Evaluation of Business Opportunities : A Comparative Eye-Tracking Study of Managers and Entrepreneurs

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EVALUATION OF BUSINESS OPPORTUNITIES: A COMPARATIVE EYE-TRACKING STUDY OF MANAGERS AND ENTREPRENEURS

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I. Introduction

In today's fast-evolving and highly competitive business landscape, decision-making is about access to information and the ability to interpret a set of signals from the environment (Butticè et al., 2022). Both entrepreneurs and managers are confronted with recognizing and evaluating business opportunities (Shane & Venkataraman, 2000), and strategic decision-making has long been seen as critical to the success of entrepreneurial ventures and organizational success (Busenitz & Barney, 1997). A recent study by Kleinert and Hildebrand (2024) underscored the role of cognitive processes in decision-making, particularly through the lens of signaling theory, highlighting the importance of different approaches in external communication and their influence on strategic decisions in various market conditions.

However, despite the research advancements in entrepreneurial decision-making and signaling theory, there remains a significant gap in understanding the cognitive mechanisms underpinning strategic decision-making during opportunity evaluation. Traditional research findings, while insightful, are prone to limitations, such as biases inherent in self-reported data (Podsakoff et al., 2003). Drawing upon existing literature, entrepreneurs may underestimate risk and have a business opportunity driven perception, interpreting ambiguous information more positively (e.g., Hmieleski & Baron, 2009). As emphasized by Palich & Ray Bagby (1995) "entrepreneurs are more likely to see the business world through "rose-colored glasses".". How distinct signals during decision-making are processed at a neurological level would provide comprehensive real-time insights and evidence for these findings. Surprisingly, only few entrepreneurial researchers have dived into applying neuroscience to entrepreneurship (Fisch et al., 2021; Halko et al., 2017; Lahti et al., 2019; Laureiro-Martínez et al., 2015; Ooms, Annen, Panda, Cecconi, et al., 2024; Ooms, Annen, Panda, Meunier, et al., 2024; Shane et al., 2020), extending the existing knowledge on the

entrepreneurial mindset. These entrepreneurial scholars have mainly employed fMRI and EEG.

The purpose of this research is to explore the cognitive processes underlying strategic decision-making and to reshape our understanding of both divergences and similarities in the evaluation process, specifically of managers and entrepreneurs. To achieve this, the project is being conducted in collaboration with Associate Professor Sabine Bergner and her team from the University of Graz. Our goal is to replicate her study, *"Keeping an eye on entrepreneurship: an eye-tracking study on entrepreneurial opportunity identification, evaluation, memorization, and recall"* (Bergner et al., 2022), which seeks to answer the question: How do managers and entrepreneurs evaluate business opportunities? Replication studies, particularly in the field of entrepreneurship (Van Witteloostuijn et al., 2021) have become increasingly important, especially in light of the broader replication crisis highlighted by Open Science Collaboration (2015), which emphasized the challenges in reproducing findings across social sciences. This crisis has underscored the need for more rigorous and transparent research practices to ensure that results, especially in dynamic fields like entrepreneurial cognition, are reliable and generalizable. First, they serve as a cornerstone of scientific rigor, enabling researchers to verify and validate prior findings. This is especially important in areas such as entrepreneurial cognition, where cognitive biases, decision-making processes, and opportunity recognition are often influenced by contextual variables that might differ across studies. Replications also contribute to the cumulative nature of scientific knowledge by confirming whether results are generalizable or whether they are contingent on specific situational factors, such as industry, cultural background, or experimental design (Simmons et al., 2011). In entrepreneurship research, where findings frequently inform policy, education, and practice, the ability to replicate cognitive studies is critical. This ensures that frameworks built around how entrepreneurs think, identify opportunities, and make decisions are based on robust evidence. Moreover, replication helps delineate the boundaries between

managers' and entrepreneurs' cognitive processes, highlighting how distinct or similar these groups are in their strategic evaluations. These insights not only enrich theoretical understanding but also have practical implications for training future entrepreneurs and managers in decision-making and opportunity recognition. Thus, replication studies are essential for advancing the field and maintaining the integrity of entrepreneurship research.

As conducted by Bergner, we will examine attention during decision-making by using SWOT analysis. A SWOT, as described by Palich and Bagby (1995), is a widely used framework in organizations, structured into four quadrants to facilitate the evaluation of internal (strengths and weaknesses) and external (opportunities and threats) factors of a strategic situation. Based on Bergner's work and the above discussion, we hypothesize that entrepreneurs will have a higher interest in opportunities and strengths than managers.

Eye-tracking is particularly relevant in the context of evaluating business opportunities since it allows for direct measurements and attention patterns typically not discoverable from self-reported data. Our findings in this study reveal surprising insights: Entrepreneurs allocate, in comparison to managers, significantly more attention to internal factors (strengths and weaknesses) when evaluating business opportunities.

The paper's structure will build upon a comprehensive literature review on decision-making, signaling theory, and cognitive neuroscience. The research design will explain the eye-tracking approach's exact methodology and analysis techniques. Following this, the empirical findings are presented, with a discussion of the interpretation of results and the context of research findings. The paper concludes by addressing limitations and proposing future research directions.

II. Literature Review

II.1 Managerial and Entrepreneurial Opportunity Evaluation and Decision Making

II.1.1 Introduction

The evaluation of business opportunities and decision-making processes are pivotal to the success of both managers and entrepreneurs. While these processes share commonalities, they are shaped by distinct cognitive frameworks, emotional dynamics, and contextual factors. Exploring them through the lens of cognitive science, heuristics, and biases provides critical insights into how managers and entrepreneurs recognize business opportunities.

II.1.2 Cognitive Processes in Opportunity Evaluation

Managers and entrepreneurs have distinct self-perceptions that influence their decision-making processes. Managers emphasize their strategic, organizational, and efficiency-oriented approach, whereas entrepreneurs often see themselves as innovative, risk-taking, and opportunity-focused (Danisman, 2018). Cognitive processes related to self-efficacy influence as well the evaluation of business opportunities (Keane et al., 2021). Cognitive flexibility, the ability to switch between different thinking strategies and perspectives, is important in relation to the ability to evaluate and act on business opportunities (Laureiro-Martínez & Brusoni, 2018). High cognitive flexibility and adaptability enhance entrepreneurial intentions and increase the likelihood of pursuing a new venture (Dheer & Lenartowicz, 2019).

Furthermore, unique cognitive processes distinguish entrepreneurs from non-entrepreneurs. These mechanisms are expressed in counterfactual thinking, affect influence, attribution of success to internal factors (e.g., skills), underestimating risk and overestimating success, self-justification, and escalation of commitment (Baron, 1998). In contrast, findings show that high cognitive flexibility can demonstrate superior performance of entrepreneurs in

business contexts, effectively balancing exploration and exploitation (Laureiro-Martínez & Brusoni, 2018).

Therefore, cognitive science enhances our understanding of business evaluation by exploring specific pattern recognition (Baron & Ward, 2004).

II.1.3 The Role of Emotions in Decision-Making

Emotions significantly influence entrepreneurial decision-making, particularly in uncertain environments. If an entrepreneur chooses to continue or discontinue an investment is often shaped by their emotional response (Brundin & Gustafsson, 2013). This focus on emotions provides an additional understanding of psychological mechanisms that influence cognitive processes in decision-making. Optimism, in particular, can drive entrepreneurs to take risks, but it can also lead to blind spots in risk management (Hmieleski & Baron, 2009). On the other hand, managers are portrayed as more risk-averse, and emotional drivers of their decisions can be fear or caution (Koudstaal et al., 2016).

II.1.4 The Impact of Heuristics and Biases on Opportunity Evaluation

Managers ' and entrepreneurs ' heuristics and biases differ in relation to strategic processes, which can lead to different opportunity evaluations. Entrepreneurs often rely on heuristics and biases and have a higher level of overconfidence (Busenitz & Barney, 1997). While these mental shortcuts can facilitate business opportunity recognition, they may lead to hasty decisions, possibly resulting in unbeneficial business decisions.

Managers, in contrast, use more deliberate and structured decision-making approaches, emphasizing risk management and strategic consistency (Koudstaal et al., 2016).

II.1.5 Cultural and Contextual Influences on Decision-Making

Cultural and contextual factors play a significant role in how individuals evaluate business opportunities and make decisions. This can explain processes and actions that drive entrepreneurial success (Ramoglou et al., 2020). There is a distinction of cultural differences

between entrepreneurs and non-entrepreneurs. Entrepreneurs often see themselves as elitists (McGrath et al., 1992), while non-entrepreneurs may represent different values and behaviors, such as a down-to-earth attitude and emphasizing cost-benefit considerations.

However, the literature does not adequately explain how these cultural self-perceptions translate into tangible business strategies and outcomes. Additionally, globalization may challenge the managerial and entrepreneurial landscape, as cultural factors influence the perception of risk and a possible business opportunity.

II.1.6 Genetic Predispositions in Entrepreneurial Behavior

Genetic factors may also play a role in entrepreneurial behavior and opportunity evaluation, as a predisposition to engage in entrepreneurship can be inherited, i.e. genetic traits, such as risk-taking and a proactive manner (Nicolaou et al., 2008). And yet, this raises the question of how genetic traits may develop into an entrepreneurial mindset. Conceivable as a significant influence could be the interactions with environmental factors such as education and the social context that may cultivate entrepreneurial behavior (Nabi et al., 2017).

II.1.7 The SWOT Analysis: A Strategic Tool for Managers and Entrepreneurs

A widely used strategic tool to evaluate internal and external factors of a business opportunity is the SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis. Both managers and entrepreneurs use the SWOT analysis to systematically evaluate new ventures (Helms & Nixon, 2010). The structured approach of the SWOT in 4 quadrants helps to identify attention related to internal factors, strengths and weaknesses, and external factors, opportunities, and threats.

II.1.8 Conclusion

As we hypothesize, entrepreneurs tend to focus on future growth potential signals and, therefore, might focus more on opportunities, whereas managers tend to focus on performance, strategic stability, and risk management, which may result in attention to strengths and weaknesses (Gruber et al., 2015; Ucbasaran et al., 2013). Previous studies have explored various aspects of decision-making in entrepreneurship (e.g. Busenitz & Barney, 1997) but have not yet explored how managers and entrepreneurs interpret signals within the SWOT framework (Helms & Nixon, 2010; Teece, 2018). Moreover, exploring the role of signals is crucial to understanding how these different signals are interpreted within this framework.

II.2 Signaling Theory in Managerial and Entrepreneurial Context

II.2.1 Introduction

Signaling theory is a valuable framework for understanding behaviors and cognitive patterns from two parties receiving different levels of information (Butticè et al., 2022). This theory helps to explain how information asymmetries between two parties (e.g., investors and entrepreneurs) can be reduced through distinct communication (e.g., potential market growth) (Connelly et al., 2011).

II.2.2 Key Concepts of Signaling Theory

Firstly, Information Asymmetry is the central aspect of signaling theory, where one party (e.g., manager or entrepreneur) has greater information than the other party (e.g., stakeholder or investor) (Connelly et al., 2011).

The Signal is the information sent by the Signaler to communicate the information to the Receiver. The communication aim is to reduce uncertainty for the Receiver. The Receiver is the party that needs to interpret these signals to make decisions accordingly (Drover et al., 2018).

Signal Strength describes a signal's credibility and clarity, such as a sender's reputation, the information provided, and the importance of the assessment. The Signal Interpretation describes the process by which the receiver decodes and evaluates the signals. These interpretations are influenced by various factors, such as social, cultural, and cognitive aspects of the receivers' past experience with similar signals (Bitektine, 2011).

Additionally, Misleading Signals occur when signals intentionally or unintentionally deliver inaccurate information. This may lead to misinterpretations and potentially unfavorable decisions (Plummer et al., 2016).

Conflicting Signals arise when multiple signals contradict one another, leading to confusion or even reduced confidence from receivers, and Signal Validation explains the process of confirming information's accuracy. These processes are often influenced by personal experience (Bergh et al., 2014).

The concept of Separating Equilibrium explains the situations where the signals' anticipated outcome is validated through personal experience and credibility between the sender and the receiver (Bergh et al., 2014).

Finally, Market Signaling defines signaling and its practical value, demonstrating, for instance, that hiring employees is seen as a company's investment decision and communicates a positive signal to stakeholders and investors (Spence, 1978). Understanding these interactions can help to influence the signal interpretation of stakeholders, entrepreneurs, and potential investors.

II.2.3 Application in Management

Managers use various signals, for instance, strategic decisions, financial reports, and overall corporate communication to display the healthiness of a company and its future goals to stakeholders. The performance metrics and the financial statements signal the company's health and long-term prospects and influence stakeholders, including investors, confidence

(Korniotis & Kumar, 2011; Stewart Jr. & Roth, 2001). The importance of strategic signaling has to be recognized by any organization in securing investments. How stakeholders and investors interpret visual cues and other signals influences their decision-making processes and can provide insights into how these signals affect their perception (Connelly et al., 2011).

As entrepreneurs primarily target investors to secure funding, managers communicate with a broad range of stakeholders, such as employees, customers, and investors (Grégoire et al., 2011; Shaver & Scott, 1992). However, both groups use signals to reduce information asymmetry and build credibility within their targeted audience. Emotional factors are crucial and greatly impact their signaling strategy (Shepherd et al., 2015), as they use communication strategies accordingly to transfer their signals effectively (Keane et al., 2021).

II.2.4 Application in Entrepreneurship

Living in an environment with a growing number of startups seeking funding, the early-stage financing is an important and challenging situation. Entrepreneurs may enhance their perceived visibility and overall potential with a well-known third party, to signal trustworthiness to potential new investors (Plummer et al., 2016). Other effective signals that improve the likelihood of an investment is transparent risk information as well as the retention of equity by the founders (Ahlers et al., 2015).

Consequently, effective signaling reduces the perceived risks and increases potential investor's trust. Crowdfunding investors often value costless signals, such as the human capital of founders, differentiating them from other investors (Anglin et al., 2018). These positive signals promote investor's confidence and lead, in many cases, to success in crowdfunding (Bitektine, 2011).

How entrepreneurs can effectively signal the value of a business opportunity to stakeholders, which is particularly relevant in the context of equity crowdfunding and venture capital, is embedded in the concept of "separating equilibrium", which occurs when a signal's

anticipated outcome is validated through the personal experience of the receiver (Bergh et al., 2014).

