher cognitive functions that exist in humans and their underlying neural bases. Affective neuroscience examines how neurons behave in relation to emotions. Behavioral neuroscience studies the biological bases of behavior, whilst cultural neuroscience looks at how beliefs, practices, and cultural values are shaped by the brain, minds, and genes over different periods. Computational neuroscience attempts to under- stand how brains compute, using computers to simulate and model brain function. Neuroinformatics integrates data across all areas of neuroscience to help understand the brain and treat diseases. Neuroinformatics involves acquiring data, sharing, publishing, and storing information, analysis, modeling, and simulation. Systems neuroscience follows the pathwaysof data flow within the central nervous system to define the kinds of processing going on there and uses that information to explain behavioral functions. Social neuroscience is an interdisciplinary field dedicated to understanding how biological systems implement social processes and behavior (Nordqvist, 2014).

There are two fundamental elements, which when applied jointly, link the contribution of the above branches of neuroscience to entre- preneurship research: the experimental research paradigm and brain- imaging technologies. On the one hand, unlike entrepreneurship, where the usage of experimental methodologies has been limited (Patel and Fiet,2010; Schade and Burmeister, 2009; Simmons et al., 2016), neuroscience research is performed fundamentally through experimental design and the use of brain-imaging technologies. An experiment is the controlled test of a hypothesis (Huettel et al., 2009) and an experimental design can allow effective hypothesis testing through the way in which a scientist sets up the manipulations and measurements of an experiment (Huettel et al., 2009). Experiments entail pluses and minuses (Coolican, 2014); nonetheless,their use might be more beneficial than detrimental to entrepreneur- ship research (Krueger and Welpe, 2008; Schade and Burmeister, 2009; Shepherd et al., 2015; Simmons et al., 2016). Because much of the focus ofentrepreneurship research is on the individual, experiments can be used to provide the most reliable and valid assessment of individual-level behaviorand processes (Patel and Fiet, 2010).

Table 1 Basic concepts

Conceptualizations	**Determining Characteristics**
Neurosciences	Known also as neural science, it studies how the nervous system develops, its structure, and what it does.
Cognitive neurosciences	Use evidence from behavior and the brain to understand human cognition.
Brain imaging	A branch of medical imaging that concentrates on the brain. It can be useful in the study of the brain, how it works, and how different activities affect the brain.
Cognitive psychology	Understands human cognition by using behavioral evidence.
Brain-driven entrepreneurship research	Combines the use of experiments and brain-imaging technologies to explore entrepreneurial phenomena.
Entrepreneurial cognition	Aims to understand the knowledge structures that people use to make assessments, judgments, or decisions involving opportunity evaluation and new venture creation and growth.
Experimental entrepreneurship	Use of natural, economic, and hypothetical experiments in entrepreneurship research.

Thus, the successful application of a neuroscientific approach to the investigation of any entrepreneurship theme presupposes the elaboration of a well-designed experiment. On the other hand, equally relevant is the technological element. The human mind has been studied for thousandsof years, but the human brain has only been studied for about a century (Carter and Shieh, 2015). Only 150 years ago, the ability to study the nervous systems of humans was limited to direct observation and by examining the effects of brain damage in people and other organisms (Carter and Shieh, 2015). Technologies have developed at such a speed that modern neuroscientists now have hundreds of techniques that can be used to answer specific scientific questions (Carter and Shieh, 2015).

Technically known as whole-brain technologies, they can be either structural or functional. Structural techniques produce images of the anatomical architecture of the brain, whereas functional techniques produce images of the physiological processes that underscore neuralactivity (Carter and Shieh, 2015). For instance, functional magnetic resonance imaging (fMRI) and magneto-encephalography (MEG) are functional imaging techniques and, as such, are suitable to be applied to the field of entrepreneurship.

Although these technologies may enable a deeper study of the brain by facilitating higher spatial and temporal resolution (Carter and Shieh, 2015), there is discussion about their relevance to the field. Some scholars argue that these technologies may advance the state of the art in entre- preneurship research (Blair, 2010; de Holan, 2014; Krueger and Welpe, 2014), allowing a better understanding of how decision making (Smith, 2010), entrepreneurial cognition, and emotions (Krueger and Welpe, 2008; Wargo et al., 2010) are processed in the brain. Other experts are cautious about any collaboration between neuroscience and entrepreneurship (Beugré, 2010; Tracey and Schluppeck, 2014).

Brain-driven entrepreneurship research refers to the study of any suit- able topic of entrepreneurship, using both an experimental design in anyof its forms and any existing or forthcoming brain-imaging technologies. Defined as such, a brain-driven approach to entrepreneurship is different from neuroentrepreneurship or entrepreneurial neuroscience in that the scope of these terms remains generic. For instance, neuroentrepreneurship is tacitly referred to as being located at the intersection of neurosciences, entrepreneurship/entrepreneurial cognition, and experiments (Krueger and Welpe, 2008). Other scholars describe it as a new field that has borrowed from work in neuroscience, neuropsychology, and neuroeconomics to better understand and test how entrepreneurs think, behave, and make decisions (Blair, 2010). It is also different from experimental entrepreneurship, because such an approach implies the sole use of experiments to investigate entrepreneurial behavior from the perspectives of economics, cognitive, social, and developmental psychology, neuroscience, philosophy, and evolutionary anthropology (Krueger and Welpe, 2008).

A brain-driven approach to entrepreneurship entails the analysisof cognitive/affective/motivational/hormonal processes, which can be depicted in a single entrepreneur or team of entrepreneurs at a neuraland behavioral level. The cognitive/affective/motivational/hormonal level concerns the internal mental processes reflected as neural substrates and behavioral responses. The neural level focuses on identifying thebrain regions that are activated when entrepreneurs display a particular type of behavior and the behavioral level focuses on the entrepreneurs' responses to various stimuli. Figure 1 presents a summary of the key components of a brain-driven perspective to entrepreneurship research.

In order to understand the scope and contribution of a brain approach to entrepreneurship research, an understanding of the basic concepts highlighted in Table 2. is necessary. From now on, the term brain-driven entrepreneurship research is used as such or in its abbreviated form, BER.

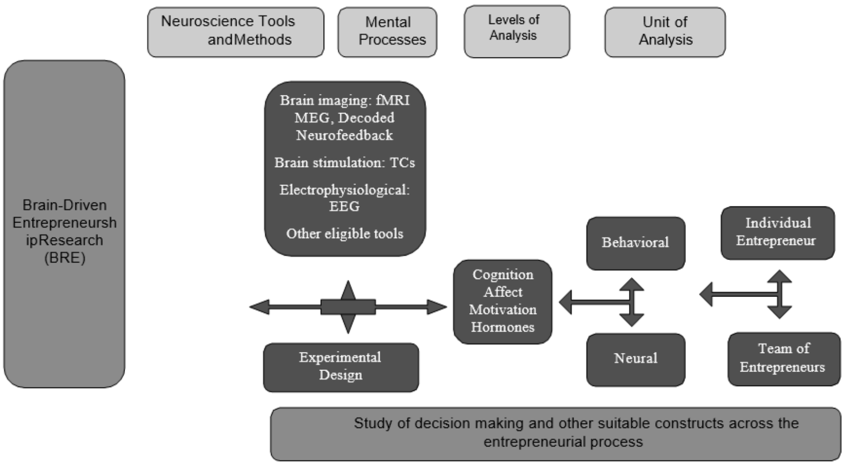

Figure 1 A brain-driven approach to entrepreneurship research (BRE)

From Entrepreneurial Cognition to Brain-Driven Entrepreneurship Research

The possibility to investigate deeper knowledge structures within the arenaof entrepreneurial cognition marks the genesis of scholarly interest in the use of neuroscientific tools (Krueger and Day, 2010). Entrepreneurial cognition is an important perspective in entrepreneurship (R.K. Mitchellet al., 2007; R.K. Mitchell et al., 2002; R.K. Mitchell et al., 2004). To put it simply, entrepreneurial cognition deals with the question: 'how do entre- preneurs think?' (R.K. Mitchell et al., 2007). While earlier approaches to entrepreneurial cognition focused on the psychological processes that underlie behavior (Shaver and Scott, 1991), the area has broadened to focus on heuristic-based logic (Simon et al., 2000), perceptual processes (Gaglio and Katz, 2001), expertise (R.K. Mitchell et al., 2000), and effectuation (Sarasvathy, 2001).

Recent contributions on entrepreneurial cognition have shed light onthe transition from static to dynamic cognitive research conceptualizationsthrough some degree of emphasis on socially situated cognition (Randolph-Seng, Mitchell, and Mitchell, 2014). Randolph-Seng, Mitchell,and Mitchell (2014) argue that these new developments concentrate on four themes: theory, entrepreneurial affect, entrepreneurial neuroscience, and entrepreneurial thought. Carsrud and Brännback (2014) suggest a linkage-focused work connecting cognitive factors such as intentions and motivations to subsequent behaviors such as goal setting. Bird (2014) highlights the crucial role that entrepreneurial behavior plays as a concreteoutcome: one of cognition's most observable outcomes. Randolph-Seng, Williams, and Hayek (2014) integrate the research literature on non- conscious cognition with research in entrepreneurial intentions and intuition.

The interface of feeling with thinking is also relevant. Foo et al. (2014) suggest that the affective/cognitive connection exists and exerts influence across both time and levels of analysis. Grégoire (2014) draws attentionto different types of affective/cognitive forces in entrepreneurship, depending on their enduring versus episodic nature and their plane of influence. Other scholars propose and test a culturally situated model that relates entrepreneurial emotions/passion and cognition/self-efficacy, exploring how these factors impact venture performance (Drnovsek etal., 2014). Baucus et al. (2014) demonstrate how entrepreneurs' brains are physiologically the same as most people's, but are different in terms of their experiences and knowledge. McMullen et al. (2014), in addition to explaining the formation and successful implementation of opportunity beliefs, provide a new view that points to the theme of entrepreneurial neuroscience.

On entrepreneurial thought, Forbes (2014) proposes a new way of thinking about advances in large-scale codification processes (media and so on) and in network formation (markets and social structures),in part because such advanced symbol systems (as well as even the conceptualization of new opportunity) depend upon language as primary to idea transmission and understanding. Clarke and Cornelissen (2014)make a claim for the formative role of language in shaping the ideasof entrepreneurs and their attempts to gain a broader understandingand recognition for a new venture from stakeholders and resource providers. This account attempts to present some of the key findings onentrepreneurial cognition and unveil a concern about its methodologicaland technological limitations, which call for consideration of a brain- driven perspective to advance the frontiers of entrepreneurship research. Some of these limitations are pointed out by Omorede et al. (2015), who argue that: 'some cognition topics that are interesting to advance are methodologically challenging, because it is difficult for peopleto reflect on their own conscious processes, studies of the brain and procedures such as brain scanning are suggested as next step' (p. 766). Baucus et al. (2014) contend that neuroscience renders the entrepreneuras human.

Strengths and Limitations:

There are optimistic and critical voices concerning the academic added value of a brain-driven perspective to entrepreneurship research. Theoptimists argue that neuroscience methods, technologies, and tools may contribute to entrepreneurship research in several ways (Nicolaou and Shane, 2014) from the new possibilities afforded by these new tools (de Holan, 2014). The use of these technologies may help to understand how entrepreneurs think, a major part of what research on entrepreneurial cognition seeks to explain (R.K. Mitchell et al., 2007). Neuroscience may complement aspects of the biological perspective on entrepreneurship (Nicolaou and Shane, 2014) and allow understanding of many facets ofthe practice of entrepreneurship and those who carry it out, by providing evidence that can be developed and taught in classrooms (de Holan, 2014). Schade (2005) highlights the ability of neuroscience to focus closely on individual decisions. Along the same direction, Krueger and Welpe (2014) claim that neuroscience might be useful for a better understanding of entrepreneurs and entrepreneurship.

Neuroscientific tools allow the examination of the mind itself as it is doing something, as it is being done elsewhere (de Holan, 2014). For example, its tools enable analysis of what happens in the mind of a personwho is looking at something that he or she considers beautiful or ugly (Cela-Conde et al., 2004) without having to ask, and therefore avoiding the issues of confusion, desirability, or outright lies (de Holan, 2014). De Holan (2014) contends that the research potential of neuroscience is vast, broad, and not limited to the topics of behavioral decision theory, game theory, perceptions, emotions, and affect. Hoskisson et al. (2011) pointout that these questions might be better approached from a neurological spectrum: what happens in the brain of an entrepreneur that allows him or her to recognize or construct an opportunity, be resourceful, or do bricolage? Is the functioning of his or her brain superior, or just pathologically biased and impervious to the rather slim odds of the successof new ventures? Is success in entrepreneurship related to the capacity to recognize an opportunity, or, as has recently been argued, the capacityto organize resources around that opportunity, or to ignore reality?[2] Is successful entrepreneurship related to a superior ability to reason, or isit more a capacity to seduce people, or both, or neither? And are these differences created? Can they be developed? Do entrepreneurs detectopportunities faster than other people? And if they do, are they more errorprone?

