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Chapter

Innovation and Entrepreneurship: The Role of Prospect Theory in Decision-Making

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Abstract

This chapter discusses prospect theory, which describes how people evaluate choices in terms of potential gains and losses and tend to be loss-averse. When it comes to innovation, the theory suggests that people are risk-averse, but may be more likely to take risks if they perceive potential losses instead of gains. The theory can also help understand how entrepreneurs make decisions. This chapter also mentions advances in behavior genetics and epigenetics that may influence innovation-promoting behaviors, but culture and how ideas spread are also important. To move innovation forward, it is important to carefully analyze risks, benefits, costs, and potential impacts and involve all relevant stakeholders in the process of innovation development and implementation.

Keywords: prospect theory, innovation, risk aversion, entrepreneurship, behavior genetics, epigenetics, cognitive biases, decision-making

1. Introduction

The prospect theory is a theory in behavioral economics that describes how people make decisions in situations of risk and uncertainty. According to this theory, people evaluate their choices in terms of potential gains and losses, and tend to be loss-averse.

When it comes to innovation, the prospect theory can have several implications. One of them is that people tend to be more risk-averse when dealing with innovations. This is because innovations often involve uncertainty and risk, as it is uncertain whether they will be successful or not.

On the other hand, the prospect theory also suggests that people may be more likely to take risks when the choice involves potential losses rather than gains. This means that if people perceive that a lack of innovation can lead to losses, they may be more likely to adopt new ideas and technologies.

Additionally, the prospect theory can also serve to understand how entrepreneurs and innovative companies make decisions. Entrepreneurs are often more willing to take risks than most people, and this can be partly explained by the prospect theory. They may be motivated to take risks because they have a different perspective on the potential gains and losses, and believe that the potential gains of a successful innovation far outweigh the potential losses.

In summary, the prospect theory can help explain why people are risk-averse when it comes to innovation, as well as motivate entrepreneurs and innovative companies to take risks to pursue potential gains.

Furthermore, some advances in science allow cognitive biases to be bypassed through very specific techniques and situations. This is the case with the study of behavior genetics. Certain gene formats generate a kind of programming for certain behaviors in favor of innovation.

Not only genetics, but epigenetics reveal that the activation of certain molecules linked to genes can affect the formation of specific behaviors, such as those related to entrepreneurship, creativity, and others.

However, genetics and epigenetics are only part of the answer. Culture and how ideas propagate are also an important component in explaining human behavior, including behaviors related to risk and uncertainty.

Simultaneously, the use of specific techniques to deal with cognitive biases also supports decision-making in innovation, especially in controlling the traps that the brain can create in the face of potential danger.

Therefore, the aim of this study is to present the prospect theory as a component part of decision-making in business innovation, especially in the context of risk and uncertainty.

Therefore, it is essential to conduct a careful analysis of risks, benefits, costs, and potential impacts before launching an innovation. This should involve all relevant stakeholders, such as users, customers, suppliers, partners, regulators, and the community at large, to minimize risks and increase the chances of success of the innovation. However, it is important to be aware of new variables arising from recent discoveries in science and behavioral economics that should also be considered.

2. Some conceptual considerations about prospect theory and innovation

2.1 The prospect theory

Prospect theory is a branch of behavioral economics that describes how people make decisions in uncertain situations. In contrast to the expected utility model, which is based on the average of possible consequences of a choice, the prospect theory suggests that people do not follow this reasoning when making decisions.

For many years, the Expected Utility Theory guided scholars in decision-making, investors, and other economic agents. However, this theory failed to explain important aspects of portfolio valuation, culminating in the criticism of two researchers, the psychologist Daniel Kahneman (1934) and the economist Amos Tversky (1937–1996), with the launch of Prospect Theory.

At the beginning of the last century, the ordinal theory and revealed preferences emerged, thus discarding the hypothesis of the interaction between decision-making and subjective feelings. This fact contained the advance of the confusion generated by the psychology involved in the theory of utility.