Besides, a great impact on stakeholder's decisions and behaviors towards organizations depends on social judgments, such as reputation, legitimacy and status. These judgements are interrelated and influence each other (Bitektine, 2011). The credibility of the entrepreneur, which is presented through a distinct human capital, such as education, previous experiences as well as previous business success, signals the ability to execute a new venture (Baron, 1998; Shane & Venkataraman, 2000). Overall, we can state that organizational success is greatly impacted by effective signaling of these social judgements.

Not to be neglected is a company's board, which can serve as a signal to investors, particularly at an initial public offering (IPO). Having notable board members can reduce signal asymmetry and enhance investor's confidence (Certo, 2003). Entrepreneurial signaling influences the dynamic stages of venture development to reduce information asymmetry and attract potential investors (Colombo, 2021).

Regarding early-stage investments, initial network positions can shape the future of a new venture in communicating how interesting an investment might be through the signal of well-established other investors already financing the venture (Hallen, 2008). Furthermore, expert entrepreneurs often use effectual logic, using their network, which also influences their signaling strategy (Dew et al., 2009). Crucial as well is "the role of market conditions for the effectiveness of entrepreneurs signaling strategies" (Kleinert & Hildebrand, 2024).

The interplay of multiple signals can either maximize or minimize the effectiveness of the signaling process. For instance, strong human capital such as high education combined with well-established social capital like industry connections, can significantly impact investor's confidence.

However, conflicting signals could irritate investors and could reduce the funding probability (Plummer et al., 2016). Understanding a sociocognitive perspective on how

signals of different strengths influence investor's interest encompasses the signal strength and strategically managed media attention (Vanacker et al., 2020).

II.2.5 Cognitive Perspective on Signaling Processing

A cognitive perspective on signaling theory and the concept of "signal sets", a group of signals, provides insights into how multiple signals are processed and evaluated in real-world contexts (Butticè et al., 2022). This approach, how signals are prioritized, explores the cognitive foundation of signal attention and their interpretation, which can significantly impact decision-making processes (Drover et al., 2018). Understanding these mechanisms can enhance strategic signal management to attract investors and other stakeholders.

While signal sets enhance the understanding of multi-signal environments, decision-makers cannot process all information due to cognitive limitations (Simon, 1991). These limitations highlight that the effectiveness of signals is vulnerable to being misinterpreted or not recognized by the receiver.

A valuable framework of cognitive science that helps us understand decision-making is the dual-process theory, which has two cognitive approaches (Chaiken, 1980). The first one being system 1, explains the fast, and intuitive thinking. The second one, system 2, refers to a slow, analytical, and deliberate thinking approach (Evans & Stanovich, 2013). Having this in mind, entrepreneurs and stakeholders often employ system 1 in situations of uncertainty and cognitive overload. In contrast, the cognitive mode of system 2 enables the assessment of factors like credibility and risk (Kleinert & Hildebrand, 2024).

II.2.6 Integration of Signaling Theory with the SWOT Analysis

Signaling theory integrated with the SWOT analysis enables the understanding of how different signals are interpreted within each quadrant, providing an accurate framework and overview of a business opportunity (Palich & Ray Bagby, 1995). Entrepreneurs tend to focus on future growth potential signals and therefore might focus more on opportunities and maybe

threats, whereas managers tend to focus on performance, strategic stability, and risk management which may result in attention to strengths and weaknesses (Gruber et al., 2015; Ucbasaran et al., 2013). Previous studies have explored various aspects of decision-making in entrepreneurship (e.g. Busenitz & Barney, 1997) but, as mentioned previously, have not yet explored how managers and entrepreneurs interpret signals within the SWOT framework (Helms & Nixon, 2010; Teece, 2018). The only exception, comparing entrepreneurs to non-entrepreneurs employing a SWOT analysis, used cognitive theory to explore entrepreneurial risk-taking behaviors (Palich & Ray Bagby, 1995).

II.2.7 Conclusion

Signaling theory provides a solid foundation for understanding strategic communication in business. Understanding the different signaling mechanisms used by managers and entrepreneurs offers valuable insights into their distinct decision-making processes and underscores the unique dynamics of their professional environments. Comparing these different signaling practices, highlights how different types of signals are interpreted and finally lead to investment decisions and to the success of a business.

However, most of these studies focus on traditional signals without exploring the full potential of contemporary communication forms, such as social media and AI-driven communication strategies used by companies.

II.3 Intersection of Neuroscience and Signaling Theory in Decision Making

II.3.1 Introduction

Integrating signaling theory and neuroscience enhances a comprehensive understanding of business opportunity evaluation and decision-making processes. Signaling theory provides the framework to understand how information is conveyed and interpreted,

whereas the integration of the neuroscientific approach, like eye-tracking, reveals the cognitive mechanisms behind these processes.

II.3.2 Connecting Signaling Theory with Neuroentrepreneurship

Signaling Theory explains how managers, entrepreneurs, and other stakeholders communicate information (signals) (Spence, 1978). This theory plays a crucial role, particularly in uncertain environments. For instance, entrepreneurs send signals, such as having an experienced team, to investors, influencing their decision-making processes (Connelly et al., 2011).

Following this, neuroentrepreneurship explores how these cognitive processes, emotions, and neural functions impact entrepreneurial behavior. This includes risk-taking, opportunity evaluation, and strategic decision-making (Krueger Jr. & Day, 2010; Massaro et al., 2023).

II.3.3 Cognitive Processes of Signals

Regarding attention and perception, neuroentrepreneurship investigates how related brain functions affect the processing of external signals (Massaro et al., 2023). In eye-tracking, the first fixation on a key business metric may shape initial judgements (Krueger Jr. & Day, 2010). This demonstrates how cognitive processes influence signal interpretation. Using a neuroscientific approach can provide deeper insights, and reduce biases that are common in self-reported and observed data (Massaro et al., 2023). Entrepreneurs also rely on cognitive shortcuts (heuristics) to process information efficiently under uncertainty, for example, time constraints (Kahneman, 2011).

II.3.4 Emotional Influence on Signal Interpretation

The emotional states, for instance, optimism or fear, affect how individuals interpret information, as decision-making outcomes are influenced by the credibility and trustworthiness of signals (Slovic et al., 2010).

In contrast, emotional signaling can positively affect investors' decisions on new ventures. Founders who demonstrate high passion increase investors' neural engagement and interest in the venture (Shane et al., 2020).

Important as well is trust-building between entrepreneurs and stakeholders. It involves brain mechanisms related to social bonding, such as oxytocin release, which enhances the feeling of trust (Kosfeld et al., 2005). Trust is a crucial aspect of reducing information asymmetry (Connelly et al., 2011).

Neuroentrepreneurship can deepen our understanding of how brain mechanisms process signals related to risk and reward, helping to explain why entrepreneurs and stakeholders make certain decisions even under uncertainty (Krueger Jr. & Day, 2010; Slovic et al., 2010). Interesting is also the ability to neurologically adapt to new signals, which is key to entrepreneurial success (Kahneman, 2011). This underlines the signaling theory's emphasis on evolving communication strategies.

II.3.5 Conclusion

Integrating signaling theory with neuroscientific insights could improve the effectiveness of entrepreneurial pitches. Entrepreneurs can tailor their presentations according to which signals capture the most interest and influence a positive emotional response from investors. For instance, using graphical icons to structure financial forecasts or implementing personal stories to underline the startup story could significantly increase neural engagement. To improve managerial communication, managers could use these insights to enhance their strategic communication with stakeholders and achieve their trust by focusing on signals that lead to a high cognitive and emotional reaction (Kaminskiene et al., 2023).

Signaling Theory explains how individuals manage external communication to reduce information asymmetry (Spence, 1978), while neuroentrepreneurship reveals the cognitive and emotional processes behind signal interpretation (Krueger Jr. & Day, 2010). This provides a robust framework for understanding entrepreneurial decision-making. Surprisingly, only a few entrepreneurial scholars have employed neuroscience techniques to explore entrepreneurial cognition (Fisch et al., 2021; Halko et al., 2017; Lahti et al., 2019; Laureiro-Martínez et al., 2015; Ooms, Annen, Panda, Cecconi, et al., 2024; Ooms, Annen, Panda, Meunier, et al., 2024; Shane et al., 2020).

II.4 Empirical Studies in Neuroentrepreneurship

II.4.1 Introduction

After a thorough examination of cognitive and behavioral aspects of decision-making in managerial and entrepreneurial contexts, it becomes evident that further empirical investigation is necessary to deepen our understanding of this research field. To build upon the theoretical foundation encompassing cognitive mechanisms, emotions, heuristics, biases, cultural influences, etc. this section delves into empirical studies in neuroentrepreneurship, providing valuable insights into cognitive processes and neural mechanisms underlying decision-making processes. Empirical studies in neuroentrepreneurship leverage advanced neuroscientific tools such as neuroimaging (fMRI), electroencephalogram (EEG), eye-tracking (ET), heart rate variability (HRV) and galvanic skin response **(**GSR).

II.4.2 Limitations of Self-Reported Data

Research in entrepreneurship often relies on self-reported data, which is prone to limitations. As mentioned previously, self-reported data is susceptible to various biases, including social desirability bias, recall bias, and self-perception bias (Podsakoff et al., 2003).

The Social Desirability Bias explains the fact that individuals give responses that align with socially acceptable norms rather than their true beliefs. This bias falsifies results, as participants may portray themselves favorably (Podsakoff et al., 2003).

The Recall Bias occurs when individuals do not accurately remember past events, leading to incorrect and incomplete statements of their experience. This bias can particularly be problematic in dynamic environments like entrepreneurship, where decisions are made frequently under uncertainty (Bradburn et al., 1987).

The Self-Perception Bias sheds light on circumstances when individuals do not have full awareness of their cognitive and emotional states. This can result in inaccurate self-assessments. Individuals often misinterpret their own thoughts and behaviors due to overestimating their rationality and underestimating the role of emotions (Pronin, 2007).

These biases underscore the need to use more objective and precise methods to capture the cognitive and emotional mechanisms that drive entrepreneurial decision-making. Relying solely on self-reported data presents an insufficient approach to fully explain the complexities of the entrepreneurial mindset and calls for the intersection of research in neuroscience with entrepreneurship.

II.4.3 Integrating Neuroscience in Entrepreneurship Research

Entrepreneurial scholars emphasize that entrepreneurship is a highly cognitive and emotional activity, including decision-making under uncertainty, opportunity evaluation, risk perception, and strategic thinking. Naturally, these activities are rooted in brain activities (Krueger & Welpe, 2014). These scholars advocate for integrating neuroscience techniques in entrepreneurship. They argue that traditional methods, such as interviews and observations, are prone to various limitations and that it is crucial to investigate the underlying neural processes that influence entrepreneurial behavior (e.g. (Laureiro-Martínez et al., 2015).

As explored previously, individuals make conscious and unconscious decisions, and neuroscientific techniques such as fMRI or eye-tracking can provide objective insights into how brain processes make fast and intuitive decisions, introduced with System 1, and deliberate and analytical decisions related to System 2 (Kahneman, 2011).

II.4.4 The Potential of Neuroscience in Entrepreneurship Research

The application of neuroscience in entrepreneurship offers the potential for reliable, precise, and more objective measurements in research.

Functional Magnetic Resonance Imaging (fMRI), for example, allows researchers to observe brain regions that show strong activation during tasks related to decision-making, and opportunity evaluation (Shane et al., 2020). This offers a direct view into how entrepreneurs process information.

Electroencephalography (EEG) measures electrical activity in the brain. It can be used as well to track real-time responses to entrepreneurial decision-making (Laureiro-Martínez et al., 2015). It is also valuable for studying how entrepreneurs switch between different cognitive states, such as analytical and intuitive thinking.

Moreover, Neurofeedback provides the opportunity to help individuals control their brain activity. This technique, using EEG to measure the brain's electrical activity, provides real-time feedback on brain signals presented on a screen. For example, if participants think of something exciting, the screen might show reactions to data. By observing how the feedback changes, entrepreneurs could learn to adjust their brain activity favorably to enhance strategic decision-making (Gruzelier, 2014).

These techniques provide more accurate and empirically grounded insights into how entrepreneurs think, feel, and act. Furthermore, this approach helps mitigate the limitations of self-reported data and offers a biological basis for entrepreneurial behavior.

II.4.5 Empirical Studies Integrating Neuroscience Methods

Only a few entrepreneurial scholars have integrated neuroscience techniques to advance our understanding of entrepreneurship.

Antonio Zaro et al. (2016) used an EEG approach to explore entrepreneurial behavior during the identification of potential business opportunities. In their study, specific brain patterns showed strong activities in areas related to attention and cognitive control, in particular in the frontal cortex, and differences between entrepreneurs and non-entrepreneurs during opportunity evaluation and risk assessment.

The relationship between impulsivity and entrepreneurial tendencies was investigated in a study by Fisch et al. (2021). Findings were that higher impulsivity, observed through quicker reaction times and specific EEG markers, was correlated with a probability of entrepreneurial intentions. This research underscores how complex a prediction of entrepreneurial behavior is and that an understanding of the need for neuroscientific approaches can significantly contribute to scientific research in this field.

The fMRI research of Lahti et al. (2019) compared neural correlates of emotional bonding between entrepreneurs and their ventures with parental bonding. Their study showed that similar brain regions are activated during both types of bonding, as well as areas associated with reward and emotional regulation. Important to mention is that self-confidence effects are crucial for bonding, i.e. how entrepreneurs relate to their ventures.

Another study from Laureiro-Martinez et al. (2015) using fMRI, revealed how entrepreneurs balance exploration and exploitation in decision-making processes. This investigation showed that successful entrepreneurs have a higher activity during these processes in brain areas associated to attention control and strategic thinking, while creating this balance.

Ooms et al. (2024) investigated a resting-state fMRI (rs-fMRI) as a novel approach in neuroentrepreneurship, i.e. without a specific cognitive task for participants. The study shows higher functional connectivity between insula and anterior prefrontal cortex with habitual entrepreneurs compared to managers. The insula is related to cognitive flexibility, the anterior cortex to explorative decision-making.

Another study by Ooms et al. (2024) investigated higher cognitive flexibility at habitual entrepreneurs, in comparison to less experienced entrepreneurs and managers. The research approach included participant's self-reported perception of their cognitive flexibility in combination with fMRI and VBM (Voxel-Based Morphometry) measures.