De Holan (2014) suggests that Hoskisson's questions can be better answered with neuroscientific tools than with most of the tools usednow, and the answers produced may permanently change the way the entrepreneur is seen, the entrepreneurial process, and entrepreneurial management in general. If what is needed is more research on the micro antecedents of innovation and performance, one cannot afford to keep ignoring the foundational micro antecedents of any human decision and action: the brain (de Holan, 2014). Entrepreneurship can use theories and techniques developed in the neurosciences to help better understand these phenomena, while neuroscientific research can exploit scientifically interesting phenomena in the field of entrepreneurship (Blair, 2010). Put simply, the application of neurosciences in entrepreneurship represents a unique opportunity to ask questions that could not be answered before, to test questions that could not even be thought to have been asked before,to test questions in a better way, and to get better answers (Krueger and Welpe, 2014).

On the other hand, the potential of neurosciences in entrepreneurship research is treated with some skepticism. McBride (2014) argues that studies linking questions of interest to techniques from cognitive science and neuroscience have been less than impressive, mixed, muddled, or onlypartially true. Tracey and Schluppeck (2014) claim that neuroimaging at the present time is incapable of shedding meaningful light on the questionsthat de Holan suggests it could answer. The cognitive processes are so complex and the uncertainties so great, that it is unclear, for example, as to whether opportunity recognition is rooted in particular cognitive functions that exist in a particular part of some brains, but not in others, and far less easy to disentangle these functions from the broader social and cultural contexts in which individual entrepreneurs (and their brains) are embedded (Tracey and Schluppeck, 2014). To suggest otherwise is to stretch the power of neuroimaging beyond the limits of credibility and may expose entrepreneurship research to ridicule (Tracey and Schluppeck, 2014).

Most neuroscientists do not believe that higher-level cognitive functionscan be localized to a small selection of brain areas: it is very likely that suchfunctions involve a distributed pattern of neural activity across different areas of the brain (Tracey and Schluppeck, 2014). Just because one partof the brain appears more active when a person performs a particulartask does not necessarily imply that it is the part of the brain responsible for that task (Logothetis, 2008). Tracey and Schluppeck (2014) claimthat there is still debate in the literature on neuroscience about the extentto which fMRI reflects excitatory or inhibitory neural responses in any particular brain region. Statistical correlation in neuroimaging data with performance in a task or behavioral traits does not imply that the identified areas play a causative role. As Wade (2006) notes, “If a scan shows that a brain area ‘lights up’ when someone is doodling, that does not mean the area is a doodling centre!” (p. 23).

Coupled with the above-mentioned technical and methodological limitations of neuroscience tools, another explanation why neuroentre- preneurship is not gaining credibility is that it is built on and/or around a view of entrepreneurship that is not a theory (individual/opportunity nexus), and that view itself is built on very dubious ontological grounds (McBride, 2014). As is the case with any methodology used to study a social phenomenon, both the tools that neuroscience uses and the waythey are used are subject to limitations, biases, and boundary conditions (Eastman and Campbell, 2006; Vul et al., 2009). Neuroscience is not a solution to all research questions; nevertheless, not using such a powerful and available research methodology would be a mistake (de Holan, 2014).

Results of the Review

The analysis unveils the early findings of a set of entrepreneurship studies carried out at a brain level. The study covered the totality of peer-reviewed eligible empirical articles published between 1900 and 2016. A summary of the studies is presented in Table 3

Findings and Contributions Using BER in Entrepreneurship Research:

I illustrate what I know about the added value of a brain-driven perspective in entrepreneurship research through the empirical findings and the conceptual ideas put forward from five perspectives: theoretical, behavioral, neural, experimental, and technological.

Decision-making Efficiency Over Decision Speed:

Entrepreneurs’ brains are physiologically the same as other persons’ brains, but in terms of experiences and knowledge they are different(Baucus et al., 2014). One of these differences has to do with how the entrepreneurial context of high uncertainty, ambiguity, time pressure, emotional intensity, and/or high risk affects decision making (Baron,2008; Busenitz and Barney, 1997; Mullins and Forlani, 2005). These studies address the issue of decision making in a context of uncertainty from a brain-level perspective and focus on what is claimed to be substantial to entrepreneurs: finding what differentiates the decision- making ability of entrepreneurs from non-entrepreneurs (Stanton and Welpe, 2010). Applying differing conceptual perspectives and methods, these studies focus on 'entrepreneurial decision making'. Judgment and decision making are well-established topics of interest in management, psychology, sociology, and political science, to name but a few (Gilovich and Griffin, 2010; Hastie, 2001). Within entrepreneurship the topic of entrepreneurial decision making is relevant as well (Baron and Ward, 2004;Shepherd et al., 2015). A recent review categorizes seven decision-making frameworks along the primary activities associated with entrepreneurship: opportunity assessment decisions, entrepreneurial entry decisions, decisions about exploiting opportunities, entrepreneurial exit decisions, heuristics and bias in the decision-making context, characteristics of the entrepreneurial decision maker, and environment as decision context (Shepherd et al., 2015).

These studies implicitly touch upon three dimensions of entrepreneurialdecision making: opportunity assessment decisions, decisions about exploiting opportunities (Laureiro-Martínez et al., 2014), and characteristics of the entrepreneurial decision maker (Ortiz-Terán et al., 2014). Opportunity is at the core of entrepreneurship, so understandinghow entrepreneurs arrive at decisions relating to opportunity recognition, evaluation, and exploitation is critical to advancing our knowledge of the field as a whole (Shane, 2003; Shane and Venkataraman, 2000).At the same time, individuals are heterogeneous in their beliefs and desires, and these differences help explain why some choose to becomeentrepreneurs and why others choose managerial or other employ- ment-related roles (Shepherd et al., 2015). Laureiro-Martínez et al. (2014) examine the neurobiological mechanisms behind decision-mak-ing efficiency among entrepreneurs and managers. They operationalize decision-making efficiency as total payoff divided by response time. Theyhighlight that the ability of making decisions quickly is vital to keep up with fast environmental changes, survival, and market performance. Ortiz-Terán et al. (2014) assess the relationship between neurophysiologic and personality characteristics in entrepreneurial decision making. They mainly focus on how decision making differs between founder entre- preneurs and non-founder entrepreneurs. To put it simply, Laureiro-Martínez et al. (2014) evaluate decision-making in terms of quality and time, whereas Ortiz-Terán et al. (2014) focus mainly on the reaction time,known also as decision-making speed, and the cognitive mechanismsbehind it.

Reaction time is the time taken between the onset of a stimulus/event and the production of a behavioral response (for example, a button press) (Bear et al., 2007). Laureiro-Martínez et al. (2014) conclude that entre- preneurs make more efficient decisions compared to managers. Theirresults suggest that expert decision-making success may be enhanced by the individual's ability to track evidence and in disengaging attentionfrom current reassuring options, both mechanisms leading to more effi- cient decision making. The evidence obtained by Ortiz-Terán et al. (2014) indicates that founder entrepreneurs make faster decisions compared to non-founding entrepreneurs. In their view, founding entrepreneurs might be more oriented toward opportunity recognition and capture and eager to make more rapid decisions about which opportunities to pursue. However, they dedicate significant cognitive resources to deci- sion closure and resolution of residual conflicts (Ortiz-Terán et al., 2014). Entrepreneurs have to invest more mental effort in this process, partly because they need to check the decisions they have just made (Baron and Ward, 2004). These studies make reference to a cognitive approach to entrepreneurial decision making. The cognitive perspective is concerned with mental processes such as perceiving, remembering, reasoning, decid-ing, and problem solving, and it assumes that only by studying mental processes is it possible to fully understand what organisms do (Nolan-Hoeksema et al., 2014). Entrepreneurial activity is influenced by cognitive biases, and cognitive biases strongly influence entrepreneurial decision making (Baron, 2004; Busenitz and Arthurs, 2007; Shaver and Scott, 1991). To examine decision-making efficiency, Laureiro-Martínez et al. (2014) combine a cognitive and exploration–exploitation view. Ortiz-Terán et al. (2014) instead mix a cognitive and personality-trait angle to assess decision making.

These studies use a cognitive view, and further value could have been achieved by characterizing it within the context of existing approaches to entrepreneurial decision making such as the two modes of entrepreneurial decision making: effectuation and causation (Maine et al., 2015), natural- istic decision making (Gustafsson, 2006), the stimulus-organism-responsemodel to entrepreneurial decision making (Michl et al., 2009), and so on. The interplay between the level of certainty (high, medium, low) and elicited cognitive processes portrayed in these studies (intuitive cognition, heuristics, analysis) could have been aided, for instance, by the cognitive continuum theory (Hammond, 1988), or the factors influencing differential susceptibility to cognitive errors by entrepreneurs and others (Baron, 1998).

Baron (1998) confirms that due to the peculiar characteristics of entre-preneurs' environment (notably high levels of uncertainty, novelty, emo- tions, and time pressure) they are apt to demonstrate decision-making biases or heuristics. The list of these includes counterfactual thinking, affect infusion, attributional style, the planning fallacy and self-justifica- tion, and self-serving bias (Baron, 1998).

Table 3 Summary of studies

Key Items	Laureiro-Martínez et al. (2014)	Ortiz-Terán et al. (2014)
Research question	What are the neural bases of individual differences in decision-making efficiency?	What are the relationships between key neurophysiological and personality characteristicsin entrepreneurial decision-making?
Definitions	Decision-making efficiency operationalized as total payoff divided by responsetime	Decision making is a common task that plays a pivotal role in translating perception into action and is affected by factors such as personality or attention. It consists of multiple operations, including multiple option evaluation, actions, and outcome monitoring
Hypothesis	While engaged in a task requiring fast and efficient decision making, individuals with experience in facing a broad range of pressing, heterogeneous decisions, compared with a group experienced in making more specialized choices, will show better performance	Decision-making is different both neurophysiologically and in terms of reaction times in founder entrepreneurs when compared with non-entrepreneurs
Decision-making measure	Performance divided byresponse time. Exploitative/explorative decision making	Reaction time Decision-making speed
Task	4-armed bandit task	Stroop reaction time task
Other measures		Personality: Temperament and character inventory-revised
Data-collectiontool	fMRI	Electroencephalography (EEG)
Sample	24 entrepreneurs and 26 managers	25 founder entrepreneurs and 20 non-entrepreneurs (people who never created a company)
Statistics	SMP toolbox, Matlab v7.4, GLM, ANOVA	Non-parametric Mann-Whitney test, linear regression, ANOVA F-tests, logistic regression analysis
Main results	The groups were comparable in terms of payoff Compared with managers, entrepreneurs get the same result in less time, showing higher decision-making efficiency and a stronger activation in the frontopolar cortex Neural signature of entrepreneurs found in the prefrontal cortex Exploitation and exploration are linked with the activation of different brain areas Exploitative choices recruit ventromedial prefrontal activation Explorative choices engage the fronto-parietal region, anterior cingulate cortex and locus coeruleus	Reaction times indicate that founder entrepreneurs make faster decisions than non-entrepreneurs, both behaviorally and physiologically Faster decision could be linked to better capacity to selective visual attention, response selection, and executive control Unlike non-entrepreneurs, founder entrepreneurs' brains display activity in the supplementary motor areas (inferior parietal sulcus) and the orbitofrontal cortex The novelty-seeking parameter is prominent among founder entrepreneurs

Since entrepreneurs are more liable to use decision-making biases and heuristics than are managers (Busenitz and Barney, 1997), these studies could have profited from the particular assessment of a suitable heuris-tic within their design. Entrepreneurial cognition-based concepts might be used to distinguish entrepreneurs from non-entrepreneurs (R. K. Mitchell, 1994), but they cannot be solely used to assess entrepreneurial decision making. Emotions and motivations also play a key role in entre- preneurial decision making (Michl et al., 2009; Reed, 2010). Evidence shows that the brain is easily fooled by emotional states, which prevent it from making fully rational decisions (Camerer et al., 2005). Lawrence et al. (2008) found that successful entrepreneurs and managers share great ability at rational analysis ('cold' cognition), but entrepreneurs display a significant edge in analyses that engaged both rational and emotional thinking ('hot' cognition). Perhaps unsurprisingly, 'hot' and 'cold' cogni- tion tend to occur in different areas of the brain's front lobes (Kruegerand Welpe, 2014).