Still, over the first decades of the last century, economics underwent a transformation by adopting mathematics as one of its main analytical tools. Therefore, they no longer needed complex—and unreliable—analyses related to the “thoughts and feelings” of decision-makers.

For example, Game Theory gained enormous prominence at that time, in particular, with the works of John Von Neumann (1903–1957) and Oskar Morgenstern

(1902–1997). The main idea of these authors was that, as in board games, economic behavior could be studied by creating games that simulated a specific economic decision-making situation.

Continuing, John Nash's (1928–2015) studies on the equilibrium point in noncooperative games, with multiple players, gave rise to interest in Game Theory in several areas of social sciences, including economics.

One of the main criticisms of the new mathematical level of economics was made by the economist Maurice Allais (1911–2010). He questioned the hypothesis of the full rationality of human beings in making economic decisions, which, in this new aspect of economics, was widely defended and used. Particularly, in situations of risk or uncertainty, human beings were completely different from what the economic-mathematical theory presented.

However, it was only with the work of Daniel Kahneman and Amos Tversky that an adequate solution was found for the problem of “exaggerated rationality” in situations of risk and uncertainty—the Prospect Theory emerged. “According to [1] you know you have made a theoretical breakthrough when you can no longer reconstruct why you failed for so long to see the obvious.”

“The Prospect Theory sought to break with the traditional idea that a single theory of human behavior can be both normative and descriptive [2].” “According to [3] the alternatives for a decision problem can be structured in different ways, even if the results are equivalent.” Therefore, irrationality can be explained by the way the decision alternatives are presented. For example, if the utility of wealth is all that matters, then transparently equivalent statements of the same problem should produce identical choices [1]. But this is not what happens in practice.

In addition, the norms, habits, and personal characteristics of those who make the decision can also bias the choice of alternatives. Kahneman and Tversky suggest that due to imperfections in human perception, changes in perspective can reverse the apparent relative size of objects and the level of desire for each option. In a survey carried out with students at Stanford and Columbia Universities, Kahneman and Tversky found evidence that changing perspectives for a given problem can influence and bias the choice of alternatives. For them, it was evident that in choices, involving certain gains, individuals are risk-averse and in choices, involving certain losses, they are prone to risk [3].

As a result, most of the time, the impact of losses is greater than the impact of gains. Representing it numerically, it is equivalent to saying that the pain of losing U\$1000 is greater than the pleasure of winning U\$1000.

Still, there are three cognitive features in Prospect Theory. They are [1] as follows:

1. The assessment is relative to a neutral reference point;
2. A principle of decreasing sensitivity applies to both sensory dimensions and the assessment of changes in richness;
3. Loss aversion.

No theory is infallible, and it is just the theory that best explains a phenomenon. Or, still, it is simply the Theory accepted by the majority of the people. Therefore, Prospect Theory also has its flaws. “For [1] Prospect Theory does not know how to deal with disappointment (for example, of not winning anything). Furthermore, she failed to admit regret.”

But, criticisms of Prospect Theory go beyond the two points highlighted by Kahneman. According to the Portuguese neuroscientist, António Damásio (1994), the considerations on the Prospect Theory are innovative and skillfully developed. After all, they showed unprecedented particularities about human economic decision-making. However, Daniel Kahneman and Amos Tversky did not explain why human beings make irrational decisions. For Damásio, the explanation lies in the field of neuroscience, specifically, in the functioning of “somatic markers.” Therefore, the functioning of the brain (and the body) makes it possible to safely investigate the triggering of the most relevant “somatic” responses.

When a bad result associated with a given response option appears, however fleeting it may be, we feel an unpleasant visceral sensation. As sensation is bodily, the phenomenon is technically called “somatic” state (in Greek, soma means body); and, because the state marks an image, we call it markers. Therefore, Damásio argues that when we analyze the infinity of future possibilities arising from each decision we can make in a given dilemma, the brain automatically marks these scenarios with a “marker,” positive or negative, according to the feelings that these imaginary scenarios arouse in us [3].