How emotions influence entrepreneurial decision-making was investigated in a study employing GSR from Serna-Zuluaga et al. (2024). Findings highlight that emotions significantly impact neural processing during decision-making processes. Positive emotions generally enhance risk-taking recognition of potential business opportunities, negative emotions can instead restrain decision-making. Early-stage entrepreneurs showed in comparison to experienced entrepreneurs higher stress levels in situations of uncertainty.

The neural engagement of founders in startup pitches was examined in a study by Shane et al. (2020), using fMRI. Higher neural engagement in brain areas related to emotional and cognitive processing was linked to greater investor's interest and engagement, and higher levels of perceived passion from entrepreneurs. The importance of emotional expressions from entrepreneurs to potential investors underscore as well the potential of using cognitive neuroscience to broaden our knowledge of entrepreneurial cognition.

Alâadany (2023) and Antony et al. (2024) investigated differences between student entrepreneurs and student non-entrepreneurs while evaluating business opportunities, using an ET approach. Their findings showed that student entrepreneurs employ a strategically more

efficient, i.e. faster approach during the decision-making process. Butticè et al. (2022) employed an ET approach as well to examine how potential investors evaluate crowdfunding campaigns. Insights revealed that attention to strong signals is not guaranteed, and that signal set formation varies significantly across different types of investors.

The integration of neuroscience with entrepreneurship research connects cognitive sciences and business studies, providing valuable enrichments in both fields. The findings have practical implications for improving entrepreneurial teaching programs, highlighting cognitive and emotional aspects of decision-making processes (de Holan, 2014).

It is important to recognize that empirical studies in neuroentrepreneurship often have a small sample size due to high costs and complexity of the used technology. In addition, most studies use data at a single point in time, which does not provide an accurate picture of entrepreneurial development stages. Also, findings are often highly context-specific, which may not apply to all managers, entrepreneurs, or business environments.

II.4.6 Conclusion

The interpretation of neuroimaging data is complex and may lead to varying conclusions from different researchers. In this early stage of research in neuroentrepreneurship, some ethical concerns may exist regarding the use of neuroscience to potentially influence managerial and entrepreneurial behavior. To specify, more consideration is needed on the ethical implications of using neuroscientific data in entrepreneurship, especially regarding privacy and the potential for manipulation. It is crucial to find a balance in the enthusiasm of these innovative approaches with a critical evaluation of their meaningful scientific contribution (Tracey & Schluppeck, 2014).

Surprisingly, empirical studies in neuroentrepreneurship often originate from an exploration of the neuroscientific part, whereas it should be considered to investigate the

entrepreneurial field primarily and integrate a neuroscientific tool to enhance our understanding in this area (Kaffka & Krueger, 2018).

In conclusion, the limitations of the self-reported measurements and the potential of neuroscience to overcome these limitations build a strong foundation to advance research in neuroentrepreneurship. Integrating neuroscience techniques offers a comprehensive understanding of cognitive and emotional mechanisms that drive entrepreneurial behavior and moves beyond traditional methods that rely on subjective and potentially biased data. Through incorporating objective, neuroscience-based approaches, researchers gain valuable insights into the entrepreneurial mindset and ultimately contribute to advancing the burgeoning field of neuroentrepreneurship.

II.5 Eye-Tracking Method in Neuroentrepreneurship

II.5.1 Introduction

Eye-tracking, employed to study cognitive processes by providing exact data of where and for how long an individual looks at different signals (or stimuli) (Duchowski, 2017), is a valuable technology for neuroentrepreneurship. While, as discussed above, pioneering empirical studies in neuroentrepreneurship have relied heavily on advanced techniques like fMRI and EEG (Fisch et al., 2021; Ooms, Annen, Panda, Meunier, et al., 2024), these methods come with significant drawbacks. They are complex, costly, and require specialized skills in neuroscience, programming, physiology of the brain, data analysis, and statistical background, among others.

II.5.2 Advantages of Eye-Tracking Technology

In contrast, eye-tracking technology offers a more accessible and practical approach to studying cognitive processes in entrepreneurship. By providing precise data on where and for how long individuals focus their attention on various signals or stimuli (Holmqvist et al.,

2011), eye-tracking can yield valuable insights into decision-making, opportunity recognition, and other cognitive processes relevant to entrepreneurship. Eye-tracking is not only less expensive and easier to set up compared to fMRI and EEG, but it also boasts greater ecological validity (Kowler, 2011). This means that eye-tracking can be used in more naturalistic settings, allowing researchers to study entrepreneurial cognition and behavior in environments that closely mimic real-world conditions.

II.5.3 Practical Application

How managers and entrepreneurs use different signals can be observed through eye-tracking technology and can provide insights into their cognitive processes and decision-making strategies (Salvucci & Goldberg, 2000). The technology measures the activity (points of the gaze and motion) relative to the head. An eye-tracker, such as the Tobii 5 eye-tracker employed in this study, uses infrared light to create a reflection on the cornea, and a high-resolution camera to capture this reflection (Housholder et al., 2022). This technology enables the determination of a person's gaze (Duchowski, 2017).

In research, eye-tracking has been used in various fields such as finance, marketing, psychology, medicine, and health to study visual attention (Adhikari & Stark, 2017; Bott et al., 2020; Duclos, 2015; Semmelmann & Weigelt, 2018), as well as cognitive and decision-making processes (Ahlers et al., 2015). Research has shown that attention plays a critical role in providing insights on how individuals interact with visual stimuli, while giving information on their cognitive strategies (Anderson et al., 2011; Holmqvist et al., 2011). This is important to uncover strategies and heuristics used during evaluation processes, displaying the allocation of the visual attention (Fiedler & Glöckner, 2012).

In empirical neuroentrepreneurial studies, eye-tracking has been used in pilot studies to explore how student entrepreneurs and non-entrepreneurs evaluate business opportunities (Alâadany, 2023; Antony et al., 2024). Moreover, an eye-tracking approach was also used in

a study to reveal insights regarding the effectiveness of educational programs in entrepreneurship. Findings in this research showed that concise and clear information can positively affect how information is processed and lead to a positive development of student competences (Kaminskiene et al., 2023).

Recent advancements have also made it possible to conduct eye-tracking online, using a webcam-based eye-tracking approach. This can significantly increase the accessibility of potential participants (Semmelmann & Weigelt, 2018). However, this approach is still seen critically, regarding accuracy and quality (Cristina & Camilleri, 2018).

Particular visual signals capture more attention of individuals than others (James, 1890). Eye movements and fixations on specific aspects of a pitch for instance, such as product images and financial forecasts, are fundamental indicators of what is interesting for potential investors and finally leads to a business decision (Ashby et al., 2016). Longer fixation on risk-related information can be related to more risk-averse decision-making. This and other specifications can be showcased through the eye-tracking approach and could therefore uncover how managers and entrepreneurs evaluate business opportunities. Patterns could determine applied strategies and heuristics for evaluations and decision-making processes (Fiedler & Glöckner, 2012). Collectively, integrating the cost-effective eye-tracking approach (Duchowski, 2017; Holmqvist et al., 2011) to entrepreneurial studies enables a comprehensive understanding of cognitive processes, of managers and entrepreneurs, involved in organizational decision-making (Meißner & Oll, 2019).

II.5.4 Conclusion

This technology is particularly useful for investigating how entrepreneurs gather and process information, how they identify and evaluate opportunities, and how they make decisions under uncertainty. By analyzing eye movement patterns, researchers can infer cognitive load, attentional focus, and even underlying decision-making strategies.

II.6 Gap in the Literature

Despite significant initial advancements in the field of neuroentrepreneurship (Antonio Zaro et al., 2016, 2016; Fisch et al., 2021; Lahti et al., 2019; Laureiro-Martínez et al., 2015; Ooms, Annen, Panda, Meunier, et al., 2024; Serna-Zuluaga et al., 2024; Shane et al., 2020), there are notable limitations and unexplored areas that request further examination. Current research has primarily focused on general aspects of neuroentrepreneurship but has not entirely investigated the intersection of signaling theory and neuroscience in the context of business evaluation in entrepreneurship.

That managers and entrepreneurs differ in their evaluation of business opportunities was investigated primarily in research based on linguistic analysis. One of these studies shows distinct differences between these two groups evaluating business opportunities (Tata & Niedworok, 2020). Furthermore, an eye-tracking approach was employed to investigate financial decision-making and consumer behavior in marketing (Holmqvist et al., 2011). As mentioned, there are existing studies using for instance fMRI and EEG to explore entrepreneurial behavior, whereas eye-tracking studies in this field are as for now very limited (Alâadany, 2023; Antony et al., 2024). However, specific comparisons of managers and entrepreneurs in research are scarce. Understanding that these two groups need to be compared in decision-making processes is crucial. Beyond mindset, education, and experience (Dweck, 2017), several other factors contribute to the effectiveness of these two groups. Social capital, emotional intelligence, cultural awareness and technological competence are as important (Brynjolfsson & McAfee, 2014; Hofstede, 2001; Mayer et al., 2004; Nahapiet & Ghoshal, 1998). Although they might commonly possess similar business management experience, they have chosen either a position in a company with promotion prospects, or the founding of their own company following a business vision (Shane & Venkataraman, 2000) and leading them to face different personal business situations and environments.

Despite the evidence from existing research that managers and entrepreneurs use a different approach of business opportunity evaluation (Busenitz & Barney, 1997), there is a lack of empirical research using eye-tracking to directly compare how these two groups interpret and prioritize signals during this evaluation. This gap is significant as it highlights the need to explore and understand visual and cognitive processes underlying evaluations and decision-making from a managerial and entrepreneurial perspective.

This research compares managers and entrepreneurs while evaluating potential business opportunities with a presented SWOT analysis, employing an eye-tracking approach. To investigate how managers and entrepreneurs interpret signals from these SWOT analyses and how they handle uncertainty, such as time constraints, is crucial to understand the decision-making process (strategy) and the influence on their judgement (decision). The integrative approach of eye-tracking introduces new possibilities to understand both cognitive and emotional responses to signals. The study's objective is to contribute to a comprehensive view and a nuanced understanding of the business evaluation processes of managers and entrepreneurs, while the multidisciplinary approach aims to strengthen the theoretical context and provide deeper insights into how these two groups strategically assess business opportunities.

II.7 Conclusion

This literature review explored the scope of managerial and entrepreneurial decision making, highlighting the significant roles of cognitive mechanisms, emotional influences and heuristic processes. The integration of signaling theory provided a theoretical framework to understand how managers and entrepreneurs communicate and interpret signals to reduce information asymmetry and make well-considered decisions (Butticè et al., 2022; Connelly et al., 2011).

The introduction of the SWOT analysis exemplifies how managers and entrepreneurs systematically evaluate business opportunities, identifying strengths, weaknesses, opportunities, and threats (Helms & Nixon, 2010; Teece, 2018). Existing literature supports the hypothesis that entrepreneurs focus on opportunities and threats to strive future growth, whereas managers tend to focus on strengths and weaknesses emphasizing operational efficiency and risk management (Busenitz & Barney, 1997).

The empirical studies in neuroentrepreneurship underscored the importance of cognitive flexibility in (adaptive) decision making, revealing cognitive and neural processes underpinning these behaviors (Antonio Zaro et al., 2016; Laureiro-Martínez et al., 2015). The empirical studies in this field validate theoretical models and provide evidence through the observed neural mechanisms during interpretations of signals, thereby bridging the gap between theory and practice (Ooms, Annen, Panda, Cecconi, et al., 2024; Shane et al., 2020).

Moreover, the eye-tracking technology has proven to be a crucial method to understand real-time cognitive strategies (Alâadany, 2023; Antony et al., 2024). This technology's application in entrepreneurship research is particularly valuable to explore how different signals are interpreted during decision making processes, underlining the significant role of visual attention, and displaying how eye-tracking can examine nuances of cognitive processes that other methods might miss. Despite these advancements, the complexity of neuroentrepreneurial research exhibits several challenges and limitations regarding their study settings, the analysis of neural and eye-tracking data as well as the nature of individual variability. Future research should aim to refine methodologies and implement real business world applications.

A significant gap identified in the literature is the comparative analysis of how managers and entrepreneurs evaluate business opportunities using SWOT analysis combined with eye-tracking technology. While previous research has explored the role of signals in decision-making (Butticè et al., 2022), and the use of the SWOT analysis in strategic planning

(Helms & Nixon, 2010), there is a lack of studies specifically exploring which signals managers and entrepreneurs prioritize within the SWOT framework and how these differ. Addressing this gap can provide deeper insights into cognitive strategies of these two investigated groups.

In conclusion, the intersection of neuroscience and signaling theory in decision making offers a promising approach to understand managerial and entrepreneurial behavior. Furthermore, this methodology could reveal how signals can be tailored to meet expectations of stakeholders and enhance the effectiveness of decision-making, while improving communication strategies in managerial and entrepreneurial context. This multidisciplinary approach will therefore contribute to refined business strategies and innovations, driving success in both managerial and entrepreneurial areas.

III. Methodology

III.1 Sample

In this exploratory study, 41 participants were recruited using a personal designed advertisement (see Appendix A) and distributed via online communication, as well as through HEC Liège's student-alumni networks, and incubators in Belgium and Germany. Volunteers first completed an online survey to satisfy inclusion criteria, including proficiency in English and familiarity with the SWOT analysis. The sample consisted of 21 managers and 20 entrepreneurs with an average age of 40,3 (SD =7,03) for managers and 40,94 (SD= 11,95) for entrepreneurs. Their professional experience as a manager or entrepreneur was on average 11,94 years (SD=9,59), with 72,2% holding a master's degree. 5 participants were excluded from the study due to technical issues during the eye-tracking procedure. Therefore, 36 participants were successfully recruited for this study as shown in table 1, consisting of 20 managers and 16 entrepreneurs. This study was approved by the ethical committee of ULiège. All participants gave their informed consent for research from the University of Liège (see Appendix B) and signed a volunteer information form (see Appendix C) prior to data collection. Herein, participants were provided with detailed information about the study's purpose and their rights, including the right to withdraw at any time without penalty. All personal information and data collected during the study were treated with strict confidentiality, and measures were taken to ensure the anonymity of participants. The eye tracking did not pose any harm or risk to participants.

Managers were selected based on their non-involvement in research and development activities within their company and no entrepreneurial intentions or experience. Entrepreneurs were asked if they created or acquired their company. Specific factors, such as revenue, VAT identification number, and the number of employees were inquired to ensure the recruitment of an entrepreneur, having business activity and operational scale. Additionally, since vision

impairments could affect the accuracy of the eye-tracking measurements, we requested information about the eyesight, such as normal vision (naturally or through LASIK and other surgery), corrected-to-normal vision (wearing glasses or contact lenses), color blindness, glaucoma, cataracts, and other specifics.