Baron (1998, 2000, 2008) postulates that entrepreneurs will experience very intense emotions in their decisions, including the effect of positive and negative emotions. Positive emotions such as joviality and happi-ness might lead entrepreneurs to not fully evaluate all possible outcome alternatives, which consequently results in hasty and premature decisions (Ardichvili et al., 2003; Baron, 2004, 2008). Negative emotions such as anxiety and shame do not have an exactly opposing effect compared to positive emotions, but they are rather heterogeneous (Michl et al., 2009).

Although some researchers still see emotions and cognitions as two independent but interacting phenomena, it is common sense that emotions and cognitions cannot be studied separately from each other, and only an integrative view will lead to an understanding of their effects on entrepre-neurial decision making (Michl et al., 2009). The consideration of emotionsand motivations within the analysis of entrepreneurial decision making from a brain perspective remains a task pending for future studies. These studies denote an effort to assess the decision-making process through the theoretical articulation of a cognitive/exploitation–exploration view (Laureiro-Martínez et al., 2014) and cognitive/personality-traits view(Ortiz-Terán et al., 2014), having in common a brain-level of analysis, never attempted before within the field. I consider these findings as the beginning of a deeper analysis of the phenomena of entrepreneurial decision making, while acknowledging the need for the consideration of the emotional and motivational component to entrepreneurial decision making.

Behavioral Modulation:

The cognitive perspective studies mental processes by focusing on specific behaviors, but interprets them in terms of underlying processes (Nolan-Hoeksema et al., 2014). Decision-making is one of these processes. Justas in neuroscience, brain-driven research in entrepreneurship requires the use of experimental tasks to modulate behavior. Research in neurosciencecomprises two steps: the first aims to assess the behavioral effects of interest, and only if these work out is a neuroimaging tool then applied to investigate the neural correlates of the studied phenomena (Palva, 2014). Avoiding the behavioral component may result in lack of credibility of theresult (Palva, 2014). Hence, any brain-oriented research in entrepreneur- ship should adhere to this requirement. These studies rightly undertake behavioral analysis first. They modulate the participant's decision makingvia the application of two tasks: the basic Stroop reaction time task (Ortiz-Terán et al., 2014) and the 4-armed bandit task (Laureiro-Martínez et al., 2014). The former consists of words about a variety of colors (blue, green,red) printed in colors different from that of the word itself (for example, the word 'blue' is printed in green or red) on a computer screen (Ortiz- Terán et al., 2014). The latter is a classical task of exploitative–explorativedecision making (Daw et al., 2006), which involves repeated choicesamong four different slot machines that lead to variable gains in successivetrials, all having the same structure (Laureiro-Martínez et al., 2014). Both tasks are generally accepted as reasonable proxies, since decisions within the spectrum of entrepreneurship are normally made under the constraints of limited time, knowledge, and computational capacity (Rieskamp and Hoffrage, 2008). The Stroop task is one of the best-known paradigms in cognitive psychology (MacLeod, 2005). The explanation that reading words was much more practiced than naming pictures or colors introducedthe concept of 'automacity' to psychology (Cattell, 1886).

The accounts of what causes the interference produced during the Stroop task are various: degree of practice (Cattell, 1886), speed of processing (Dyer, 1973), competition between ongoing processing of the word and the color dimensions at the same time (Logan, 1980), and build-up of practice for the word pathway being greater than that for the color pathway (Cohen et al., 1990). This variety of possible causal factorssuggests that interpreting the results of Stroop experiments as evidencefor a particular type of processing or for a particular process is suspect (MacLeod, 2005). The reasons behind the interference should be takenas a first step in attempting to explain how entrepreneurs react when presented with an ambiguous stimulus. The scientific measurement of the speed factor in decision making nonetheless provides concrete scientific evidence that proves that founding entrepreneurs make faster decisions as compared to non-founding entrepreneurs. In doing so, it adds value to the topic of entrepreneurial decision making.

Prior studies argued that entrepreneurs rely on heuristics in their decision making more than managers (Deligonul et al., 2008); that the founders of new firms must make quicker decisions than the managersof established firms (Shepherd et al., 2015); that heuristics facilitate entrepreneurial decision making (Busenitz and Barney, 1997); and that optimism, experience, and overconfidence affect entrepreneurial decision making (Shepherd et al., 2015). However, none of them measured the moment in which decision making takes place nor attempted to explain the neural mechanisms behind it. Since every task is subject to improvement, a natural next step is to include the emotional aspect that can be assessedwithin the context of the Stroop task (McKenna and Sharma, 1995). Onthe other hand, the 4-armed bandit task used by Laureiro-Martínez et al. (2014) is appropriate to modulate entrepreneurial decision making, because entrepreneurs make decisions about where to search for new opportunities, and how to exploit known opportunities (Bryant, 2014). They also concentrate their enquiry on measuring performance, which hasalso been a subject of interest in cognitive neuroscience (Cohen et al., 2007;Daw et al., 2006).

Similar to Ortiz-Terán et al. (2014), the investigation of Laureiro-Martínez et al. (2014) is the first of its kind to apply the 4-armed bandittask in the context of entrepreneurial exploration and exploitation. Thetask used by Laureiro-Martínez (2014) is a modified version of the original bandit problem, which is a dynamic decision-making task that is simplydescribed, well-suited to controlled laboratory study, and representativeof a broad class of real-world problems (Steyvers et al., 2009).

Some of the reasons for the suitability of this task to entrepreneurship are the following: bandit problems provide an interesting and useful task for the study of human capabilities in decision making and problem solving (Steyvers et al., 2009). They provide a challenge similar to many real-world problems that is nevertheless simple to understand. They require people to search their environment in intelligent ways to make decisions, exploring uncertain alternatives and exploiting familiar ones (Steyvers et al., 2009). The ability to search effectively, striking the rightbalance between exploration and exploitation, is a basic requirement for successful decision making (Gigerenzer and Todd, 1999) and banditproblems shed light on how people make decisions in general and on howinformation is integrated into decisions in particular (Schulz et al., 2015). The results obtained by Laureiro-Martínez et al. (2014) are the first to assess decision-making efficiency based on data collected directly fromentrepreneurs' brains and elaborate on the possible processes takingplace. They also confirm that entrepreneurs are quicker than managers and as equally efficient as managers when faced with a simulated task ofexploration and exploitation. The depth of analysis and results achievedby Laurie's team is germane when taking into account that a growing body of research on exploration and exploitation study the phenomena from anarrow perspective, mostly within larger, well-established firms (Jansenet al., 2012; Stettner et al., 2014), SMEs to a lesser extent (Frigotto et al.,2014), and entrepreneurial behavior from an individual-level perspective (Kuckertz et al., 2010; Voutsina et al., 2014).

In addition to the appropriateness of the task and the implied cognitive mechanisms trailing decision-making efficiency, the measures of the task could have been improved had the emotional and personality-trait aspect been considered, because performance in bandit problems also seems to have natural links to the personality traits that control risk behavior. Too much exploration in solving a bandit problem could be regarded as a form of risk-seeking behavior, while too much exploitation could be regarded as risk-averse behavior (Steyvers et al., 2009). Moreover, the analysis of individual differences in solving bandit problems, which is also said to be feasible and important (Steyvers et al., 2009), is also a relevant construct to entrepreneurship research, and hence remains a topic for future study.

Experimental Design:

A common complaint among brain-imaging specialists is the misconceptionthat you can simply place a human subject into a scanner, tell them tolook at some stimulus, and then publish the results. Like any other tech- nique, whole-brain imaging experiments must be carefully designed and interpreted, more than the non-specialist may sometimes appreciate (Carterand Shieh, 2015). A brain-driven approach to entrepreneurship requires exactly the same level of accuracy. Like any other experiment in neuro- science, experiments examine the effect of an independent variable on a dependent variable. The independent variable is the experimental variablethat is intentionally manipulated by the researcher and is hypothesizedto cause a change in the dependent variable (Carter and Shieh, 2015).

Experiments, in a technical sense of the word, first manipulate some aspect of the world and then measure the outcome of that manipulation (Huettel et al., 2009). Experiments can isolate cause and effect because the independent variable is controlled (Coolican, 2014) and can control many extraneous influences so that validity is high and alternative explanations of events are eliminated or weakened (Coolican, 2014). Experiments in entrepreneurship research are not prevalent (Schade and Burmeister, 2009; Simmons etal., 2016) in spite of the fact that they may address the internal validity problem of empirical research in entrepreneurship (de Holan, 2014), are effective for theory building (Colquitt, 2008), and facilitate the effective discrimination of the factors of interest from other factors that are often rapidly changing (Krueger and Welpe, 2014).

An exploratory search performed on the SSCI database using the keyword entrepreneur* AND experimental design from 2000 to date revealed that out of 996, only 13 articles have been produced using either an experimental (eight articles) or quasi-experimental (five articles) design. This suggests that experiments in entrepreneurship research represent3 percent of the papers produced. Though the studies differ in terms of their design and measurement tools, so a strict comparison among themis not feasible, it is possible to assess the coherence of their experimental design. A well-designed experiment shares three key characteristics: appropriateness of the independent variable, appropriateness of the dependent variable, and testability of the hypothesis (Huettel et al., 2009).In an experiment, the independent variable can be a stimulus, task, oreven a difference in the subjects being tested, such as their age, gender, ordisease state (Carter and Shieh, 2015). Ortiz-Terán et al. (2014) measured event-related potentials (ERPs), specifically N200,[3] P300,[4] and N450[5] generated by a Stroop task and complemented by the Temperament and Character Inventory revised.[6] They collected brain electrical activity using electroencephalogram (EEG). Laureiro-Martínez et al. (2014) measured BOLD signal intensity generated by a 4-armed bandit task. In their case, indirect brain activity data was gathered using fMRI.

The employed independent variables are suitable: Stroop task (Ortiz-Terán et al., 2014) and 4-armed bandit task (Laureiro-Martínez et al., 2014). The use of subject-generated event boundaries seems appropriate, in that it provides a better estimate of how each subject performs as compared to having other people do the task for them (Huettel et al., 2009). Because the participants do not know that they are going to respond to the tasks until after they have finished viewing them for thefirst time, no bias is introduced by the chosen independent variables (Huettel et al., 2009). The dependent variables: ERPs (Ortiz-Terán et al., 2014) and BOLD signal (Laureiro-Martínez et al., 2014), are appropriate despite the inevitable pluses and minuses of EEG and fMRI. For instance,the pulse sequence used can provide good BOLD and ERP contrast andthus can provide appropriate dependent measures (Huettel et al., 2009). Finally, the hypothesis predicts a straightforward relationship between theindependent and dependent variables: that changes in BOLD signals and ERPs should preferably occur at event boundaries as compared to othertime points. They are also falsifiable, in that it is possible for there to beno significant BOLD or ERP differences associated with event boundaries(Huettel et al., 2009). Based on the above, these studies appear to be well-designed and capable of answering the stated experimental questions.

Neurocognitive Mechanisms of Entrepreneurial Decision-making:

Social and psychological sciences can investigate the effects that changes in the environment and/or in personality traits have on behavior, and can, at most, infer the cognitive and emotional underpinnings (Polezzi et al., 2012). However, to have a proper understanding of the complexity of the interaction going on during a decision process, it is fundamental to also investigate the mutual effects that changes in the environment, behavior, and neural underpinnings have on each other (Polezzi et al., 2012). For this reason, neuroscientific methods can lead to a better understanding of decision making (Polezzi et al., 2012). Aided by comprehensive experimental designs and standard neuroimaging technologies, these studies were successful in locating the brain regions concerned with decision making and provided explanations on how the decision-making processes may take place in the brains of entrepreneurs. Ortiz-Terán et al. (2014) found that founder entrepreneurs need less time to visualize stimulibefore making a decision, a task undertaken mainly in the occipital area, which they claim is due to greater attention to stimuli. Founder entre- preneurs required a longer time for post-evaluation, and the researchers proposed that this might be due to a complex interaction between systems affecting memory, active searching, attention, complex computations, establishing comparisons, decision making, and checking of answers. Theyalso found that entrepreneurs can be differentiated by brain location with regard to two cognitive processes: an early one linked with motor responseinitiation, mostly localized around supplementary motor areas, and a late one linked to integrative cognitive processes, which serves to analyze and evaluate a given response, mainly in the anterior frontal regions.
Laureiro-Martínez et al. (2014) found that, compared with managers, entrepreneurs show higher decision-making efficiency and a stronger activation in regions of the frontopolar cortex (FPC). They confirm that exploitative choices recruit ventromedial prefrontal activations involvedin reward anticipation (Tobler et al., 2007) and tracking the value of thecurrent choice (Boorman et al., 2009; Kolling et al., 2012). Explorativechoices engage the frontoparietal regions, alongside the dorsal sector of the anterior cingulate cortex (dACC) and locus coeruleus, associated with executive and attentional control (Boorman et al., 2009; Corbetta and Shulman, 2002). They conclude that decision-making success might be enhanced by the individual’s ability to track evidence in favor of constantly evolving alternative options, and in disengaging attention from current reassuring options, both mechanisms leading to more efficient decision making. These same skills are likely to promote success in entrepreneurial endeavors that require adaptation to rapidly changing and unforgiving environmental circumstances.