Therefore, the somatic marker is what allows the restriction among infinite possible decisions to be taken, selecting only a small set of rationally analyzed choices.

Interestingly, the “somatic marker” mechanism seems consistent with the theory of bounded rationality. According to the assumption of bounded rationality. There are two decision-making problems:

- Economic agents cannot have all the relevant information;
- Even if they did, the amount of information would be so great that the brain would not be able to process it.

Finally, to understand the decision-making process, especially in the context of risk and uncertainty, the decision-maker is not obliged to know the historical evolution of this process. However, such knowledge provides the basis for explaining many past events in the economy. And, it allows comparison with the Prospect Theory, that is, it clarifies between the decision that should be (traditional economics) and the decision that “real” people make in their day-to-day economic interactions.

2.2 Innovation

An innovation can generate unimaginable gains in all areas of the economy. If an innovation is successful, as in the case of Henry Ford’s cars or Melitta Bentz’s coffee filter, it can change the lives of entrepreneurs, companies, countries, and even the entire world. However, nothing is more risky than innovating—no one knows what the future holds. Therefore, innovation is a challenge that requires specific skills from innovators.

Innovating means giving life to an original product or service, and it is a broad concept applicable to several areas. However, “according to [4] value innovation occurs only when companies align innovation with utility, price, and cost gains.”

A recent example of innovation occurred on February 7, 2023, when Microsoft CEO Satya Nadella told journalists that artificial intelligence was opening up new possibilities in the field of research. Microsoft, which had long been criticized for its search engine, Bing, decided to incorporate OpenAI’s ChatGPT technology to provide

direct information to users instead of just presenting links. With this, the company directly challenged the undisputed search engine leader, Google, by innovating in its own territory [5].

Capitalism works thanks to new products, production methods, and markets created by companies. This changes the economy, destroying the old structure and creating a new one. This is called “creative destruction” and is essential to understanding capitalism [6].

According to Schumpeter, the following situations can be considered innovation [6]:

1. Introduction of a new good;
2. Introduction of a new production method;
3. Opening a new market;
4. Conquest of a new source of supply of raw materials or semifinished goods;
5. Establishment of a new organization of any industry.

An example of product innovation can be identified in the launch of the iPhone by Apple in 2007. This innovation was characterized by the combination of various functions in a single portable device, including phone, internet, music, and camera, among others. Thus, the iPhone represented a break from conventional cell phones of the time, which were limited mainly to making phone calls and sending text messages. In addition, the elegant and intuitive design of the iPhone also represented an innovation compared to the existing cell phones at that time, which generally had physical keyboards and complex interfaces. In summary, the launch of the iPhone had a significant impact on the smartphone market, transforming the way people communicate and access information.

Innovation also provides indirect gains. Here are four of them [7]:

1. Knowledge: The innovation process always generates knowledge, some of which can be used in more than one way to generate money;
2. Brand: Innovation can expand a brand, attracting more customers and allowing companies to charge a higher price, which can mean greater financial returns;
3. Ecosystem: Innovators can create exceptionally strong ecosystems of partners and associated organizations, allowing them to leverage their position in various ways for their benefit;
4. Organization: We all want to work for and contribute to innovative companies, and being innovative allows companies to attract and retain more and better talent, or at least some of the most innovative. Having better employees, with lower costs to maintain, results in more money.

“According to [4] innovation can occur in three platforms: product, service, and delivery.” According to this approach, the most successful companies regarding innovation are those that take advantage of the three platforms in which value innovations occur:

- Product: The product platform refers specifically to the physical product;
- Service: The service platform deals with the support offered, such as maintenance, customer services, warranties, and training of distributors and retailers;
- Delivery: The delivery platform covers logistics and distribution channels.