III.2 Procedure

Before starting the experiment, participants were provided with a task instruction document (see Appendix D) and required to carefully read it. Upon completion, they were asked to summarize the explanations to ensure clarity and understanding of the task. If necessary, misunderstandings were clarified. The experiment utilized a laptop, a Tobii 5 eye-tracker, and a chin rest (see Figure 1). The Tobii 5 eye tracker was positioned beneath the laptop screen. The eye tracker, originally designed for video games, has a data capturing capacity of 33 Hz (recording x and Y coordinates of eye positions 33 times per second), a precision of the gaze of 1.01°, and a coverage spanning 40° in both X-Y planes. The system uses infrared corneal reflection to determine the allocation of the gaze (Housholder et al., 2022). The laptop had a screen resolution of 1920 x 1080.

Participants were seated on an adjustable office chair to allow them to modify the height as needed, as the chin rest stayed in a fixed position. The distance of the eyes to the screen was maintained at 60 cm, which was optimal for the required task completion involving the use of the laptop keyboard arrows and pressing the Enter key. The recommended distance to the eye-tracker is 45 – 95 cm (*Tobii Eye Tracker 5 | Next Generation of Head and Eye Tracking*, n.d.). The ReastEasy open-source chin rest (RestEasy, 2019), a 3D printed device, was used to ensure consistent positioning of the participants as shown in figure 1. The eye tracker is capable of accommodating head movements with six degrees of freedom (6DoF), including translational movements such as surge, sway, heave, as well as rotational movements such as roll, pitch and yaw.

Table 1

Demographics of Total Participants (n=36)

Characteristic	Managers (n=20)	Percentage (%) Managers	Entrepreneurs (n=16)	Percentage (%) Entrepreneurs	Total (n=36)	Percentage (%) Total
Gender						
Male	19	95	12	75	31	86,1
Female	1	5	4	25	5	13,9
Age						
Mean (SD)	40.3 (7.03)		40.94 (11.95)		40,58 (9,39)	
Range	30 - 54		26 - 68		26 - 68	
Educational Level						
CESS	0	0	1	6,25	1	2,8
Bachelor's Degree	7	35	1	6,25	8	22,2
Master's Degree	12	60	14	87.5	26	72,2
PhD	1	5	0	0	1	2,8
Company Size						
Small (1-99 employees)	2	10				
Medium (100-499 employees)	3	15				
Large (500+ employees)	14	70				
Freelancer	1	5				
Owned Company						
Yes	5	25				
No	15	75				
Number of Employees in Owned Company						
Mean (SD)	0.4 (0.89)		10,25 (14,58)		7,90 (13,35)	
Range	0 - 2		0 - 48		0 - 48	
Turnover of Owned Company (€)						
Mean (SD)	182.600,00 (184.506,91)		2.462.500,00 (3.832.092,06)		1.791.941,18 (3.354.251,79)	
Range	22.000,00 - 500.00,00		20.000,00 - 11.000.000,00		20.000,00 - 11.000.000,00	
Eye Sight						
Normal	15	75	8	50	23	63,9
Corrected-to-Normal	5	25	8	50	13	36,1
Weekly Working Hours						
Max. 20 hours	0	0	1	6,25	1	2,8
Max. 38 hours	1	5	0	0	2	5,6
More than 38 hours	19	95	15	93,75	34	94,4
MBA Status						
MBA Student	13	65	1	6,25	14	38,9
MBA Alumni	2	10	7	43,75	9	25
None of these	5	25	8	50	13	36,1
Professional Experience (Years)						
Mean (SD)	10.55 (6.45)		13,69 (12,50)		11,94 (9,59)	
Range	3-30 years		3-45 years		3-45 years	

Note. CESS = Certificate of Secondary Education (Belgium). Turnover data is unavailable for 4 companies with entrepreneurs' group, as participants either opted not to share this information or were unable to provide it.

The accuracy and reliability of the data were ensured through a six-point calibration performed prior to the task using the Tobii Experience software and forwarding to the Mill Mouse software to control the mouse with the gaze. Subsequently, an additional manual check was conducted, asking participants to focus on items on the laptop screen to validate the precision of calibration. If any detection malfunctions occurred, the entire calibration process was repeated. The study room was illuminated with natural light, avoiding direct sunlight (infrared light). Eye movements were acquired using the Tobii 5 eye-tracker and processed with the "EyeSwot" software developed using MATLAB. The raw data included the X-Y coordinate positions and corresponding time stamps.

Figure 1. The data collection setup including the Tobii eye-tracker and the RestEasy chin rest

III.3 Stimuli

Participants evaluated 16 SWOT analyses, with 4 being "Control SWOTs" under a time constraint (6 seconds) added to create an uncertainty. The remaining 12 SWOTs allowed participants to control their time needed. The SWOT slides were translated from the original German SWOTs in Bergner's study into English by a native speaker, employing a back translation method facilitated by artificial intelligence using DeepL (Kunst & Bierwiaczonek, 2023). The slides were presented in a fixed order to ensure consistency across participants.

The SWOT analysis (figure 2) was selected due to its comprehensive approach to assess internal (strengths and weaknesses) and external factors (opportunities and threats) of a business case (Helms & Nixon, 2010). Additionally, the SWOT analysis is widely recognized and employed as a strategic tool among business professionals (Namugenyi et al., 2019).

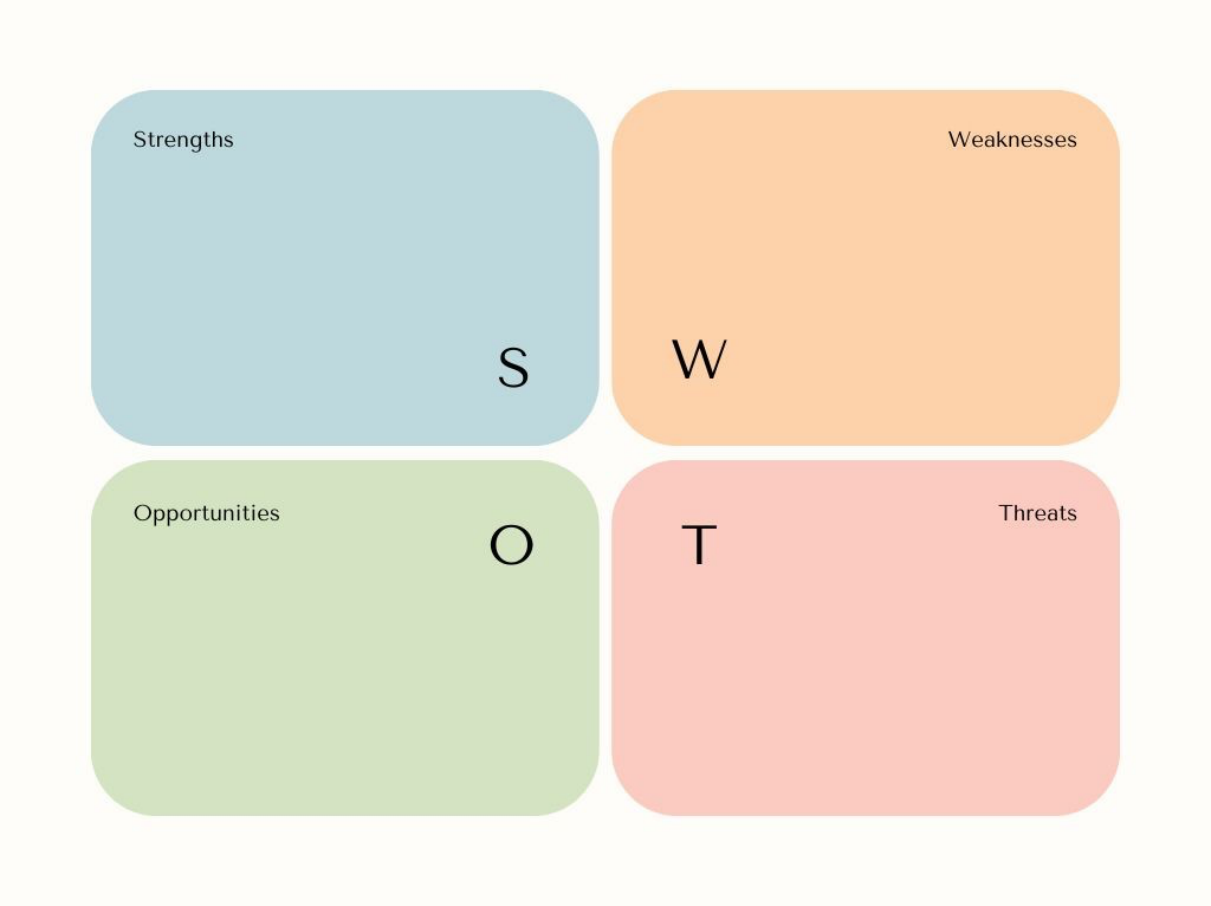

Figure 2. Example of a SWOT Analysis Framework

https://www.canva.com/design/DAGN1U2-zqg/mkwkV6TzCIufa9iODpaGBg/edit

The eye-tracking task consisted of seven phases: (1) The fixation stage where a slide showed a central cross dividing the screen into 4 quadrants. (2) The validation stage presenting a slide with a small cross, in randomized order in one of the quadrants. This small fixation cross needed to be fixated, for quality check, by the participant for at least 1 second to turn green. If the quality check was not successful, the task was terminated. (3) The SWOT category presentation slide familiarized participants during 1 second with the location of the categories as they were constantly randomized (i.e. not in the usual position of a typical SWOT). Participants could identify the placement of the SWOT categories to direct their gaze immediately to the preferential category to complete the task in the next phase. (4) In this phase, four characteristics corresponding to each SWOT category were presented. (5) After each SWOT presentation participants were asked a question using a 7-point Likert scale (1 = "not at all"; 7 = "very much") to determine how likely they would implement the business opportunity. The answer was selected using the arrows on the laptop keyboard, for ease of use for participants and avoiding any strong movements. See figure 3 for the trial sequence of the study design. (6) We implemented a recall question after each SWOT analysis where participants verbally reported about one standout item (i.e. what had led them primarily to their rating). After completion of this analysis, participants pressed the Enter key to get to the next SWOT analysis (i.e. the stimulus). Once answered, no changes were possible.

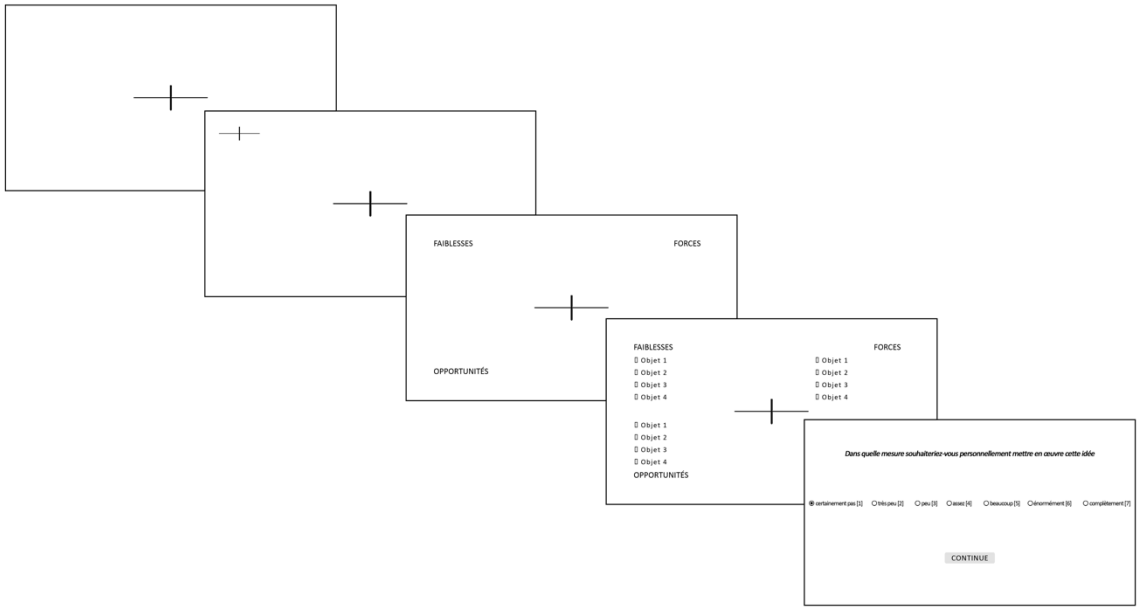

Figure 3. The trial sequence of the study design consisting of 5 slides

After completion of the 16 SWOT trials (12 SWOTs and 4 "Control SWOTs"), participants were asked about the experiment and whether they had used any specific strategy using a semi-structured interview (7). The question asked to participants was: "Did you use any specific strategy when evaluating the business opportunities? If so, please describe the strategy you applied."

Additionally, observations were made regarding the participants' behavior, including attentiveness, nervousness, irritations, and other relevant factors. The entire process, encompassing the eye-tracking procedure and the semi-structured interview, took an average of 30 minutes per participant in the manager's group and 45 minutes per participant in the entrepreneur's group.

III.4 Behavioral and Eye-Tracking Measures

The duration of the gaze, i.e. the length of time spent on specific information areas, can significantly impact the quality and outcomes of decision-making. Extended gaze durations on specific areas correlate with more informed decision-making (Orquin & Mueller

Loose, 2013). In this study, gaze duration and gaze frequency on the different SWOT categories were used as measures of the participant's information processing.

Four regions of interest (ROI) were defined around the SWOT elements to isolate and retain only the fixations specifically associated with each SWOT element (see figure 4). Fixation and saccades detection was performed using the velocity threshold detection, I-VT algorithm (Salvucci & Goldberg, 2000), using the MATLAB R2023a software (see Appendix E for further information regarding full data extraction pipeline). The first fixation point at the first quadrant looked at was recorded without considering the length of time. The fixation time was measured by the sum of durations spent attending to a specific area.