Though perfect research is neither necessary nor possible (Davidsson, 2007), these findings represent the first efforts to understand the decision-making process among entrepreneurs at a brain level, and they add depthto the analysis of existing theories (Endres and Woods, 2006), processes(Gibcus and Hoesel, 2008; Schade and Burmeister, 2009; Vermeulen andCurseu, 2008), and models (Khefacha and Belkacem, 2015; Macchione etal, 2013; Miao and Liu, 2010; Olayinka et al., 2015; Pech and Cameron, 2006; Vermeulen and Curseu, 2008) in entrepreneurial decision making. The explanatory power of their results would have been strengthened by embedding their results within the three stages of the decision-making process: emergence of an idea, elaboration of an idea, and implementationof the decision (Gibcus and Hoesel, 2008), or the six steps in the decision-making process: recognition, formulation, search, evaluation, choice, and implementation. If the decision-making processes of entrepreneurs is influenced by the interplay between the attributes of the decision makerand the specifics of the situation that he or she is facing, it may have beenhelpful to consider the entrepreneurial decision styles that are argued to be characterized by distinct cognitive decision content (Lucas et al., 2008).Since the design of these studies is based on a cognitive view, the analysis of the cognitive components in relation to decision making would have beenenhanced with the use of tools such as cognitive maps (Gómez et al., 2000)and cognitive scripts, both viable ways of examining the cognitive struc- tures of entrepreneurs and understanding the differences between entre-preneurs and managers (Brännback and Carsrud, 2009). These studies arethe first to explore the neural correlates of entrepreneurial decision makingunder an ambiguous task (Ortiz-Terán et al., 2014) and an exploratory–exploitative task (Laureiro-Martínez et al., 2014) and confirm their resultswith prior evidence found in neuroscience research. They conclude that entrepreneurs make faster decisions, and this time issue is relevant because a basic finding in cognitive science is a relation called the speed–accuracytrade-off: a decision maker can increase accuracy at the cost of increasing decision time (Busemeyer, 2015). Decisions take time and the time taken tomake a choice can change the decision (Busemeyer, 2015).

Furthermore, EEG and fMRI technologies were used for the first timein the analysis of entrepreneurial decision making and provide evidence that links decision making with speed (Ortiz-Terán et al., 2014) andwith efficiency (Laureiro-Martínez et al., 2014). The causal evidence achieved at the experimental level by Ortiz-Terán et al. (2014) and Laureiro-Martínez et al. (2014) enhances theory building in a field thatis dominated by retrospective, self-reporting, and correlational research methods (Simmons et al., 2016). For those who doubt the potential of a brain-level approach to entrepreneurship, these results may possiblytell little, but for those who assess this evidence as the natural perfectible steps of an emerging research stream, this evidence may represent the opportunity to get involved.

EEG and fMRI:

One of the major aims of entrepreneurship is to explore how entrepreneursthink differently from non-entrepreneurs (Busenitz and Barney, 1997; R.K.Mitchell, 1994; R.K. Mitchell et al., 2002) and from other entrepreneurs (Baron, 2004, 2006; R.K. Mitchell et al., 2007). Whether decisions are made consciously or unconsciously, they rely heavily on neural processes that entail selection, inhibition, planning, and other aspects of executive control (Purves et al., 2008). To understand the cognitive processingthat underlies decision making means to investigate different factors that collectively can contribute to the final decision (Polezzi et al., 2012). Several techniques allow neuroscientists the opportunity to study the neural basis of cognition, emotion, sensation, and behavior in humans (Carter and Shieh, 2015). These methods are known as functional brain- imaging techniques, and they are used to measure neural activity in the central nervous system without physically penetrating the skull (Carterand Shieh, 2015), that is, to determine which neural structures are active during certain mental operations (Carter and Shieh, 2015). These toolscan show that information is represented in certain places within thebrain without being consciously perceived (Carter and Shieh, 2015). Palva (2014) contends that the neural correlates might be found only if there is prior confirmatory behavioral data. These studies examine the neurocognitive decision-making mechanisms among entrepreneurs and non-entrepreneurs by making use of two brain-imaging techniques: fMRI (Laureiro-Martínez et al., 2014) and EEG (Ortiz-Terán et al., 2014). SincefMRI or EEG training is outside the scope of this chapter, those interestedshould consult additional resources for detailed information about fMRIdesign and analysis (Buxton, 2009; Huettel et al., 2009; Jezzard et al., 2001) or EEG (Picton et al., 2000).

Both tools are appropriate to these studies since their use within neuroscience is known to monitor the evidence or preference accumulation process during decision making (Busemeyer, 2015). Within entrepreneurship, it is the first time these technologies have been applied to the study of decision making. EEG is a non-invasive technique that measures the gross electrical activity of the surface of the brain (Carter and Shieh, 2015). Though it is not truly a brain-imaging technique, since no meaningful images of the brain can be produced using this technique alone, it can be used to ascertain certain particular states of conscious- ness with a temporal resolution of milliseconds (Carter and Shieh, 2015). A powerful application of EEG is in event-related potentials (ERPs), which are distinct, stereotyped waveforms in an EEG report that corresponds to a specific sensory, cognitive, or motor event. For example, if a human subject hears a sudden alarm, the perception of the soundmay be represented as an ERP in the EEG waveform (Carter and Shieh, 2015). An ERP waveform is an electrical signature of all the different cognitive components that contribute to the processing of that stimulus. Systematically varying certain aspects of the stimulus may lead to system-atic variations in particular aspects of the ERP waveform. This enables inferences to be drawn about the timing and independence of cognitive processes (Bear et al., 2007).

What is of interest in ERP data is the timing and the amplitude ofthe task (Bear et al., 2007). Ortiz-Terán et al. (2014) employed ERPsto compute the reaction time among founding entrepreneurs and non-founding entrepreneurs. Aided by LORETA software, they also pursuedidentification of the brain locations generated by the Stroop task. Yetbeyond the explanation of possible decision-making mechanisms, they are unable to disentangle the series of decision-making stages produced. Theapplication of a general method for dividing reaction times into differentstages, such as the additive factors method (Sternberg, 1969), could help to single out the decision-making stages in a more comprehensive fashion.fMRI on the other hand, is a tool to study the neural basis of cognition (Aldrich and Carter, 2004). The main goal of fMRI is to detect the localvariation of the BOLD signal in the brain and its potential correlation witha given task or action (Charron et al., 2008). BOLD is a marker of neuronalmetabolism based on the principle that neurons that are becoming rapidlymore active require nutrients from the blood to support their energy requirements. As part of this hemodynamic response, active neurons will quickly extract oxygen from the blood. This leaves more oxyhemoglobin in the region of the active neurons compared to deoxyhemoglobin, each ofthese displaying different magnetic properties. This variation in magnetic signal can be detected using fMRI to obtain what is referred to as a BOLDsignal (Hart, 2015). One of the biggest limitations of this technique is thatthe signal actually represents an indirect measure of cerebral activity; however, it is a non-invasive, safe, and relatively available technique (Polezzi et al., 2012).

Laureiro-Martínez et al. (2014) applied fMRI to assess decision-making efficiency and identify the neural correlates of exploration and exploitation among entrepreneurs and managers. Their findings are important because, apart from indicating which areas in the brain light up under one condition or another, fMRI can provide access to processes that overt behavior and self-reporting measures cannot. These results can lead tothe identification of causal brain mechanisms that underlie important and complex phenomena (Norris et al., 2007) such as entrepreneurial decision making. fMRI and EEG studies are also complementary, and combining information from them is a useful way to examine the spatial and temporaldynamics of brain processes (Babiloni et al., 2004; Dale et al., 2000; Liebenthal et al., 2003). Each method has its strengths and limitations: the spatial resolution is in the range of millimeters with fMRI, and the time resolution is in the range of milliseconds with EEG (Mulert et al., 2004). This means that the integration of more techniques (fMRI, ERPs and so on) and different kinds of data (behavioral and neurophysiological) can lead to more robust and reliable conclusions compared to those exclusivelybased on behavioral data (Polezzi et al., 2012).

The combined use of fMRI and EEG might also be beneficial to entrepreneurship research, but it is challenging to implement due to the significant amount of new knowledge required. In short, these methods hold much promise (Foo et al., 2014). Brain imaging is making real and important methodological progress, and it is no longer a field that can be characterized as being in its infancy. The practical consequence of all this is that contemporary researchers can no longer afford to be unaware of themethods and language of neuroimaging generally and fMRI in particular (Norris et al., 2007).

Agenda For Future Development And Research

The research agenda suggests paying increased attention to the added value of using a brain-driven approach to entrepreneurship research, particularly, but not only, to the facet of entrepreneurial decision making. It is argued that there is value in grounding entrepreneurship research in neuroscience (Baucus et al., 2014; de Holan, 2014), and neuroscience can be beneficial to entrepreneurship scholarship (Blair, 2010) both in developingunderstanding of the many facets of the practice of entrepreneurship and those who carry it out (de Holan, 2014).

To encourage future research in this direction I then proposed the term 'brain-driven entrepreneurship' and suggested the following definition: brain-driven entrepreneurship research refers to the study of any suitable topic of entrepreneurship using both an experimental design in any of its forms and any existing or forthcoming brain-imaging technologies. The accelerated development of brain-imaging technologies in neuroscience has attracted the attention of scholars from various fields. Although relatively new for our field, these tools have been validated in otherdisciplines such as economics and marketing, and have shown great potential to help clarify questions such as how entrepreneurs perceive andact upon opportunities, what areas of their brain are mobilized when they do so, and whether these differ from other, less entrepreneurial subjects (de Holan, 2014).

While neuroscientific technologies hold much promise (Foo et al., 2014), they do have limitations that need to be taken into account: they rely on reverse inference, in which the engagement of a particular cognitiveprocess is inferred from the activation of a particular brain region (Poldrack, 2006), and these technologies produce largely correlative measures of brain activity, making it difficult to examine the causal roleof specific brain activations for a chosen behavior (Glimcher et al., 2009). Also, research questions related to the interaction of environmental factorswith individual characteristics, to predict how people make decisions, are difficult to operationalize with fMRI studies because only a small numberof individuals, and consequently a small number of environments, are available (Foo et al., 2014). Nonetheless, the advantages afforded bythese tools, such as the possibility to pinpoint what happens in the brain when people make decisions and the precise neural analysis of the links between affective and cognitive processes (Foo et al., 2014), should not be neglected by entrepreneurship scholars, especially by those interested in cognitive, affective, and motivational issues of entrepreneurial behavior.

The use of any of the technologies highlighted in this chapter is not straightforward. Their application requires the elaboration of a well- designed experiment and the existence of behavioral evidence. Any attempt to bypass this 'golden rule' of neuroscience will result in non- credible evidence (Palva, 2014). Further, the multidisciplinary nature of this research methodology demands the collaboration of experts from at least three fields: entrepreneurship, psychology, and neuroscience. Those interested in joining this camp will possibly need to upgrade their skillsin experimental design, cognitive psychology, and, possibly others of the more specialized neuroscience areas.

Broadening the Scope of Research Streams:

Investigation into how entrepreneurs think has become one of the major targets within entrepreneurship research, but a thorough examination of this phenomenon entails methodological (Omorede et al., 2015) constraints and technological opportunities (Foo et al., 2014; Smith, 2010; Wargo et al., 2010) that may be afforded by neuroscience. In fact, neurosciencemay provide new ways to conceptualize and measure important facets of decision making (Smith, 2010). These studies reveal that entrepreneurshipresearch at the brain level is scarce and thus far limited to the topic of entrepreneurial decision-making speed between entrepreneurs and non- entrepreneurs (Ortiz-Terán et al., 2014) and decision-making efficiency (Laureiro-Martínez et al., 2014) among entrepreneurs and managers. The techniques used and the results achieved might not be perfect, as is usual in any new and emerging approach, but the potential is there (Blair, 2010; de Holan, 2014; Nicolaou and Shane, 2014; Smith, 2010).

Neuroscientific tools facilitate a breadth of potential topics and research areas (Smith, 2010). The potential of entrepreneurship research using neuroscientific technologies and tools is broad (Nicolaou and Shane, 2014) and not limited to the topics of behavioral decision theory, game theory, perceptions, emotions, and affect (Krueger and Welpe, 2014). In addition to the need for more brain-driven research on traits, adaptation, expertise, and mindset (McMullen et al., 2014), future research is highly encouraged, particularly from four perspectives: importing concepts and theories from other branches of neurosciences, combining multiple levels of analysis, taking into consideration the mechanisms of each of the stages of the entrepreneurial process, and exploring the links between entrepreneurial mental processes and business sectors.

First, future studies may take into account the inputs of affective neuroscience, behavioral, cultural, computational, social neuroscience, neuroinformatics, and systems neuroscience, as these fields may allow a profound level of analysis of cognitive, motivational, affective, and hormonal processes and mechanisms behind entrepreneurial decision making in particular, and the entrepreneurial process in general. They may also complement research on how hormonal (Nicolaou and Shane, 2014) and genetic differences influence the wiring, structure, and function of the brain (Toga and Thompson, 2005). These topics may represent a completely new world for the majority of entrepreneurship scholars, and its progressive incorporation to the field will take some time. Questions of interest include, for example:

- How do entrepreneurs emotionally process decisions under situations of certainty and uncertainty?
- What are the motivational mechanisms that are activated before, during, and after decision making?
- How do hormones impact upon entrepreneurs' decisions?
- How do all of these factors together affect decision making among entrepreneurs?
- How does the leverage of these factors differ from non-entrepreneurs?
- Where in the brain do these phenomena take place?

Second, Low and MacMillan (1988) argue that entrepreneurship studies could and should be carried out at multiple levels of analysis, and that these analyses complement each other. Entrepreneurship research can be performed at various levels: individual, team, firm, industry/ population, regional, and national (Davidsson and Wiklund, 2001). The reasons for studying entrepreneurship on multiple levels of analysis lie in the characteristics of the entrepreneurial phenomenon itself (Low and MacMillan, 1988). In addition to the need for more studies at the individual level, new investigations are required at the team level. For instance, the two major aims of entrepreneurial team research: how the interaction (Breugst et al., 2015) and composition of the team influence the team's and the venture's development (Knockaert et al., 2011) might be explored at a brain level. An exercise of this nature will need a well- thought-out experimental design and a smart combination of available brain-imaging tools, but it is certainly feasible.

Investigations at other levels: firm, industry/population, regional, and national, might prove to be more challenging to implement. Interesting questions include, for example:

- How does cognition influence decision making among entrepre- neurial teams?
- How does affect impact upon decision making among entrepre- neurial teams in situations of uncertainty?
- How does motivation operate among entrepreneurial teams compared to managerial teams?
- How do these factors change in terms of gender, age, level of education, and culture?
- Which of the brain regions are related to these factors?

Third, the entrepreneurial process is defined as a set of stages and eventsthat follow one another. These stages are the idea or conception of the business, the event that triggers the operations and implementation, and growth (Bygrave, 2009). These studies do not mention the stage to which participating entrepreneurs belong, but they specify that at the time of the study the entrepreneurs had created at least one company (Ortiz-Terán et al., 2014) and they had implemented their idea and were running theirfirms (Laureiro-Martínez et al., 2014). That means that participating entrepreneurs may belong to the stage of either implementation or growth. Further studies should delve deeper into the mechanisms of decision making that take place along the entrepreneurial process froma brain perspective. For instance, studies that examine entrepreneurial decision making during the conception of the business or across the event that triggers the entrepreneurial action may provide new evidence on the interplay of decision making as the entrepreneurial process evolves. The questions of interest include, for example:

- How do cognitive mechanisms of decision making evolve across the stages of the entrepreneurial process?
- What is the interplay of affect and motivation during the conception of the business and the triggering of operations?
- How are these processes reflected in the brain?
- Which brain regions are involved?

Fourth, 'necessity' entrepreneurial activities are commonly observedin the traditional (and informal) sectors, whereas 'opportunity' entrepre- neurial activities occur more in the modern sectors (Caliendo and Kritikos,2010; Desai, 2011; Naudé, 2011). 'Necessity' entrepreneurs are those whoare forced to go into entrepreneurship for reasons such as poverty andlack of employment opportunities. Starting a business is not their prime consideration until they have exhausted other options. On the other hand, 'opportunity' entrepreneurs are those who desire to go entrepreneurial to exploit some identifiable business opportunities such as the perception of amarket opportunity, an innovative idea, or an existing network to exploit (Cheung, 2014). These studies do not provide much information aboutthe sectors in which entrepreneurs operate, which is a relevant issue since it may provide further evidence of their necessity/opportunity orientation and may imply different decision-making mechanisms. Future research should take this into account to be able to parse out the possible cognitive,affective, motivational, and hormonal similarities or differences during decision-making and their possible link to traditional or technology- oriented sectors. Questions of interest include, for instance:

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- What are the cognitive and affective decision-making mechanisms of a necessity entrepreneur compared to an opportunity entrepreneur?
- How does motivation impact on decision-making among necessity entrepreneurs in contrast to opportunity entrepreneurs?
- How does the brain represent these mechanisms?
- Which brain areas are linked to these processes?

Enhancing the Use of Experimental Designs:

One of the primary challenges for a researcher in entrepreneurship is to engage in more systematic, theory-driven efforts (Tan et al., 2009). But, despite the number of published papers that might be considered relatedto the theory of entrepreneurship, no generally accepted theory of entrepreneurship has emerged (Bull and Willard, 1993). Rather than explainingand predicting a unique set of empirical phenomena, entrepreneurshiphas become a broad label under which a wide range of research is housed (Shane and Venkataraman, 2000). Entrepreneurship as a field of research is in need of experimental methodologies to fully study key phenomena (Shane, 2003), but the field is dominated by retrospective, self-reporting, and correlational research methods (Simmons et al., 2016). These research methods do not usually allow researchers to establish causality because thevariables are all measured concurrently, therefore one cannot assume that one variable influences another as the result of a significant correlation (Simmons et al., 2016).

On the other hand, research streams within the field such as, but not limited to, entrepreneurial cognition are facing growing methodological constraints (Omorede et al., 2015) and technological opportunities, which,if adopted, may enhance causality and thus theory-building. Causality is relevant to theoretical contributions as testing causality can validate or reject relationships predicted by theory and answer the question of what triggers the dependent variable and perhaps even why (Simmons et al., 2016). An experiment enables the plausible establishment of causality and,if properly designed, can exclude alternative interpretations by direct and indirect control. Experiments thus address the internal validity problemof empirical research in entrepreneurship (Foo et al., 2014; Krueger and Welpe, 2014). Gatewood et al. (1995) also advocate the use of experimentaldesigns in entrepreneurship research in order to randomize the allocation of respondents to research conditions.

In addition to the advantages of the experiments listed above, experimentsare especially suited to investigate entrepreneurial decision making, due to its dynamic nature. Only with experimental control might the factors of interest be discriminated from 'noise' (Schade, 2005). On a review of 29 academic entrepreneurship-related journals published over the period 2000–15 (Simmons et al., 2016), 40 articles were found with single or multiple designs that employed experimental methods to explore diverse themes, including entrepreneurial decision making, emotions, intentions, opportunities, risk propensity and perception, team dynamics, education, and methodological approaches. The majority of entrepreneurship studies that use experimental design focus on opportunity identification and entrepreneurial intentions.

A lack of use of experiments in entrepreneurship research is a critical issue, not only because it reduces the theory-building possibilities for the field, but also because the methodological component that precedes the use of any neuroimaging technique (EEG, fMRI and so on) is certainlythe articulation of a well-designed experimental design. Not even themost advanced brain-imaging technology can replace the faults of a poor experimental design. Further experimental research is needed not onlyin entrepreneurial decision making, but also other research streams suchas cognitions and emotions, social and human capital, business exits and failure, corporate venture logic and methods (Simmons et al., 2016). It is the articulation of both elements – experimental designs and the use of brain-imaging technologies – that makes a brain-oriented approach to entrepreneurship promising. I anticipate a challenging learning process, especially for scholars unfamiliar with this approach, but at the same timean opportunity to test causality and enhance theory-building within the field.

Promoting the Use of Brain-assessment Technologies:

We do not need to reinvent the wheel in entrepreneurship research as thereare external concepts and theories in other fields that could be tested inthe entrepreneurial context (Landström and Benner, 2010). Brain imagingis an important new addition to the toolbox of empirical researchers,as it provides new behavioral hypotheses and data that can evaluate current theories (Pushkarskaya et al., 2010). It may also provide useful information about the timing and location of brain activation during performance of an enormous range of cognitive tasks. Such information (when combined with behavioral evidence) has proved to be of much valuein increasing our understanding of human cognition (Eysenck, 2006).

Besides EEG and fMRI mentioned in previous sections, there are at leastthree other technologies that deserve consideration. These are magneto-encephalography (MEG), transcranial direct current stimulation (tDCS), and decoded neurofeedback. MEG involves using a superconducting quantum interference device (SQUID) to measure the magnetic fields produced by electrical activity. It has excellent temporal resolution and its spatial resolution can be reasonably good (Eysenck, 2006). In thesame way as fMRI, MEG might be used to examine the neural correlates and the cognitive/affective mechanisms of any them within the scope of entrepreneurial thinking.

Transcranial direct current stimulation (tDCS) is a safe method for non-invasively (Nitsche and Paulus, 2011) modifying the behavior ofneurons and/or neural networks using weak electrical currents (usually 1-2mA) (Lewis et al., 2016) circulating between two scalp electrodes (such as an anode and a cathode) placed over the target cortical regions (Nitsche and Paulus, 2011). tDCS might be useful for entrepreneurial research and practice, because it modulates decision making (Ouelletet al., 2015) and allows studying the interplay of behavior and a specific brain region based on the excitation or inhibition of neuronal activity. Decoded neurofeedback is a technique that helps individuals learn how to self-regulate brain activity with the help of neurological feedback providedby sensory devices. Recent studies suggest that neurofeedback is capable of extinguishing fear memories, changing facial preferences, and so on,at a subconscious level (Kawato and Koizumi, 2016). The application of this method in entrepreneurship might be influential as well, for example the possibility of subconsciously mitigating fear of failure among novice entrepreneurs.

The selection of the appropriate method depends on five factors: the type of phenomena to be investigated, the availability of theoretical/ conceptual skills, the suitability of the chosen techniques, the availability of statistical skills, and the budget. EEG and tDCS are the most economical technologies, whereas the use of MEG, fMRI, and decoded neurofeed- back is rather expensive. Despite the advantages that tools like fMRI may afford to entrepreneurship research, there is a deeper methodology knownas neuronal recording (Rolls, 2014). At this level it is possible to measure the full richness of the information being represented in a brain region by measuring the firing of its neurons. This is impossible with brain-imaging techniques, which also are susceptible to the interpretation problem that whatever causes the largest activation is interpreted as what is beingencoded in a region (Rolls, 2014). Tough neuronal recording can reveal fundamental evidence crucial for our understanding of how the brain operates. It is an invasive method, which significantly limits its application(Rolls, 2014). Neuroscience may generate new ways to conceptualize and measure important facets of decision making, but it should not be forgottenthat there is also a role to be played by qualitative research methodologiessuch as in-depth interviews, observational techniques, self-reflective action research (Smith, 2010), and so on. In addition to recommending thetriangulation of neuroscience tools and field studies (Foo et al., 2014), future research should also aim to intensify the individual and combined use of electrophysiological methods such as EEG; functional brain-imaging techniques such as fMRI and MEG; brain stimulation tools such as tDCS; and novel techniques such as decoded neurofeedback, as longas their use is preceded by a well-designed experiment and backed by behavioral evidence.

Fostering the Development of Skills in Psychology, Neuroscience, andBrain-imaging Tools:

Entrepreneurship researchers have already borrowed concepts and theories from mainstream disciplines such as economics, psychology,and sociology and adapted them to the study of entrepreneurship (Lohrke and Landström, 2010). This intellectual borrowing of concepts and theories from other fields has already produced several major benefits (Lohrke and Landström, 2010). Certainly, undertaking research using a brain-driven approach may become a challenging journey for an entrepre-neurship scholar familiar with traditional research methods, because the execution of such an approach requires the posing of new concepts and theories outside the walls of business schools.