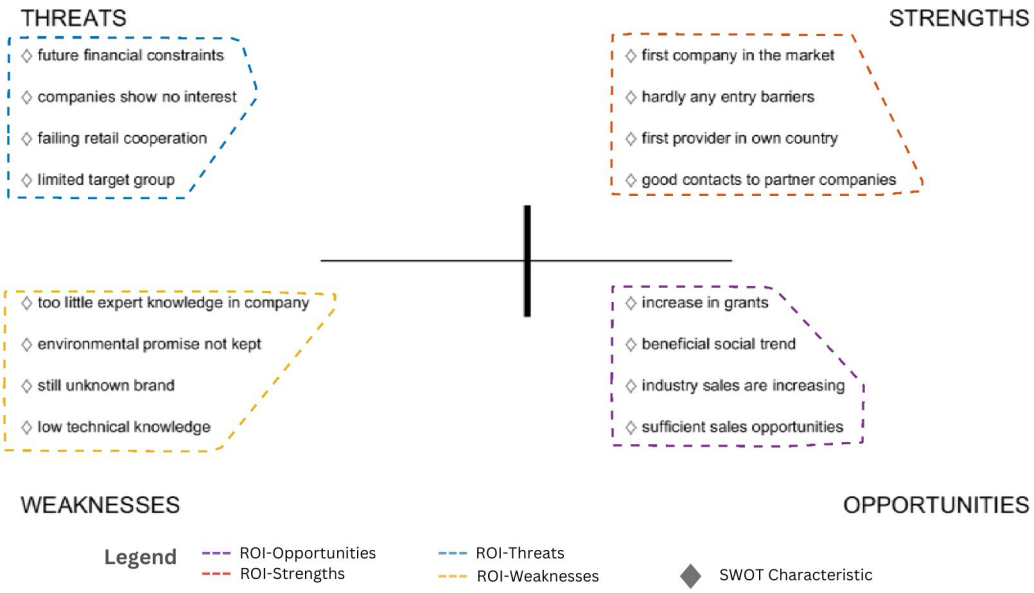

Figure 4. Exemplar Illustration of the 4 ROIs

The dependent metrics for analyzing participant responses to SWOT analyses stimuli are:

1. Total SWOT Presentation
2. SWOT category of first fixation (FFC, First Fixation Count). The FFC is the number of times a participant's first fixation falls on a particular SWOT category.

3. Total and mean fixation duration (TFD and MFD) grouped as FD, as statistical results are identical. FD (Fixation Duration) is the total and mean amount of time spent fixating on a region (SWOT category) to gather the necessary information.

III.4 Semi-Structured Interview

The semi-structured interview served as well as a dependent variable. These self-reported measures, often prone to biases (Podsakoff et al., 2003), aimed to complement the collected eye-tracking data to ensure a comprehensive understanding of the underlying decision-making processes.

III.5 Statistical Analysis

The data analysis included following points:

1. Analyzing normality, homoscedasticity, sphericity
2. JASP statistical analysis software (implemented tests)
3. Independent Samples T-Test: comparison of difference in means between two groups (managers and entrepreneurs).
4. Repeated Measures ANOVA: between-group factor (participant groups of managers and entrepreneurs), within-group factor (SWOT categories, 4 levels).

IV. Results

IV.1 Overview of Findings

This chapter shows the results of the statistical analysis conducted to explore the decision-making processes of managers and entrepreneurs during the SWOT analysis task, and under conditions of uncertainty induced by "Control SWOTs". The analysis focused on four primary measures: The Total SWOT Presentation Time needed to complete the task, First Fixation Category, Fixation Duration, and a semi-structured interview providing insights into the participants' applied strategy.

IV.2 Eye-Tracking Data Analysis

This section presents the analysis of eye-tracking data to explore how the two investigated groups interacted with the SWOT categories during the task. The analysis focuses on between-group differences in the First Fixation Category, Fixation Duration, and the comparison of the Total SWOT Presentation Time.

IV.2.1 Comparison of Total SWOT Presentation Time

An Independent Samples T-Test was conducted to compare the Total SWOT Presentation Times for the SWOT task between the groups of managers and entrepreneurs. The analysis revealed a statistically significant difference in SWOT Presentation Times, $t(430) = 2.432$, $p = 0.015$, as shown in figure 5. These findings indicate that entrepreneurs spend more time to analyze the SWOT than managers.

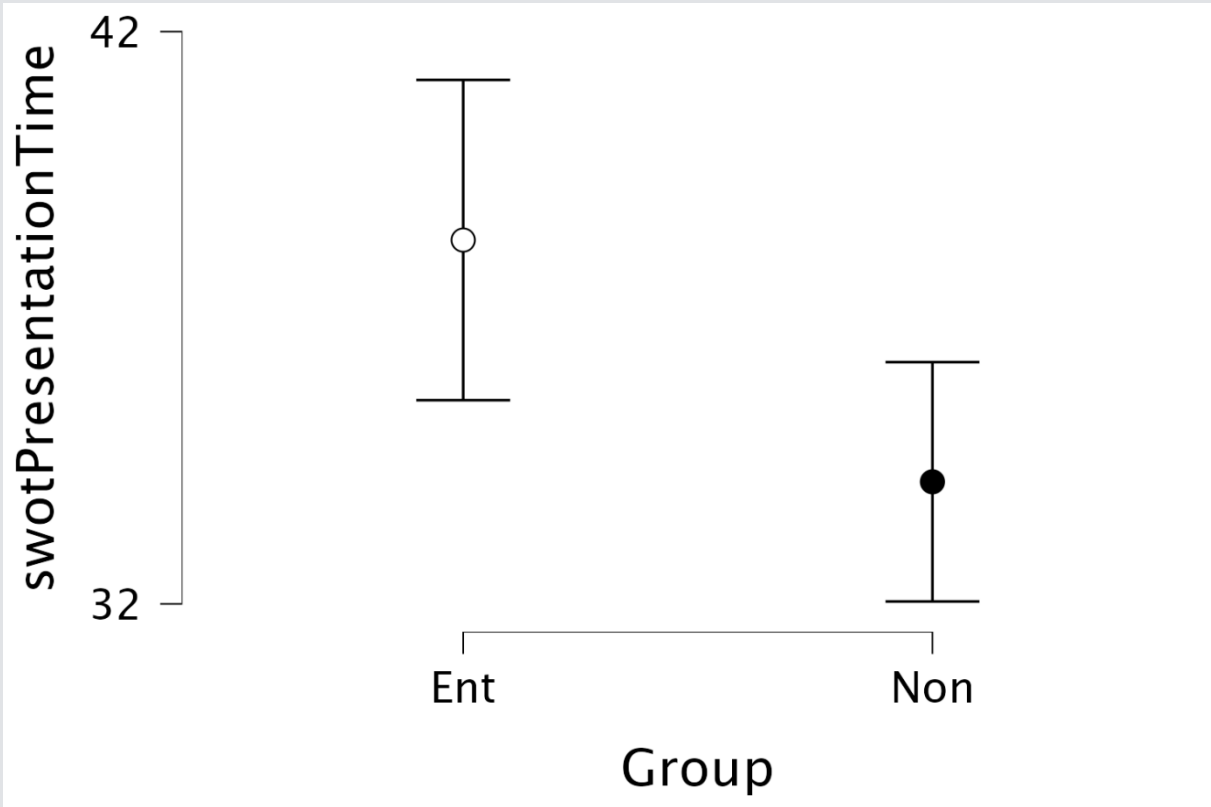

Figure 5. Total SWOT Presentation Time

IV.2.2 Between-Group Differences in First Fixation Category

To examine between-group differences in the First Fixation Category, we analyzed the initial SWOT category that managers and entrepreneurs fixated upon during the task. The managers (n=20) and the entrepreneurs (n=16) each participated in 12 trials, leading to a total of 240 fixations for the managers and 192 fixations for the entrepreneurs. The contingency table shows the distribution of First Fixation Categories across both groups, as shown in table 2.

	FirstFixationCategory				
Group	O	S	T	W	Total
Ent	61	38	62	31	192
Non	114	34	58	34	240
Total	175	72	120	65	432

Table 2. Contingency Table of First Fixation Category

A descriptive analysis of the First Fixation Count of the different characteristics of the SWOT, presented with a Pivot Table, is shown in figure 6.

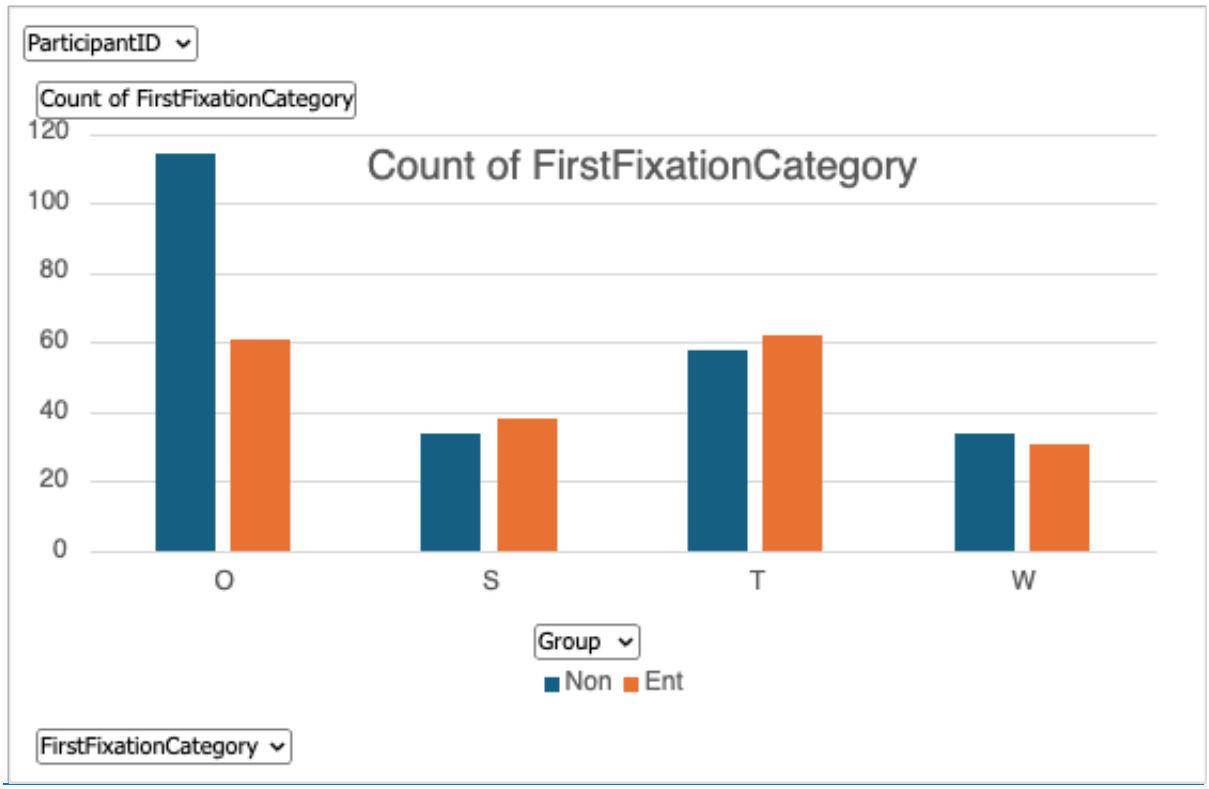

Figure 6. Pivot Table with Count of First Fixation Category

IV.2.3 Between-Group Differences in Fixation Duration

The custom contrast analysis, conducted within the framework of a Repeated Measures ANOVA for the interaction between group and SWOT factors revealed, as shown in figure 7, the following results: The first comparison of the opportunity category showed no significant effects, with an estimate of 0.174 (SE = 0.817, t(1179.788) = 0.212, p = 0.832). The second comparison of the strengths category revealed a significant effect, with an estimate of 2.227 (SE = 0.817, t(1179.788) = 2.725, p = 0.007), indicating that entrepreneurs had a longer fixation duration. The third comparison of the threats category showed no

significant effect, with an estimate of 0.427 (SE = 0.817, t(1179,788) = 0.522, p = 0.602). The fourth comparison of the weaknesses category demonstrated a highly significant effect, with an estimate of 2.805 (SE = 0.817, t(1179.788) = 3.432, p < 0.001), surprisingly indicating that entrepreneurs had a substantially longer fixation duration. These findings partly contradict the hypothesis.

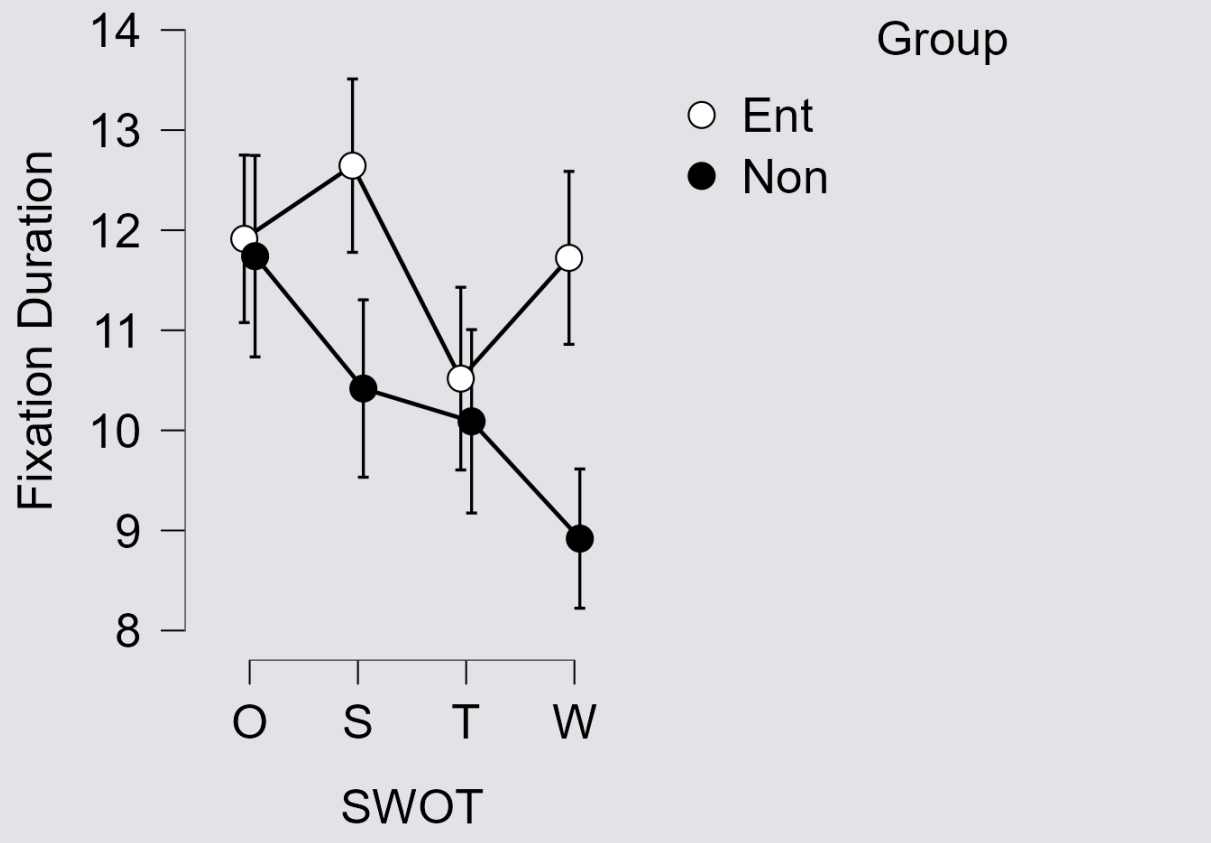

Figure 7. Descriptive Plots Fixation Duration

IV.3 Qualitative Data Analysis through Semi-Structured Interviews

This section presents the findings from the semi-structured interviews conducted with both managers (n=20) and entrepreneurs (n=16), aiming to uncover the strategies employed while performing the SWOT analysis task and providing a broader context to interpret the eye-tracking data and contribute to a more nuanced understanding.