Importing theories from other fields of research is often a necessary first step toward developing unique theories of one's own (Zahra, 2007). For example, terms such as N200, P300, and N450, quite usual in EEG research, or concepts like dopaminergic mesocorticolimbic system, quite common in neuroscience undergraduate courses, might not be under- stood by an entrepreneurship scholar. Therefore, future investigators interested in embracing a brain-oriented research approach should focus on enhancing their knowledge of experimental design, cognitive and affective neuroscience, social neuroscience, brain-imaging technologies, data collection, and analysis tools. This is the minimum toolbox to be equipped with to start this journey.

Entrepreneurship research from a brain perspective is a multidisciplinary endeavor, which requires the accumulation of expertise from various fields. However, when borrowing theories from other disciplines, we need to contextualize the theories that we use (Zahra, 2007). Imported theories and concepts from neurosciences must be adapted because imported theories from other disciplines have been developed to under- stand fundamentally different phenomena from entrepreneurship; there- fore, a mismatch between theory and context can result in inconclusiveor even incorrect findings (Lohrke and Landström, 2010). These studies reveal the high level of cooperation required among disciplines. An average of six scholars contributing from various fields such as economics,management, neurosciences, technology, psychiatry, and business took part in these studies. To increase the production of new evidence and the quality of it within this approach, future efforts should encourage the establishment and formalization of interdisciplinary teams, interfaculty teams, research groups and, ultimately, a research community. The setting and formalization of such initiatives is vital in that it will enhance the implementation of research projects, facilitate knowledge exchange among participating scholars, and ensure the academic quality of resultingevidence. Some steps in this direction have already been carried out with theorganization of two consecutive neuroentrepreneurship symposia during 2014 and 2015 by the Academy of Management, and the preparation of a Massive Open Online Course (MOOC) on brain-driven entrepreneurship. Nonetheless, to date no other initiatives are known to have taken place at an international or university level.

Important Notes

- Cognition focuses on the knowledge structures that people use to make assessments, judgments, or decisions related to evaluating opportunities and creating growing ventures (R.K. Mitchell et al., 2002).
- Each involves different parts of the brain, different neuronal paths, and different skills, some of which are acquired (de Holan, 2014).
- N200 is associated with changing features in the stimulus environment and has been interpreted as an automatic filtering stage for selective attention toward novelty (Luck and Hillyard, 1994). Two specific cognitive processes (response selection and executive control), both related to response inhibition, have been identified in the N200 (Falkenstein et al., 1999).
- P300 is a marker of memory in evaluation of environmental stimuli whenever an ongoingtask requires identification of salient information (Donchin and Coles, 1988).
- Cognitive tasks that require detection of processing conflicts between competing response options (for example, incongruent condition of the Stroop task) reliably elicita N450 (Appelbaum et al., 2009). The N450 is present following both stimulus and response conflict (West et al., 2004).
- (TCI) is an inventory for personality traits devised by Pelissolo et al. (2005). Ortiz-Teránet al. (2014) focused on the dimensions of novelty seeking, harm avoidance, reward dependence, persistence, and self-directedness (Gutiérrez-Zotes et al., 2004).

References

Aldrich, H. and N.M. Carter (2004), “Social Networks,” in W.B. Gartner, K.G. Shaver, N.M. Carter, and P.D. Reynolds (eds), Handbook of Entrepreneurial Dynamics: The Process of Business Creation, London: SAGE, pp. 324–35.

Appelbaum, L., K. Meyerhoff, and M. Woldorff (2009), “Priming and backward influences in the human brain: processing interactions during the stroop interference effect,” *CerebralCortex*, **19** (11), 2508–21.

Ardichvili, A., R. Cardozo, and A. Ray (2003), “A theory of entrepreneurial opportunity identification and development,” Journal of Business Venturing, 18 (1), 105–23.

Babiloni, F., D. Mattia, C. Babiloni, L. Astolfi, S. Salinari, A. Basilisco, . . . and F. Cincotti (2004), “Multimodal integration of EEG, MEG and fMRI data for the solution of the neuroimage puzzle,” Magnetic Resonance Imaging, 22 (10), 1471–6.

Baron, R. (1998), Cognitive mechanisms in entrepreneurship: why and when entrepreneurs think differently than other people. Journal of Business Venturing, 13(4), 275-294.

Baron, R. (2000), “Counterfactual thinking and venture formation: the potential effects of thinking about ‘what might have been’,” Journal of Business Venturing, 15 (1), 79–91.

Baron, R. (2004), “The cognitive perspective: a valuable tool for answering entrepreneur- ship’s basic ‘why’ questions,” Journal of Business Venturing, 19 (2), 221–39.

Baron, R. (2006), “Opportunity recognition as pattern recognition: how entrepreneurs ‘connect the dots’ to identify new business opportunities,” The Academy of Management Perspectives, 20, 104–19.

Baron, R. (2008), “The role of affect in the entrepreneurial process,” Academy of Management Review, 33, 328–40.

Baron, R. and T. Ward (2004), “Expanding entrepreneurial cognition’s toolbox: potential contributions from the field of cognitive science,” Entrepreneurship Theory and Practice, 28 (6), 553–73.

Baucus, D.A., M.S. Baucus, and R.K. Mitchell (2014), “Lessons from the neural foundation of entrepreneurial cognition: the case of emotion and motivation,” in J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham: Edward Elgar, pp. 254–315.

Bear, M.F., B.W. Connors, and M.A. Paradiso (2007), Neuroscience, vol. 2, Boston: Lippincott Williams and Wilkins.

Beugré, C.D. (2010), "Brain and human behavior in organizations: a field of neuro- organizational behavior," in A.A. Stanton, M. Day, and I.M. Welpe (eds), Neuroeconomics and the Firm, Cheltenham, UK: Edward Elgar, pp. 289–303.

Bird, B. (2014), "Toward a taxonomy of entrepreneurs' behaviour," in J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham: Edward Elgar, pp. 113–31.

Blair, E.S. (2010), "What you think is not what you think: unconsciousness and entrepreneurial behavior," in A.A. Stanton, M. Day, and I.M. Welpe (eds), Neuroeconomics and the Firm, Cheltenham, UK: Edward Elgar, pp. 50–65.

Boorman, E.D., T.E. Behrens, M.W. Woolrich, and M.F. Rushworth (2009), "How green is the grass on the other side? Frontopolar cortex and the evidence in favor of alternative courses of action," Neuron, 62 (5), 733–43.

Brännback, M. and A.L. Carsrud (2009), "Cognitive maps in entrepreneurship: researching sense making and action," in A.L. Carsrud and M. Brännback (eds), Understanding the Entrepreneurial Mind, Heidelberg: Springer, pp. 75–96.

Breugst, N., H. Patzelt, and P. Rathgeber (2015), "How should we divide the pie? Equity distri- bution and its impact on entrepreneurial teams," Journal of Business Venturing, 30 (1), 66–94.

Bryant, P.T. (2014), "Self-regulation and entrepreneurial ambidexterity," in U. Stettner, B.S. Aharonson, and T.L. Amburgey (eds), Exploration and Exploitation in Early Stage Ventures and SMEs (Technology, Innovation, Entrepreneurship and Competitive Strategy, vol. 14,Bradford: Emerald Group Publishing Limited, pp. 15–37.

Bull, I. and G.E. Willard (1993), "Towards a theory of entrepreneurship," Journal of Business Venturing, 8 (3), 183–95.

Busemeyer, J.R. (2015), "Cognitive science contributions to decision science," Cognition,135, 43–6.

Busenitz, L.W. and J.D. Arthurs (2007), "Cognition and capabilities in entrepreneurial ventures," in B.J. Robert, M. Frese, and R. Baron (eds), The Psychology of Entrepreneurship, London: Lawrence Earlbaum Associates Publishers, pp. 131–50.

Busenitz, L.W. and J.B. Barney (1997), “Differences between entrepreneurs and managers in large organizations: biases and heuristics in strategic decision-making,” Journal of Business Venturing, 12 (1), 9–30.

Busenitz, L.W. and C.-M. Lau (1996), “A cross-cultural cognitive model of new venture creation,” Entrepreneurship Theory and Practice, 20 (4), 25–40.

Buxton, R.B. (2009), Introduction to Functional Magnetic Resonance Imaging: Principles and Techniques, Cambridge: Cambridge University Press.

Bygrave, W.D. (2009), “The Entrepreneurial Process,” in W.D. Bygrave and A. Zacharakis (eds), The Portable MBA in Entrepreneurship, 4th edn, Hoboken, NJ: John Wiley and Sons, pp. 1–26.

Caliendo, M. and A.S. Kritikos (2010), “Start-ups by the unemployed: characteristics, survival and direct employment effects,” Small Business Economics, 35 (1), 71–92.

Camerer, C., G. Loewenstein, and D. Prelec (2005), “Neuroeconomics: how neuroscience can inform economics,” Journal of Economic Literature, 43 (1), 9–64.

Carsrud, A.L. and M. Brännback (2014), “Linking achievement motivation to intentions, goals and entrepreneurial behaviors,” in J.R. Mitchell, R.K. Mitchell, and B. Randolph- Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham: Edward Elgar, pp. 86–112

Carter, M. and J.C. Shieh (2015), Guide to Research Techniques in Neuroscience, 2nd edn, San Diego: Academic Press.

Cattell, J.M. (1886), “The time it takes to see and name objects,” Mind, 11 (41), 63–5.

Cela-Conde, C.J., G. Marty, F. Maestú, T. Ortiz, E. Munar, A. Fernández, . . . and F. Quesney (2004), “Activation of the prefrontal cortex in the human visual aesthetic perception,” Proceedings of the National Academy of Sciences of the United States of America, 101 (16), 6321–5.

Charron, S., A. Fuchs, and O. Oullier (2008), “Exploring brain activity in neuroeconomics,” Revue d’Economie Politique, 118 (1), 97–124.

Cheung, O.L. (2014), “Are we seeing ‘necessity’ or ‘opportunity’ entrepreneurs at large?,” Research in Business and Economics Journal, 9, 1.

Clarke, J.S. and J.P. Cornelissen (2014), "How language shapes thought: new vistas for entrepreneurship research," in J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham, Edward Elgar, pp. 383–97.

Cohen, J.D., K. Dunbar, and J.L. McClelland (1990), "On the control of automatic processes: a parallel distributed processing account of the Stroop effect," Psychological Review, 97 (3), 332.

Cohen, J.D., S.M. McClure, and J.Y. Angela (2007), "Should I stay or should I go? How the human brain manages the trade-off between exploitation and exploration," Philosophical Transactions of the Royal Society of London B: Biological Sciences, 362 (1481), 933–42.

Colquitt, J.A. (2008), "From the editors publishing laboratory research in AMJ: a question of when, not if," Academy of Management Journal, 51 (4), 616–20.

Coolican, H. (2014), Research Methods and Statistics in Psychology, Hove: Psychology Press.

Cooper, A.C., C.Y. Woo, and W.C. Dunkelberg (1988), "Entrepreneurs' perceived chances for success," Journal of Business Venturing, 3 (2), 97–108.

Corbetta, M. and G.L. Shulman (2002), "Control of goal-directed and stimulus-driven attention in the brain," Nature Reviews Neuroscience, 3 (3), 201–15.

Dale, A.M., A.K. Liu, B.R. Fischl, R.L. Buckner, J.W. Belliveau, J.D. Lewine, and E. Halgren (2000), "Dynamic statistical parametric mapping: combining fMRI and MEG for high-resolution imaging of cortical activity," Neuron, 26 (1), 55–67.

Davidsson, P. (2007), "Method challenges and opportunities in the psychological study of entrepreneurship," In B.J. Robert, M. Frese, and R. Baron (eds), The Psychology of Entrepreneurship, London: Lawrence Earlbaum Associates, pp. 287–323.

Davidsson, P. and J. Wiklund (2001), "Levels of analysis in entrepreneurship research: current research practice and suggestions for the future," Entrepreneurship Theory and Practice, 25 (4), 81–100.

Daw, N.D., J.P. O'Doherty, P. Dayan, B. Seymour, and R.J. Dolan (2006), "Cortical substrates for exploratory decisions in humans," Nature, 441 (7095), 876–9.

de Holan, P.M. (2014), “It’s all in your head: why we need neuroentrepreneurship,” Journal of Management Inquiry, 23, 93–7.

Deligonul, Z.S., G.T.M. Hult, and S.T. Cavusgil (2008), “Entrepreneuring as a puzzle: an attempt to its explanation with truncation of subjective probability distribution of prospects,” Strategic Entrepreneurship Journal, 2 (2), 155–67.

Desai, S. (2011), “Measuring entrepreneurship in developing countries,” in W. Naudé (ed.), Entrepreneurship and Economic Development, Basingstoke: Palgrave Macmillan, pp. 94–107.

Donchin, E. and M.G. Coles (1988), “Is the P300 component a manifestation of context updating,” Behavioral and Brain Sciences, 11 (3), 357–427.

Drnovsek, M., A. Slavec, and M.S. Cardon (2014), “Cultural context, passion and self- efficacy: do entrepreneurs operate on different ‘planets’?,” in J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham: Edward Elgar, pp. 227–53.

Drucker, P. (2014), Innovation and Entrepreneurship, New York: Routledge.

Dyer, F.N. (1973), “Interference and facilitation for color naming with separate bilateral presentations of the word and color,” Journal of Experimental Psychology, 99 (3), 314.

Eastman, N. and C. Campbell (2006), “Neuroscience and legal determination of criminal responsibility,” Nature Reviews Neuroscience, 7 (4), 311–18.

Endres, A.M. and C.R. Woods (2006), “Modern theories of entrepreneurial behavior: a comparison and appraisal,” Small Business Economics, 26 (2), 189–202.

Eysenck, M.W. (2006), Fundamentals of Cognition, Hove: Psychology Press.

Falkenstein, M., J. Hoormann, and J. Hohnsbein (1999), “ERP components in Go/NoGo tasks and their relation to inhibition,” Acta Psychologica, 101 (2), 267–91.

Foo, M.-D., C.Y. Murnieks, and E.T. Chan (2014), “Feeling and thinking: the role of affect in entrepreneurial cognition,” in J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham: Edward Elgar, pp. 154–81.

Forbes, D.P. (1999), “Cognitive approaches to new venture creation,” International Journal of Management Reviews, 1 (4), 415–39.

Forbes, D.P. (2014), The infrastructure of entrepreneurial learning. In J. R. Mitchell, R. K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition (pp. 364- 382), Cheltenham, UK: Edward Elgar Publishing, Inc.

Frigotto, M.L., G. Coller, and P. Collini (2014), “Exploration and exploitation from start- up to sale: a longitudinal analysis through strategy and MCS Practices,” Exploration and Exploitation in Early Stage Ventures and SMEs (Technology, Innovation, Entrepreneurship and Competitive Strategy, vol. 14, Bradford: Emerald Group Publishing, pp. 149–79.

Gaglio, C.M. and J.A. Katz (2001), “The psychological basis of opportunity identification: entrepreneurial alertness,” Small Business Economics, 16 (2), 95–111.

Gatewood, E.J., K.G. Shaver, and W.B. Gartner (1995), “A longitudinal study of cognitive factors influencing start-up behaviors and success at venture creation,” Journal of Business Venturing, 10 (5), 371–91.

Gibcus, P. and P. v. Hoesel (2008), “Strategic decision-making processes in SMEs: an exploratory study,” in P.A.M. Vermeulen and P. L. Curseu (eds), Entrepreneurial Strategic Decision-making: A Cognitive Perspective, Cheltenham, UK: Edward Elgar, pp. 89–104.

Gigerenzer, G. and P.M. Todd (1999), Simple Heuristics that Make Us Smart, New York: Oxford University Press.

Gilovich, T.D. and D.W. Griffin (2010), “Judgment and decision making,” in S.T. Fiske, D.T. Gilbert, and L. Gardner (eds), Handbook of Social Psychology, Hoboken, NJ: John Wiley and Sons, pp. 542–88.

Glimcher, P.W., C.F. Camerer, E. Fehr, and R.A. Poldrack (2009), “Introduction: a brief history of neuroeconomics,” in P.W. Glimcher, C.F. Camerer, E. Fehr, and R.A. Poldrack (eds), Neuroeconomics: Decision Making and the Brain, New York: Academic Press, pp. 1–12.

Gómez, A., A. Moreno, J. Pazos, and A. Sierra-Alonso (2000), “Knowledge maps: an essential technique for conceptualisation,” Data and Knowledge Engineering, 33 (2), 169–90.

Grégoire, D.A. (2014), “Exploring the affective and cognitive dynamics of entrepreneurship across time and planes of influence,” in J.R. Mitchell, R.K. Mitchell, and B. Randolph- Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham, UK: Edward Elgar, pp. 182–226.

Gustafsson, V. (2006), Entrepreneurial Decision-Making: individuals, Tasks and Cognitions. Cheltenham, UK: Edward Elgar Publishing Inc.

Gutiérrez-Zotes, J.A., C. Bayón, C. Montserrat, J. Valero, A. Labad, C. Cloninger, and F. Fernández-Aranda (2004), "Inventario del Temperamento y el Carácter-Revisado (TCI-R), Baremación y datos normativos en una muestra de población general," Actas Españolas de Psiquiatría.

Hammond, K.R. (1988), "Judgement and decision making in dynamic tasks," Colorado University at Boulder Center for Research on Judgment and Policy.

Hart, J. (2015), The Neurobiology of Cognition and Behavior, Oxford: Oxford University Press.

Hastie, R. (2001), "Problems for judgment and decision making," Annual Review of Psychology, 52 (1), 653–83.

Haynie, J.M., D. Shepherd, E. Mosakowski, and P.C. Earley (2010), "A situated metacognitive model of the entrepreneurial mindset," Journal of Business Venturing, 25 (2), 217–29.

Hoskisson, R.E., J. Covin, H.W. Volberda, and R.A. Johnson (2011), "Revitalizing entrepreneurship: the search for new research opportunities," Journal of Management Studies, 48 (6), 1141–68.

Huettel, S., A. Song, and G. McCarthy (2009), Functional Magnetic Resonance Imaging, 2nd edn, Sunderland, MA: Sinauer Associates.

Jansen, J.J., Z. Simsek, and Q. Cao (2012), "Ambidexterity and performance in multiunit contexts: cross-level moderating effects of structural and resource attributes," Strategic Management Journal, 33 (11), 1286–303.

Jezzard, P., P.M. Matthews, and S.M. Smith (2001), Functional MRI: An Introduction to Methods, Oxford: Oxford University Press.

Kawato, M. and A. Koizumi (2016), Decoded Neurofeedback for Extinction of Fear Memory(manuscript submitted for publication).

Khefacha, I. and L. Belkacem (2015), "Modeling entrepreneurial decision-making process using concepts from fuzzy set theory," Journal of Global Entrepreneurship Research, 5 (1), 1–21.

Knockaert, M., D. Ucbasaran, M. Wright, and B. Clarysse (2011), “The relationship between knowledge transfer, top management team composition, and performance: the case of science-based entrepreneurial firms,” Entrepreneurship Theory and Practice, 35 (4), 777–803.

Kolling, N., T.E. Behrens, R.B. Mars, and M.F. Rushworth (2012), “Neural mechanisms of foraging,” Science, 336 (6077), 95–8.

Krueger, N. and M. Day (2010), “Looking forward, looking backward: from entrepreneurial cognition to neuroentrepreneurship,” in Z.J. Acs and D.B. Audretsch (eds), Handbook of Entrepreneurship Research, New York: Springer, pp. 321–57.

Krueger, N. and I. Welpe (2008), “Experimental entrepreneurship: a research prospectus and workshop,” paper presented at the USASBE Annual Conference, San Antonio, TX, 10–13 January.

Krueger, N. and I. Welpe (2014), “Neuroentrepreneurship: what can entrepreneurship learn from neuroscience?,” in M. H. Morris (ed.), Annals of Entrepreneurship Education and Pedagogy, Cheltenham: Edward Elgar, pp. 60–90.

Kuckertz, A., M. Kohtamäki, and C. Droege gen. Körber (2010), “The fast eat the slow – the impact of strategy and innovation timing on the success of technology-oriented ventures,” International Journal of Technology Management, 52 (1/2), 175–88.

Landström, H. (2004), “Pioneers in entrepreneurship research,” in G. Corbetta, M. Huse, and D. Ravasi (eds), Crossroads of Entrepreneurship, Dordretch: Kluwer Academic Publishers, pp. 13–32.

Landström, H. (2007), Pioneers in Entrepreneurship and Small Business Research, New York: Springer.

Landström, H., M. and Benner (2010), “Entrepreneurship research: a history of scholarly migration,” in H. Landström and F. Lohrke (eds), Historical Foundations of Entrepreneurship Research, Cheltenham: Edward Elgar, pp. 15–45.

Laureiro-Martínez, D., S. Brusoni, N. Canessa, and M. Zollo (2014), “Understanding the exploration–exploitation dilemma: an fMRI study of attention control and decision- making performance,” Strategic Management Journal, 36, 319–38.

Lawrence, A., L. Clark, J.N. Labuzetta, B. Sahakian, and S. Vyakarnum (2008), “The inno- vative brain,” Nature, 456, 168–9.

Lewis, P.M., R.H. Thomson, J.V. Rosenfeld, and P.B. Fitzgerald (2016), “Brain neuromodu- lation techniques: a review,” The Neuroscientist, 22 (4), 406–21.

Liebenthal, E., M.L. Ellingson, M.V. Spanaki, T.E. Prieto, K.M. Ropella, and J.R. Binder (2003), “Simultaneous ERP and fMRI of the auditory cortex in a passive oddball paradigm,” Neuroimage, 19 (4), 1395–404.

Logan, G.D. (1980), “Attention and automaticity in Stroop and priming tasks: theory and data,” Cognitive Psychology, 12 (4), 523–53.

Logothetis, N.K. (2008), “What we can do and what we cannot do with fMRI,” Nature, 453(7197), 869–78.

Lohrke, F., and H. Landström (2010), “History matters in entrepreneurship research,” in H. Landström and F. Lohrke (eds), Historical Foundations of Entrepreneurship Research, Cheltenham: Edward Elgar, pp. 1–11.

Low, M.B., and I.C. MacMillan (1988), “Entrepreneurship: past research and future challenges,” Journal of Management, 14, 139–61.

Lucas, G.J., P.A. Vermeulen, and P.L. Curseu (2008), “Entrepreneurial decision styles and cognition in SMEs,” in P.A.M. Vermeulen and P.L. Curseu (eds), Entrepreneurial Strategic Decision Making: A Cognitive Perspective, Cheltenham, UK: Edward Elgar, pp. 105–22.

Luck, S.J. and S.A. Hillyard (1994), “Spatial filtering during visual search: evidence from human electrophysiology,” Journal of Experimental Psychology: Human Perception and Performance, 20 (5), 1000–1014.

Macchione S,M.S., M.A.C. Rocha, and P.S. Bigio (2013), “Entrepreneurial decision-making using the knightian uncertainty approach,” Revista de Administração, 48 (4), 716–26.

MacLeod, C.M. (2005), “The Stroop task in cognitive research,” in A. Wenzel and D.C. Rubin (eds), Cognitive Methods and their Application to Clinical Research, Washington, DC: American Psychological Association, pp. 17–40.

Maine, E., P.-H. Soh, and N. Dos Santos (2015), “The role of entrepreneurial decision- making in opportunity creation and recognition,” Technovation, 39, 53–72.

McBride, R. (2014), “Toward a study of neuroentrepreneurship,” paper presented at the Annual Academy of Management Conference “In Search of the Entrepreneurial Mindset: Insights from Neuroscience,” Philadelphia, 1–5 August.

McKenna, F.P. and D. Sharma (1995), "Intrusive cognitions: an investigation of the emotional Stroop task," Journal of Experimental Psychology: Learning, Memory, and Cognition, 21 (6), 1595.

McMullen, J.S., M.S. Wood, and L.E. Palich (2014), "Entrepreneurial cognition and social cognitive neuroscience," in J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham: Edward Elgar, pp. 316–63.

Miao, Q. and L. Liu (2010), "A psychological model of entrepreneurial decision making,"Social Behavior and Personality, 38 (3), 357–63.

Michl, T., I.M. Welpe, M. Spörrle, and A. Picot (2009), "The role of emotions and cognitions in entrepreneurial decision-making," in L.A. Carsrud and M. Brännback (eds), Understanding the Entrepreneurial Mind, Heidelberg: Springer, pp. 167–90.

Mitchell, J.R., P.N. Friga, and R.K. Mitchell (2005), "Untangling the intuition mess: intuition as a construct in entrepreneurship research," Entrepreneurship Theory and Practice, 29 (6), 653–79.

Mitchell, R.K. (1994), "The composition, classification, and creation of new venture formation expertise," PhD thesis, University of Utah, Salt Lake City, UT.

Mitchell, R.K., L. Busenitz, B. Bird, M. Gaglio, J. McMullen, E. Morse, and B. Smith (2007), "The central question in entrepreneurial cognition research 2007," Entrepreneurship Theory and Practice, 31 (1), 1–27.