IV.3.1 Comparison of Order-Based Strategy and of Experienced-Based Strategy

We explored two distinct strategies of participants evaluating business opportunities. The Order-Based Strategy (OBS) and the Experienced-Based Strategy (EBS). These strategies reflect different cognitive approaches in decision-making. For the Order-based Strategy, we analyzed the reported First Fixation Category. The Experienced-Based Strategy is based on experiences and a "gut feeling" in decision-making, without a specific strategy. The data revealed that managers and entrepreneurs predominantly employ the Order-Based Strategy, as shown in figures 8 and 9.

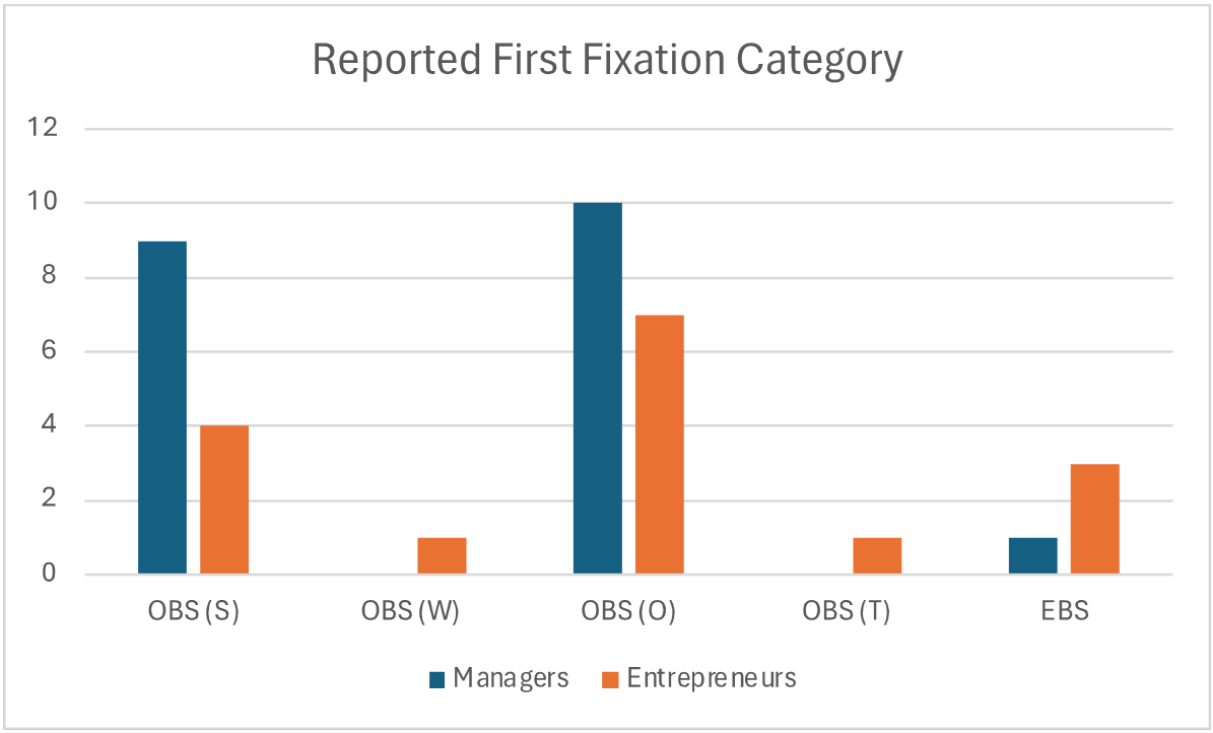

Figure 8. Reported First Fixation Category

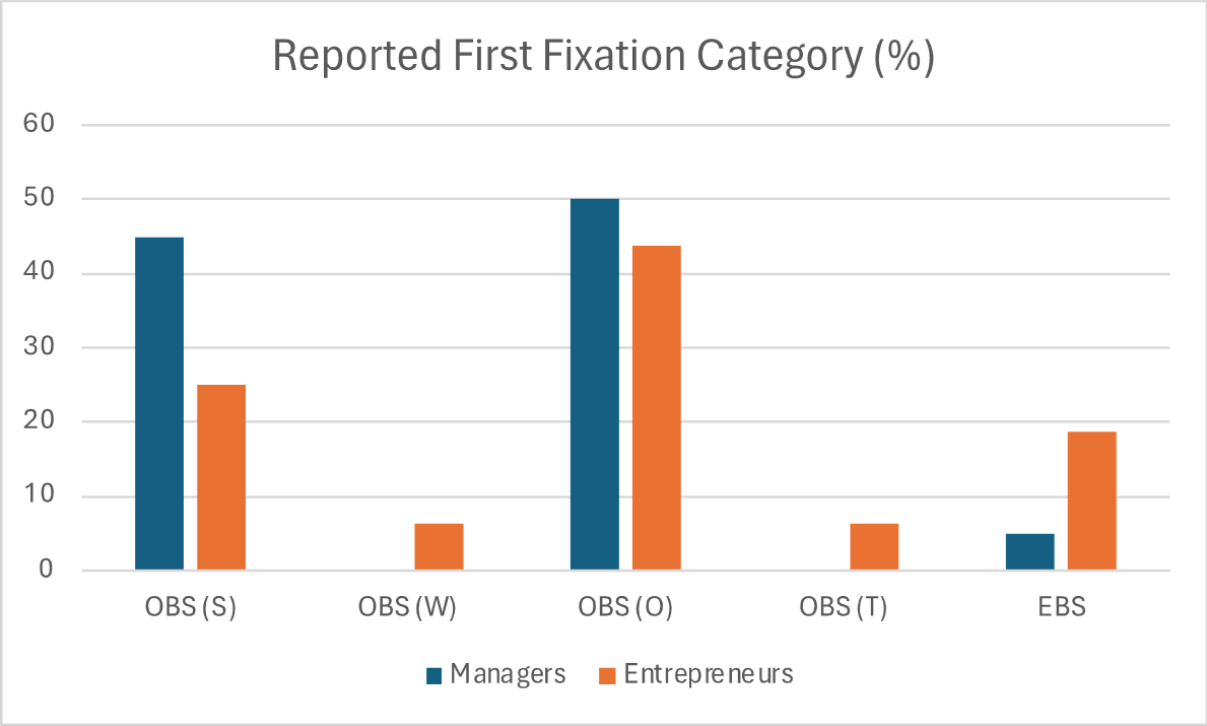

Figure 9. Reported First Fixation Category (%)

Within the managers' group, 10 (50%) participants reported to strategically focus on opportunities first. As one participant described it with "I always look on opportunities first" (Participant CG0002, Manager). 9 (45%) managers explained focusing first on strengths, while none referred to weaknesses and threats in the evaluation of the SWOT analysis. Solely 1 (5%) manager reported using the Experienced-Based Strategy, and in this case, communicated from the participant as a "gut feeling".

Within the entrepreneurs' group, 7 (43,75%) participants explained that they drive their attention first on opportunities, 4 (25%) on strengths, 1 (6,25%) on weaknesses, and 1 (6,25%) on threats. 3 (18,75%) entrepreneurs employed the Experienced-Based Strategy, which demonstrates a more diverse use of both strategies in this group. One participant highlighted the Experienced-Based Strategy, saying "Firstly I look at the quality of the team. Secondly, I concentrate on the market traction. If that's good, you can place your money." (Participant CG0040, Entrepreneur).

IV.4 Integration of Quantitative and Qualitative Findings

This section aims to combine the eye-tracking with the interview findings to enrich our understanding of cognitive and strategic patterns underlying the decision-making of managers and entrepreneurs. Given the comparability of data sets, we are integrating quantitative data from the First Fixation Category with qualitative data from the Reported First Fixation Category.

IV.4.1 Comparison of First Fixation Category and Applied Strategy

The importance of integrating both data sets of First Fixation Category and Reported Strategy lies in the aim of a more comprehensive view to understand what participants focused on and in comparison, what they said they focused on.

Important to note is that for comparison of this data we needed to exclude the Experienced-Based Strategy Findings. The sample size for this analysis from the semi-structured interview is therefore slightly reduced by 4 participants (5% of Managers, 18,75% of Entrepreneurs). The use of percentages will help maintain comparability between remaining participants, as it adjusts for the varying sample size as well as decodes the First Fixation Count.

Comparing the two data sets, a discrepancy is observed in how participants described their focus versus what their fixation behavior demonstrated (see figures 10 and 11).

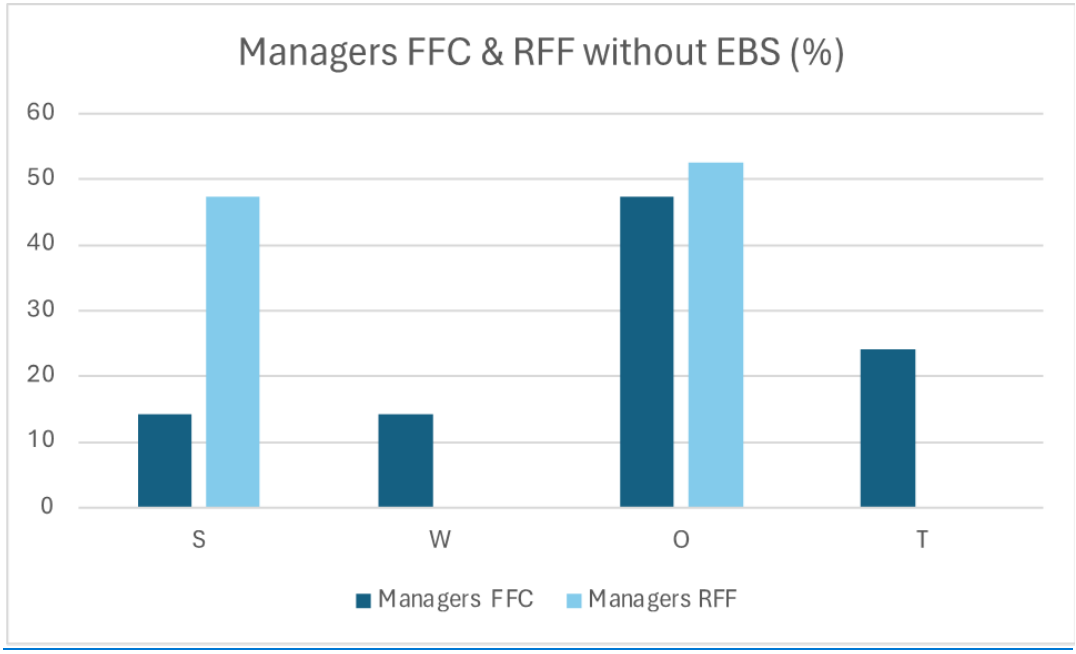

Figure 10. Integration of Quantitative Findings of First Fixation Count (FFC) with Qualitative Findings of Reported First Fixation Category (RFF) without Experienced-Based Strategy (EBS) of Managers (%)

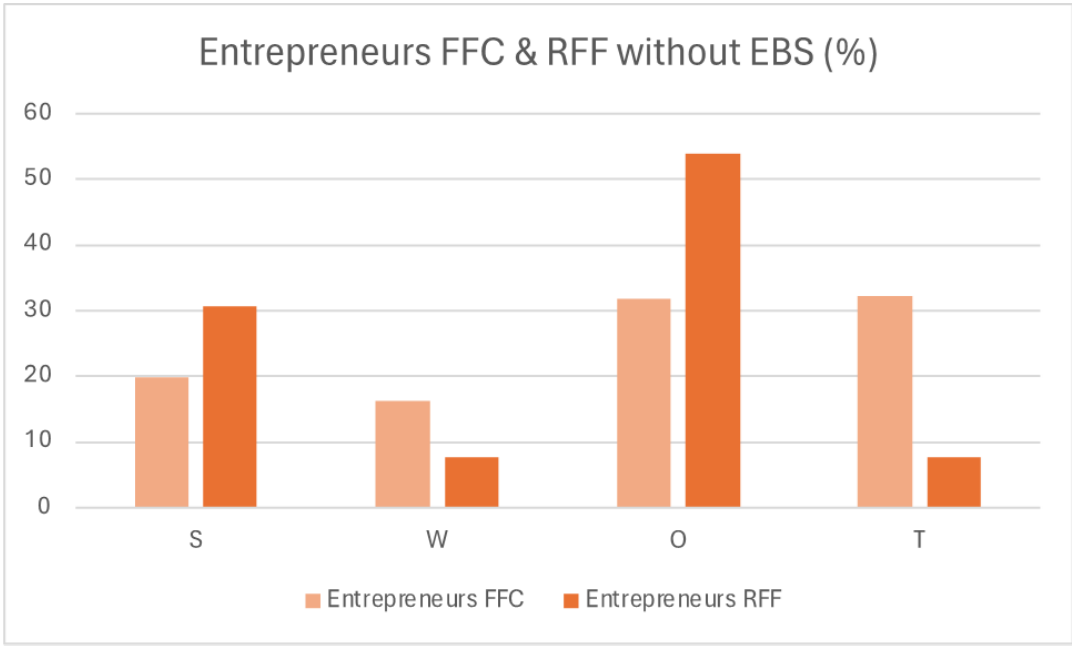

Figure 11. Integration of Quantitative Findings of First Fixation Count (FFC) with Qualitative Findings of Reported First Fixation Category (RFF) without Experienced-Based Strategy (EBS) of Entrepreneurs (%)

Managers, according to the eye-tracking data, fixated for the First Fixation Category differently on opportunities (47,5%), threats (24,17%), weaknesses (14,17%), and strengths (14,17%). However, in the qualitative reports, managers only mentioned opportunities (52,63%) and strengths (47,37%) as their primary focus, completely excluding threats and weaknesses.