Mitchell, R.K., L. Busenitz, T. Lant, P. McDougall, E. Morse, and J.B. Smith (2002), "Toward a theory of entrepreneurial cognition: rethinking the people side of entrepreneurship research," Entrepreneurship Theory and Practice, 27 (2), 93–104.

Mitchell, R.K., L. Busenitz, T. Lant, P. McDougall, E. Morse, and J.B. Smith (2004), "The distinctive and inclusive domain of entrepreneurial cognition research," Entrepreneurship Theory and Practice, 28 (6), 505–18.

Mitchell, R.K., B. Smith, K. Seawright, and E. Morse (2000), "Cross-cultural cognitions and the venture creation decision," Academy of Management Journal, 43 (5), 974–93.

Mulert, C., L. Jäger, R. Schmitt, P. Bussfeld, O. Pogarell, J.-J. Möller, . . . and U. Hegerl (2004), "Integration of fMRI and simultaneous EEG: towards a comprehensive understanding of localization and time-course of brain activity in target detection," Neuroimage, 22 (1), 83–94.

Mullins, J.W., and D. Forlani (2005), “Missing the boat or sinking the boat: a study of new venture decision making,” Journal of Business Venturing, 20 (1), 47–69.

Naudé, W. (2011), “Entrepreneurship is not a binding constraint on growth and develop- ment in the poorest countries,” World Development, 39 (1), 33–44.

Nicolaou, N. and S. Shane (2014), “Biology, neuroscience, and entrepreneurship,” Journal of Management Inquiry, 23 (1), 98–100.

Nitsche, M.A., and W. Paulus (2011), “Transcranial direct current stimulation – update 2011,” Restorative Neurology and Neuroscience, 29 (6), 463–92.

Nolan-Hoeksema, S., B.L. Frederickson, G.R. Loftus, and W.A. Wagenaar (2014), Atkinson and Hilgard’s Introduction to Psychology, Mason, OH: Cengage.

Nordqvist, C. (2014), “What is neuroscience?” Medical News Today, accessed 11 October 2016 at http://www.medicalnewstoday.com/.

Norris, C.J., J.A. Coan, and T. Johnstone (2007), “Functional magnetic resonance imaging and the study of emotion,” in J.A. Coan and J.J.B. Allen (eds), Handbook of Emotion Elicitation and Assessment, Oxford: Oxford University Press, pp. 440–59.

Olayinka, I., A.K. Olusegun, G. Kellikume, and K. Kayode, K. (2015), “Entrepreneur deci- sion making process and application of linear programming technique,” European Journal of Business, Economics and Accountancy, 3 (5), 1–5.

Omorede, A., S. Thorgren, and J. Wincent (2015), “Entrepreneurship psychology: a review,”International Entrepreneurship and Management Journal, 11 (4), 743–68.

Ortiz-Terán, E., A. Turrero, J.M. Santos, P.T. Bryant, T. Ortiz, E. Ortiz-Terán, . . . and T. Ortiz (2014), “Brain cortical organization in entrepreneurs during a visual Stroop deci- sion task,” Clinical, Cosmetic and Investigational Dentistry, 6, 45–56.

Ouellet, J., A. McGirr, F. Van den Eynde, F. Jollant, M. Lepage, and M.T. Berlim (2015), “Enhancing decision-making and cognitive impulse control with transcranial direct current stimulation (tDCS) applied over the orbitofrontal cortex (OFC): a randomized and sham-controlled exploratory study,” Journal of Psychiatric Research, 69, 27–34.

Palva, S. (2014, 14 August), Personal communication.

Patel, P.C. and J.O. Fiet (2010), "Enhancing the internal validity of entrepreneurship experi- ments by assessing treatment effects at multiple levels across multiple trials," Journal of Economic Behavior and Organization, 76, 127–40.

Pech, R.J. and A. Cameron (2006), "An entrepreneurial decision process model describing opportunity recognition," European Journal of Innovation Management, 9 (1), 61–78.

Pelissolo, A., L. Mallet, J.M. Baleyte, G. Michel, C. Cloninger, J.F. Allilaire, and R. Jouvent (2005), "The temperament and character inventory-revised (TCI-R): psychometric characteristics of the French version," Acta Psychiatrica Scandinavica, 112 (2), 126–33.

Picton, T., S. Bentin, P. Berg, E. Donchin, S. Hillyard, R. Johnson, . . . and M. Rugg (2000), "Guidelines for using human event-related potentials to study cognition: recording standards and publication criteria," Psychophysiology, 37 (02), 127–52.

Poldrack, R.A. (2006), "Can cognitive processes be inferred from neuroimaging data?"Trends in Cognitive Sciences, 10 (2), 59–63.

Polezzi, D., C. Guarneri, and C. Civai (2012), "The point of view of neuroscience on decision-making," in K.O. Moore and N.P. Gonzalez (eds), Handbook on Psychology of Decision-Making: New Research, New York: Nova Science Publishers, pp. 1–31.

Purves, D., E.M. Brannon, R. Cabeza, S.A. Huettel, K.S. LaBar, M.L. Platt, and M.G. Woldorff (2008), Principles of Cognitive Neuroscience, vol. 83, Sunderland, MA: Sinauer Associates.

Pushkarskaya, H., M. Smithson, X. Liu, and J.E. Joseph (2010), "1. Neuroeconomics of environmental uncertainty and the theory of the firm," in A.A. Stanton, M. Day, andI.M. Welpe (eds), Neuroeconomics and the Firm, Cheltelham: Edward Elgar, pp. 13–28.

Randolph-Seng, B., J.R. Mitchell, and R.K. Mitchell (2014), "Introduction: historical context, present trends and future directions in entrepreneurial cognition research," In J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial Cognition, Cheltenham: Edward Elgar, pp. 1–60.

Randolph-Seng, B., W.A. Williams, and M. Hayek (2014), "Entrepreneurial self-regulation: consciousness and cognition," in J.R. Mitchell, R.K. Mitchell, and B. Randolph-Seng (eds), Handbook of Entrepreneurial

Cognition, Cheltenham: Edward Elgar, pp. 132–53.

Reed, S.K. (2010), Cognition: Theories and Application, Belmont, CA: Wadsworth Cengage Learning.

Rieskamp, J., and U. Hoffrage (2008), "Inferences under time pressure: how opportunity costs affect strategy selection," Acta Psychologica, 127 (2), 258–76.

Rolls, E.T. (2014), Emotion and Decision-Making Explained, Oxford: Oxford University Press.

Sánchez, J.C., T. Carballo, and A. Gutiérrez (2011), "El emprendedor desde una orientacion cognitiva," Psicothema, 23 (3), 433–9.

Sanders, M. (2007), "Scientific paradigms, entrepreneurial opportunities and cycles in economic growth," Small Business Economics, 28 (4), 339–54.

Sarasvathy, S.D. (2001), "Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency," Academy of Management Review, 26 (2), 243–63.

Schade, C. (2005), "Dynamics, experimental economics, and entrepreneurship," The Journal of Technology Transfer, 30, 409–31.

Schade, C. and K. Burmeister (2009), "Experiments on entrepreneurial decision making: a different lens through which to look at entrepreneurship," Foundations and Trends in Entrepreneurship, 5 (2), 81–134.

Schulz, E., E. Konstantinidis, and M. Speekenbrink (2015), "Exploration-exploitation in a contextual multi-armed bandit task," paper presented at the International Conference on Cognitive Modeling, Groningen, 9–11 April.

Schumpeter, J.A. (1934), The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle, Cambridge, MA: Harvard University Press.

Shane, S. (2000), "Prior knowledge and the discovery of entrepreneurial opportunities," Organization Science, 11 (4), 448–69.

Shane, S. (2003), A General Theory of Entrepreneurship: The Individual-Opportunity Nexus, Aldershot: Edward Elgar.

Shane, S. and S. Venkataraman (2000), "The promise of entrepreneurship as a field of research," The Academy of Management Review, 25, 217–26.

Shaver, K.G. and L.R. Scott (1991), Person, process, choice: the psychology of new venture creation," Entrepreneurship Theory and Practice, 16 (2), 23–45.

Shepherd, D.A., T.A. Williams, and H. Patzelt (2015), "Thinking about entrepreneurial decision making review and research agenda," Journal of Management, 41 (1), 11–46.

Simmons, S., D. Hsu, A. Wieland, and M. Begelfer (2016), "Experimental methodologies: applications and agendas for entrepreneurship research," paper presented at the USASBE Annual Conference, San Diego, CA, 8–14 January.

Simon, M., S.M. Houghton, and K. Aquino (2000), "Cognitive biases, risk perception, and venture formation: how individuals decide to start companies," Journal of Business Venturing, 15 (2), 113–34.

Smith, R. (2010), "Mapping neurological drivers to entrepreneurial proclivity," in A.A. Stanton, M. Day, and I.M. Welpe (eds), Neuroeconomics and the Firm, Cheltenham: Edward Elgar, ch. 11.

Stanton, A.A. and I.M. Welpe (2010), "Risk and ambiguity: entrepreneurial research from the perspective of economics," in A.A. Stanton, M. Day, and I.M. Welpe (eds), Neuroeconomics and the Firm, Cheltenham: Edward Elgar, pp. 29–49.

Sternberg, S. (1969), "The discovery of processing stages: extensions of Donders' method,"Acta Psychologica, 30, pp. 276–315.

Stettner, U., B.S. Aharonson, and T.L. Amburgey (2014), "The interplay between exploration and exploitation in SMEs," in U. Stettner, B.S. Aharonson, and T.L. Amburgey (eds), Exploration and Exploitation in Early Stage Ventures and SMEs (Technology, Innovation, Entrepreneurship and Competitive Strategy), vol. 14, Bradford: Emerald Group Publishing Limited, pp. 3–13.

Steyvers, M., M.D. Lee, and E.J. Wagenmakers (2009), "A Bayesian analysis of human decision-making on bandit problems," Journal of Mathematical Psychology, 53 (3), 168–79.

Tan, J., E. Fischer, R.K. Mitchell, and P. Phan (2009), "At the center of the action: inno- vation and technology strategy research in the small business setting," Journal of Small Business Management, 47 (3), 233–62.

Tobler, P.N., J.P. O'Doherty, R.J. Dolan, and W. Schultz (2007), "Reward value coding distinct from risk attitude-related uncertainty coding in human reward systems," Journal of Neurophysiology, 97 (2), 1621–32.

Toga, A.W. and P.M. Thompson (2005), "Genetics of brain structure and intelligence,"Annual Review of Neuroscience, 28 (1), 1–23.

Tracey, P. and D. Schluppeck (2014), "Neuroentreprenuership: 'brain pornography' or new frontier in entrepreneurship research?" Journal of Management Inquiry, 23 (1), 101–3.

Vermeulen, P.A.M. and P.L. Curseu (2008), "Entrepreneurs and strategic decisions," in P.A.M. Vermeulen and P.L. Curseu (eds), Entrepreneurial Strategic Decision-Making: A Cognitive Perspective, Cheltenham: Edward Elgar, pp. 1–10.

Voutsina, K., G. Mourmant, and F. Niederman (2014), "The range of shocks prompting entrepreneurial employee turnover through the lenses of exploration and exploitation framework," in U. Stettner, B.S. Aharonson, and T.L. Amburgey (eds), Exploration and Exploitation in Early Stage Ventures and SMEs (Technology, Innovation, Entrepreneurship and Competitive Strategy, vol. 14, Bradford: Emerald Group Publishing Limited, pp. 39–66.

Vul, E., C. Harris, P. Winkielman, and H. Pashler (2009), "Puzzlingly high correlations in fMRI studies of emotion, personality, and social cognition," Perspectives on Psychological Science, 4 (3), 274–90.

Wade, C. (2006), "Some cautions about jumping on the brain-scan bandwagon," Observer, 9 September, accessed 11 October 2016 at http://www.psychologicalscience.org/

Wargo, D.T., N.A. Baglini, and K.A. Nelson (2010), "What neuroeconomics informs us about making real-world ethical decisions in organizations," in A.A. Stanton, M. Day, and I.M. Welpe (eds), Neuroeconomics and the Firm, Cheltenham: Edward Elgar, pp. 235–62.

West, R., R. Bowry, and C. McConville (2004), "Sensitivity of medial frontal cortex to response and nonresponse conflict," Psychophysiology, 41 (5), 739–48.

Zahra, S.A. (2007), "Contextualizing theory building in entrepreneurship research," Journal of Business Venturing, 22 (3), 443–52.