Entrepreneurs also demonstrated differences between their eye-tracking and reported results. According to the eye-tracking data, entrepreneurs focused almost equally between threats (32,29%) and opportunities (31,77%), followed by strengths (19,79%) and weaknesses (16,15%). However, in their self-reports, they predominantly stated opportunities (53,85%), followed by strengths (30,77%) as their first fixation category. Weaknesses and threats were both stated with only 7,69%.

This discrepancy between the quantitative and qualitative findings reveals that both managers and entrepreneurs, in some cases, seem to underestimate their attention to weaknesses and threats as First Fixation Category. A consistency can be solely demonstrated among managers with the opportunity category.

V. Discussion

V.1 Summary of Key Findings

This study revealed key insights into the cognitive processes of managers and entrepreneurs while evaluating business opportunities.

Our eye-tracking results show that entrepreneurs spend significantly more time evaluating the SWOT analysis compared to managers. Regarding First Fixation Category, entrepreneurs fixated on threats and opportunities first almost evenly split between threat category (62 counts) and opportunity category (61 counts), while managers fixated predominantly on opportunities (114 counts) first. In terms of Fixation Duration, entrepreneurs surprisingly spend significantly more time focusing on strengths and weaknesses, suggesting a deeper evaluation of internal factors. Their focus here on opportunities and threats is similar to those of managers. Managers spend clearly less time on weaknesses, implying a relative neglect of this area in their evaluation.

The Reported Strategy findings show that the First Fixation Category was for both groups predominantly opportunities, followed by strengths. The distinction between Experienced-Based Strategy (EBS) and Order-Based Strategy (OBS) reflects the dual-process theory. EBS corresponds to the intuitive System 1, and OBS to the analytical System 2 (Kahneman, 2011).

A closer examination of the integration of quantitative and qualitative results shows that a discrepancy between the eye-tracking data and self-reported data in First Fixation Category exists. Both managers and entrepreneurs seem to underestimate, in some cases, their attention to weaknesses and threats as First Fixation Category.

V.2 Interpretations of the Findings

These results do not entirely align with the observations made by Professor Sabine Bergner's team at the University of Graz, when comparing dwell time to our fixation duration

measures. Bergner's team main finding is that entrepreneurs pay more attention to strengths than non-entrepreneurs. Our findings confirm this, showing a (significant) higher fixation duration on strengths from entrepreneurs in comparison to managers. They contradict the 3 other categories, i.e., weaknesses, opportunities, and threats. Entrepreneurs' attention to weaknesses in our study was significantly higher in comparison to managers, whereas the two investigated groups in Bergner's study focused on this category almost equally. Furthermore, entrepreneurs from our study had a (not significantly) higher fixation duration on opportunities and threats, whereas entrepreneurs from Bergner's study had a (not significantly) lower dwell time on these 2 categories compared to non-entrepreneurs.

Due to differences in our research design, it is important to clarify that we are only comparing dwell time from Bergner's study with fixation duration in our study.

Bergner's sample consisted of 30 male entrepreneurs and 30 male non-entrepreneurs, while we examined 16 entrepreneurs and 20 managers both males and females.

While we did not use identical measurements, the dwell time in their study corresponds to the fixation duration in ours. Bergner's team used an iViewx2RED eye-tracker from SensoMotoric Instruments, specifically designed for research purposes. We used the Tobii 5 eye-tracker primarily deployed for video games and not meeting the high-quality standards of professional eye-tracking equipment.

Although the overall research design was similar, including task instruction, SWOT analysis, evaluation of the business opportunity using a Likert scale, recall question and questionnaire, we decided not to analyze the Likert scale or the recall question in this study. Additionally, we implemented Control SWOTs to assess the implications of uncertainty.

Our findings show that the Total SWOT Presentation Time for entrepreneurs was significantly longer, despite both groups being aware that there was no time constraint for several SWOTs, knowing they could move to the next SWOT trial once they had completed their analysis. While both managers and entrepreneurs knew they may have unlimited time,

managers have moved to the next trial prematurely, possibly anticipating the appearance of time-constrained SWOT trials (Control SWOTs). A possible interpretation is that uncertainty did not influence entrepreneurs in their business evaluation.

By hypothesizing that entrepreneurs tend to look at the positive aspects, we can state that this appears to be more nuanced. From the First Fixation Category, we showed that entrepreneurs almost equally focus either on opportunities or threats. This showcases the first attention on external factors of the company, being likely future oriented aspects. As entrepreneurs like to find a solution for a specific problem or need (opportunity) this is the first step to investigate (Shane & Venkataraman, 2000). This may suggest a positivity bias among entrepreneurs (Baron, 1998), but upon closer examination, the situation has a different dynamic. Subsequently, they focus intensively on "what is happening in the business", the internal factors, and if it provides the possibility of a new business opportunity. This brings a more refined discussion of the initial setup hypothesis, as this approach demonstrates the opposite. Entrepreneurs draw on their experience (Sarasvathy, 2001) and demonstrate with our data clearly that they are not binary thinkers- they tend to look on "both sides".

Managers, on the other hand, predominantly evaluated the opportunities first, possibly indicating a desire to avoid missing out on a business opportunity (Eisenhardt & Martin, 2000). We can state that the attention on the external factors is similar regarding Fixation Duration in comparison to entrepreneurs, whereas weaknesses get noticeably neglected by managers. An interpretation could be the statement of one participant "You can always work on your weaknesses" (Participant CG0010, Manager), believing that the right strategy just needs to be applied.

Regarding the Self-Reported Strategy for the First Fixation Category, we can state that for both managers and entrepreneurs, the positive factors of the SWOT, i.e. opportunities and strengths (Helms & Nixon, 2010) are predominantly applied.

The integration of quantitative and qualitative findings in First Fixation Category allows us to cross validate the results. Managers and entrepreneurs both consciously emphasize opportunities and strengths, whereas their actual focus captured by eye-tracking reveal a more balanced consideration of risks. This underscores, in some cases, a not self-aware first step in strategic evaluation of business opportunities.

Complementing these findings and emphasizing the fact that entrepreneurs draw their attention predominantly to weaknesses and strengths contradicts the insights of Palich and Ray Bagby (1995). Our study shows that entrepreneurs do not wear "rose-colored glasses", they focus on the internal aspects of an organization, focusing on what they can influence with the resources at hand. This aligns with "the pilot in the plane" principle of the effectuation theory (Sarasvathy, 2023). Like a pilot navigating a plane, entrepreneurs steer their ventures toward success. They focus on actions and decisions made in the present, using resources (internal factors) to create new business opportunities. They do not want to predict the future; they want to be in control of the future.

V.3 Implications

The findings have implications for educators and organizations. The distinction between cognitive patterns as well as strategy perspectives of managers and entrepreneurs during business opportunity evaluations, provides valuable insights for adapting the design of innovation and entrepreneurship programs for students. Incorporating these insights into executive education programs could enhance the learning experience of managers and entrepreneurs. Integrating behavioral insights into workshops could facilitate a more balanced decision-making approach. Furthermore, tailored learning modules could focus on overcoming cognitive biases, where managers, for instance, are encouraged to adopt a more strengths-weaknesses-driven mindset. Additionally, fostering collaboration between

managers and entrepreneurs in educational settings could cultivate more nuanced strategic skills that directly impact business success.

Strategic teams in organizations could shift to a more comprehensive SWOT approach, especially during product development and market entry strategies. This could prevent managers from their potential blind spot in their decision-making: weaknesses. To specify, this approach could help organizations address the tendency of managers to overlook internal weaknesses, as the pressure for excellent performance in highly competitive environments may favor this issue. Therefore, managers could cultivate this new approach and further enhance their strategy towards business innovation and growth.

V.4 Limitations

Recruiting participants for this study proved to be challenging. Although 76 prospects responded to the advertisement and completed the survey, only 41 participants took part in the study. Many prospects did not react to our invitation, others requested the option of remote data collection, and in several cases, the proposed dates were not convenient. While the relatively small sample size may limit the generalizability of our findings, our study replicates in part Bergner's results, i.e. the higher attention of entrepreneurs on strengths, compared to managers (non-entrepreneurs). We complement their insights by demonstrating that entrepreneurs not only focus on strengths but also significantly on weaknesses.

The study was conducted within a specific cultural and economic context of managers and entrepreneurs from Belgium and Germany. Differences in market conditions, regulatory environments, and business practices may influence how managers and entrepreneurs approach the SWOT analysis. Furthermore, we must recognize that the study measured participant's evaluation of business opportunities at a specific moment in time, and decision-making processes can evolve over time.

During data collection we encountered difficulties in accurately collecting the data, possibly due to the Tobii 5 eye-tracker, which is primarily designed for video games but served as a cost-effective alternative for our study. Although the calibration was successful, the task occasionally stopped because the eye-tracker failed to maintain consistent eye detection throughout the task. Consequently, we had to exclude 5 participants out of 41 due to issues with data collection. It is important to note that these issues may also have arisen because several participants, who reported having normal vision, might have needed vision correction.

Additionally, one participant (CG0041, Entrepreneur) was left-handed, and data collection was unsuccessful. This may have occurred because the participants' arm touched the laptops' touchpad while reaching for the arrow keys to answer the Likert scale, causing the trial to stop. After several attempts, we had to exclude this participant from the study.

V.4 Recommendations for Future Research

Considering the findings from this study, we propose certain points for future research to deepen the understanding of the entrepreneurial mindset and to broaden the application of these insights across different contexts and methodologies.

Due to the small sample size, future research should aim to include a larger sample to enhance the robustness of findings.

Furthermore, we would recommend conducting longitudinal studies to observe how cognitive patterns and strategic focus evolve over time.

Several participants inquired about having a test trial before the actual data collection. Offering such a trial could be beneficial, as it would allow participants to become familiar with the task, ensuring their comfort and better understanding of the exercise.

Professional eye-tracking equipment would increase the accuracy of data collection. It should also be highlighted that eye-tracking technology continues to advance, making it

perhaps feasible to consider remote eye-tracking solutions. This could possibly facilitate participant recruitment and, therefore, increase the sample size.

Additional methods, such as EEG, in combination with the eye-tracking approach, could enhance the depth of analysis. We also recommend that future research considers employing the Business Model Canvas (BMC) instead of the SWOT, as entrepreneurs are as well familiar with its practical application. This could offer a more comprehensive understanding of neural and gaze activities underpinning business investment decisions and entrepreneurial success.

VI. Conclusion

Our empirical study aimed to explore the divergences and similarities of managers and entrepreneurs while evaluating business opportunities. In view of our results, our understanding of how entrepreneurs direct their attention during this evaluation has shifted from the previous assumption that they mainly focus on positive aspects, i.e. opportunities and strengths, to a more balanced consideration of internal business factors.

This study contributes to the bourgeoning field of neuroentrepreneurship by highlighting how cognitive processes differ between managers and entrepreneurs during decision-making. It introduces the role of fixation patterns in understanding business opportunity evaluation, offering new perspectives on how entrepreneurs navigate the challenges of undertaking a new venture in dynamic environments.

Concluding this research with a personal reflection enables me to acknowledge the broader impact of my executive studies on both my personal and professional development.

The MBA journey has been transformative, allowing me to deepen my skills and cultivate a passion for research. My exploration of neuroentrepreneurship has challenged me to think critically and solve problems systematically, which has, in turn, enriched my role as a design manager. Furthermore, I now appreciate that research is not merely a requirement but also an opportunity to contribute meaningfully to knowledge – a path I am keen to pursue in the future.

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Appendix A: Recruitment Advertisement

https://www.canva.com/design/DAF0-6w5WEE/AQ1PXlHqGUQxrUKyidcw9w/edit

Appendix B: Informed Consent for Research Involving Human Participants

Faculté de Psychologie, Logopédie et des Sciences de l'Education

Comité d'éthique
PRESIDENTE : Fabienne COLLETTE
SECRETAIRE : Annick COMBLAIN

INFORMED CONSENT
FOR RESEARCH INVOLVING HUMAN PARTICIPANTS

Study Title	The entrepreneur's view - Study using the "eye tracking" technique of evaluating an entrepreneurial opportunity.
Responsible researchers	*Carmen Geafer* carmen.geafer@student.uliege.be *Harry Antony* harry.antony@uliege.be
Promoter	Fabienne Collette & Frédéric Ooms
Service and contact telephone number	GIGA – Cyclotron Research Center 04 / 366 35 64 HEC Liège 0496/385388

- *I, the undersigned*

  …… …… *declare:*

- to have received, read and understood a written description of the research whose title and responsible researcher(s) appear above;
- was able to ask questions about this research and received all the information I wanted.
- have received a copy of the participant information and informed consent.

I have understood that :

- I can end my participation in this research at any time without having to give a reason for my decision or suffer any prejudice whatsoever. The acquired coded data will remain available for statistical processing.
- I can request to receive the overall results of the research, but I will not receive any feedback regarding my personal performance.
- I can contact the researcher for any questions or dissatisfaction relating to my participation in the research.
- data will be collected during my participation in this study and that the researcher/student responsible and the promoter of the study guarantee the confidentiality of these data. I retain the right to review and rectify my personal data (demographic data). I have a series of rights

(access, rectification, deletion, opposition) concerning my personal data, rights which I can exercise by contacting the Data Protection Officer of the institution whose contact details can be found on the participation information given to me. I can also address any complaints to him regarding the processing of my personal data. I also have the right to submit a complaint with the Data Protection Authority (https://www.autoriteprotectiondonnees.be, contact@apd-gba.be).

- Personal data will only be kept for as long as is useful for carrying out the study in question, i.e. for a maximum of 36 months.

I consent to:

- the anonymous data collected as part of this study will also be used in other similar future studies, possibly including in countries other than Belgium.
- the anonymous data collected are, where appropriate, transmitted to colleagues in other institutions for analyzes similar to those of this project or are deposited in scientific directories accessible to the scientific community only.
- my personal data are processed according to the terms described in the section dealing with confidentiality guarantees of the participant information form.

I authorize the responsible researcher to register me for research purposes for the correction of one of the tests: **YES** – **NO**

Consequently, I give my free and informed consent to participate in this research.

I have read and approved,

Date and signature

Responsible researcher

- I, Carmen Geafer/ Harry Antony, the responsible researcher/s, confirm that I have verbally provided the necessary information about the study and have provided a copy of the participant information and informed consent documents to the participant.
- I confirm that no pressure was exerted on the individual to agree to participate in the study and that I am prepared to answer any additional questions, if necessary.
- I confirm that I work in accordance with the ethical principles set out in the latest version of the "Déclaration d'Helsinki", "Bonnes pratiques Cliniques" and the Belgian law of May 7, 2004, relating to experiments on human beings, as well as in respect for the ethical and deontological practices of my profession.

Appendix C: Volunteer Information Form

Faculté de Psychologie, Logopédie et des Sciences de l'Education
Comité d'éthique
PRESIDENTE : Fabienne COLLETTE
SECRETAIRE : Annick COMBLAIN

Volunteer information form

RESEARCH TITLE

The entrepreneur's view - Study using the "eye tracking" technique of evaluating an entrepreneurial opportunity.

STUDENTS

Carmen Geafer carmen.geafer@student.uliege.be

Harry Antony harry.antony@uliege.be

PROMOTERS

Fabienne Collette
University of Liege
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Frédéric Ooms
University of Liege
HEC
Rue Louvrex 14
4000 Liège

Version validated by the FPLSE ethics committee on 14.12.2023

DESCRIPTION OF THE STUDY

Introduction

You are invited to participate in a behavioral study carried out among a population of entrepreneurial and non-entrepreneurial students. This study, carried out as part of a dissertation project by a student enrolled in the openBorderMBA and a student enrolled in a doctorate at the University of Liège, explores decision-making and more particularly the evaluation of an entrepreneurial opportunity. Before you agree to participate, we invite you to familiarize yourself with its implications in terms of organization, benefits and possible risks, so that you can make a fully informed decision. This is called giving "informed consent."
Please read these few pages of information carefully and ask any questions you wish to the investigator or the person representing him or her.

Objectives and description of the study protocol
This study is carried out in a single appointment.

Schedule of the meeting

We suggest you meet at the Grand Poste de Liège or at the Kloster Heidberg . If this is more comfortable for you, we can schedule this session in our research unit (HEC Liège or Giga CRC). We will ask you to complete some demographic questionnaires and psychometric tests measuring entrepreneurial self-efficacy, your entrepreneurial intention, cognitive flexibility.

Entrepreneurial self-efficacy refers to an individual's belief in their abilities to carry out the tasks and activities necessary to successfully complete an entrepreneurial project.

Entrepreneurial intention refers to an individual's conscious and premeditated decision to start a business. This includes the motivation and desire to start and run a business, as well as the commitment to dedicate time and resources to this project.

Cognitive flexibility refers to an individual's ability to adapt and change beliefs, attitudes, and behaviors in response to new and complex situations.

We will then carry out 5 tests to assess your attention skills and your cognition overall. These tests will be offered via an electronic form. We will also ask you not to consume caffeine or other psychoactive substances for 2 hours before the experience. This meeting will last approximately 1 hour 15 minutes.

Benefits
If you agree to participate in this study, you will not personally benefit from your participation, but the results obtained may prove useful for understanding changes in cognitive and attentional functioning depending on life circumstances.

Withdrawal from the study
Your participation is voluntary and you have the right to withdraw from the study at any time, for any reason, without having to give a reason. However, it may be useful for the principal investigator and study sponsor to know if you are withdrawing because the constraints of the study are too great.
If the experimenter notices that the general conditions for carrying out the experiment are not met, it is possible that the latter will exclude your results from the study .
If you participate in this study, we ask you:
➢ To collaborate fully in the smooth running of this research.

➢ Not to hide any information relating to your state of health, the medications you are taking or the symptoms you are experiencing.

Eye data recording

To ensure accurate processing of research data, your participation implies that you are registered for one of the tasks, namely tracking your gaze. This recording will only be useful to us to evaluate your performance as accurately as possible. The recording will be deleted 12 months after the end of the study.

The people who will have access to it will be the researchers associated with the project as well as the person who administered the task to you.

Before participating in the study, we draw your attention to a number of points.

Your participation is conditional on a series of rights for which you are covered in the event of harm. Your rights are explained below.

- Your participation is free. You can interrupt it without justification.
- No disclosure of your personal information is possible even unintentionally. If you agree to a recording, your data will be even more secure. Only coded data can be transmitted to the research community. This coded data no longer allows you to be identified and it will be impossible to link them to your participation.
- The retention period for your personal data is reduced to 36 months. On the other hand, encoded data can be kept *ad vitam aeternam* .
- The results of this study will always be communicated from a scientific and/or teaching perspective.
- In the event of damage, know that insurance covers you.
- If you wish to make a complaint regarding the processing of your data or your participation in the study, contact the study manager and/or the DPO and/or the Ethics Committee (see addresses at the end of the document) .

All these points are detailed on the following pages . If you have any further questions, please contact the researcher or study leader. If this information is clear and you wish to participate in the study, we invite you to sign the consent form. Keep a copy of each document sent so that you can contact us if necessary.

DETAILED INFORMATION

All information collected during this study will be used in the strictest confidentiality and only the experimenters, responsible for the study, will have access to the data collected. Your information will be encoded. Only the head of the study as well as the person in charge of your follow-up will have access to the encrypted file allowing the participant's code to be associated with their first and last name, their contact details and the research data. These people will be required to NEVER disclose this information.

The coded data resulting from your participation may be transmitted as part of other research related to this study. They may be compiled in databases accessible only to the scientific community. Only encoded information will be shared. As things currently stand, no identification will be possible. If a report or article is published at the end of this study, nothing will allow your identification. Your personal data stored in the secure database are subject to the following rights: rights of access, rectification and erasure of this database, as well as the right to limit or oppose the processing of the data . To exercise these rights, you must contact the researcher responsible for the study or, failing that, the data protection officer of the University of Liège, whose contact details can be found at the bottom of the information form . The retention period for your personal data will be as short as possible, with a maximum duration of five years. The data resulting from your participation in this research (coded data) will be kept as long as it is useful for research in the field.

If you change your mind and decide to no longer participate in this study, we will no longer collect additional data about you and your identifying information will be destroyed. Only data made anonymous may be stored and processed.

The practical methods of management, processing, conservation and destruction of your data comply with the General Data Protection Regulation (EU 2016/679), the patient's rights (law of August 22, 2002) as well as the law of May 7, 2004 relating to to studies on the human person. All procedures are carried out in accordance with the latest European recommendations on data collection and sharing. The person responsible for processing your personal data is the University of Liège (Place du XX-Août, 7 in 4000 Liège), represented by its Rector. These processing of personal data will be carried out as part of the public interest mission in terms of research recognized at the University of Liège by the Decree defining the landscape of higher education and the academic organization of studies from 7 November 2013, art.2. You also have the right to lodge a complaint with the Data Protection Authority (https://www.autoriteprotectiondonnees.be, contact@apd-gba.be).

Insurance has summer subscribed At case Or YOU would suffer a pity related has your participation in this research. THE promoter assume , _ even without fail , _ there responsibility of Shame cause At participant (or to his holders right) and linked so _ direct Or indirect has there to participate in this study. In this optical , _ promoter _ has subscribed A CONTRACT insurance with of Ethias, in accordance with article 29 of the Belgian law relating to experiments on humans (May 7, 2004).

You will sign informed consent before taking part in the experiment. You will keep a copy of this consent as well as the study information sheets.

This study received a favorable opinion from the ethics committee of the faculty of psychology, speech therapy and educational sciences of the University of Liège. Under no circumstances should you consider this favorable opinion as an incentive to participate in this study.

People to contact.

You have the right to ask and receive answers to any questions you wish about this research.

If you have any questions or in the event of a study-related complication, you can contact the following people:

Frédéric Ooms
Email : fooms@uliege.be
Telephone: 0496/385388

or the principal investigator of the project:

Fabienne Collette
Email: f.collette@uliege.be
Telephone: 04 366 23 69
Address: B30 – 8 Allée du 6 Aout, 4000 Liège

For any questions, requests to exercise rights or complaints relating to the management of your personal data, you can contact the data protection officer by e-mail (dpo@ uliege) or by signed and dated letter addressed as following :

Mr. Data Protection Officer
Bldg. B9 "GDPR" cell,
Village 3 district,
Boulevard de Colonster 2,
4000 Liège, Belgium.

You also have the right to lodge a complaint with the Data Protection Authority (https://www.autoriteprotectiondonnees.be, contact@apd-gba.be).

Appendix D: Task Instruction Document

Task Directions:

Dear Study participant,

For today's study, we will present you with various entrepreneurial pitchs on the laptop screen in front of you. In order to adequately represent an entrepreneurial pitch, *the results of SWOT analyses* will be used. As a reminder, a SWOT comprises the first letters of Strengths, Weaknesses, Opportunities and Threats. A SWOT analysis, thus, is simply the systematic listing of a pitch's Strengths and Weaknesses as well as its Opportunities and Threats in its environment.

Your task will be to evaluate how promising you think these entrepreneurial pitchs are based on the information presented in the SWOT analyses in every trial.

At the beginning of each trial, before the contents of the SWOT analysis are displayed, you will be first presented with a screen with a cross at the centre (Figure 1). This cross divides the screen into 4 regions where the SWOT analysis will be later presented.

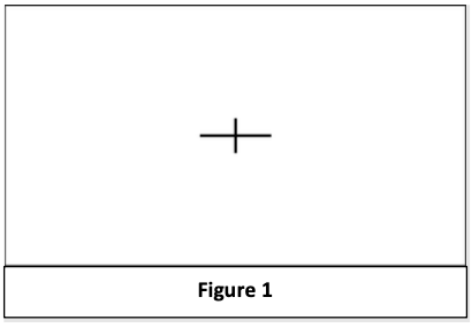

Figure 1

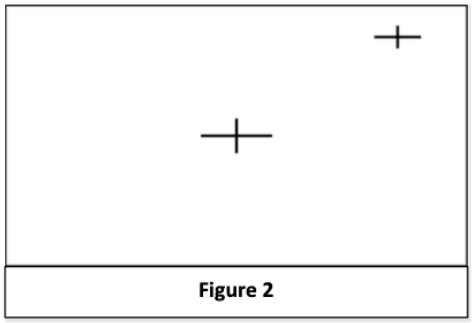

Figure 2

This will be followed by the screen having a smaller cross randomly on one of these four regions (Figure 2). You have to direct your gaze to the smaller cross until it turns green. You have 30 seconds to do so and start the trial at your own will. After this, kindly return your focus, back to the cross at the centre.

You will be then shown for **one** second which information category (Strengths, Weaknesses, Opportunities and Threats) of the SWOT analysis will be displayed in which region of the screen for that trial (see Figure 3). Note again that this order of the categories changes every trial. As soon as you have completed this orientation process and **have been able to internalize which category of information is displayed in which quadrant of the screen**, please focus on the cross in the middle of the screen again.

Task Directions:

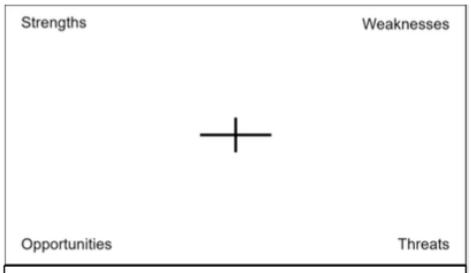

Figure 3

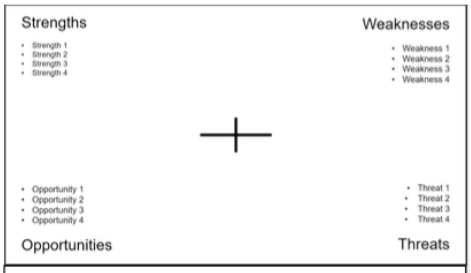

Figure 4

Then the screen will display the contents of the SWOT analysis in the four regions. Focus and go through the lists on Strengths, Weaknesses, Opportunities and Threats (see Figure 4), which will provide you necessary information to evaluate the pitchs. You can proceed in the way that seems most appropriate to your usual way of working to assess the content of each SWOT. Press Enter on the keyboard once you feel you have gathered necessary information for the evaluation.

IMPORTANT NOTE! You will only have a very limited time to be able to see some SWOT analyses before the evaluation page appears. Thus, it will not be possible to capture all information about the entrepreneurial pitch in every trial. **Therefore, it is important to focus first on the items and/or categories that you think will provide the best information to understand the pitch and make your decision. Try to be as fast as possible. As stated earlier,** press Enter on the keyboard once you feel you have gathered the necessary information if the evaluation page is not already presented.

Finally, after the presentation of each entrepreneurial pitch, you will have to answer the following two questions (see Figure 5):

To what extent would you personally like to implement this idea?

Not at all(1) – Very little(2) – Little(3) – Fairly(4) – Very much(5) – Completely(6) – Very much(7)
Select your rating in the scale!

What was one stand-out item that you think influenced your rating?
Respond verbally!

For the first question, select your rating option. You can also use the arrow buttons to select your rating and press 'Enter.' Verbally answer the second question. Next, click 'Continue' for the next trial.

Task Directions:

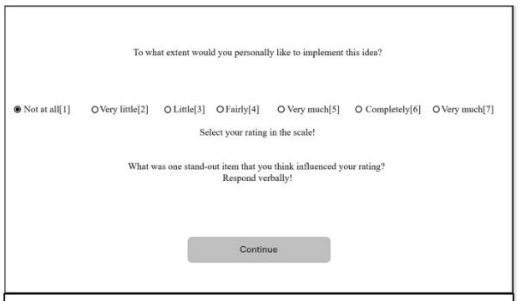

Figure 5

In total you will have 16 trials of SWOT analyses to go through and evaluate the corresponding entrepreneurial pitch.

If you still have any doubts/questions, feel free to ask me/your investigator!

We thank you again for your participation!

Verbal summary before launching the task

- The trial starts with a central cross
- You have to fix the cross that appears in a corner for one second and then look back at the center
- The position of the four categories is briefly presented; explore them and then fix the central cross
- Explore the SWOT content that appears on the screen
- Answer the question (First: arrows, second: orally/verbally)

Appendix E: Figure of a Simplified Data Extraction Pipeline