Innovation encompasses the entire process of developing ideas to capture returns and comprises three phases of action, each with a different result [7]:

- Idea conception: This is the phase in which ideas are created, developed, tested, evaluated, and improved, but during which the company does not commit to creating a product or service (or taking any other action) based on them. The result, at this stage, is an idea.
- Commercialization: This phase begins when management gives the green light to develop the proposed idea and turn it into a product that can be produced and marketed, either externally or internally, and ends when the product is launched in the market. In this phase, the process produced an invention—the technology, product, service, or process improvement, which has taken tangible form but has not yet been tested by the external (or internal) market. The invention is the thing itself. Innovation is the process.
- Implementation: This phase begins with the market launch and ends when the product or service reaches the end of its life cycle. Although this phase is where financial returns are realized, many important aspects of the size and timing of the return were determined in the earlier phases.

It is equally important to differentiate between “invention” and “innovation.” While invention involves the creation or discovery of a new product or process, innovation pertains to the successful introduction and adoption of a new product or process in the market.

In addition, the timing of the generation of an innovation is crucial. However, an innovation happens when an inventor seeks the realization of his dreams through the commercialization of his brilliant idea in the market. It also happens when there is a specific need or demand to be met and when there is a clear opportunity to bring significant benefits to society, the economy, or the environment. Furthermore, it is important that the innovation is viable and sustainable in financial, technical, and social terms.

Just as innovation generates direct and indirect gains, failure to innovate can generate direct losses, such as financial losses, indirect losses, such as the depreciation of the entrepreneur’s reputation.

Innovating can involve several costs for a company, both financial and nonfinancial. Some of the more common costs include

- Research and development (R&D);
- Staff training and development;
- Information technology (IT);

- Marketing and advertising;
- Patents and intellectual property;
- Risks and uncertainties;
- Organizational changes.

In addition to conceptual aspects, innovation is influenced by a management culture. This culture, which is conducive to innovation, is not just good for a company's bottom line. It is also something that both leaders and employees value in their organizations. But despite the fact that innovative cultures are desirable and most leaders claim to understand what they entail, they are difficult to create and sustain [8].

In this context, entrepreneurship emerges as a concept related to innovation. "Enterprise" is the realization of new combinations; we call "entrepreneurs" the individuals whose function it is to carry them out [9].

Entrepreneurial discovery, for Kirzner, unlike Schumpeter, comes out of nowhere and entrepreneurship consists of a state of alertness: being alert, ready to perceive profit opportunities that have not yet been explored and take advantage of them. For him, the market is not a state, but a process of a dynamic reality in constant movement and never in equilibrium, where the entrepreneur acts as an internal element and an integral part of the system, and not as a destroyer of a supposedly perfect equilibrium, but as the agent who observes and takes advantage of opportunities not yet explored, thus coordinating the various individual plans and triggering a mechanism that tends to balance. In this perspective, the entrepreneur is the engine of the system, the one who, in a way, from the beginning, enables the exploration of opportunities, interaction, exchange, and coordination of individual plans [10].

Nevertheless, according to Schumpeter's theory, entrepreneurs are responsible for disruptive innovations that change existing markets. These innovations generate above-average profits for pioneering firms, attracting the entry of imitators and Kirznerian-type entrepreneurs. These entrepreneurs seek to reduce excessive profits through competition, bringing the new market to a state of equilibrium in which firms compete on more equal terms. In this way, entrepreneurs play a key role in economic development, driving innovation and competition, and contributing to the long-term growth of the economy.

Finally, it is important to remember that innovation is not an end in itself, but a means to meet specific needs and demands. Therefore, innovation must be carried out in a responsible and ethical manner, taking into account the values and objectives of the organization or society in general.

3. Possible solutions: genetics, epigenetics, and culture: the challenges and strategies to deal with risks in business innovation

No one escapes the deleterious effects of cognitive biases, not even innovators, so innovators can suffer from the biases studied by Prospect Theory. For example, an entrepreneur may show loss aversion when carrying out an innovation project, causing him to abandon the idea of innovating and opt for conventional solutions—nothing innovative. However, some behavioral economics strategies and

new developments in neuroscience and genetic research can help entrepreneurs deal with cognitive biases.

For example, Schumpeterian achievers excel at overcoming loss aversion. In fact, these entrepreneurs are not afraid, seeming always willing to take risks even in the face of the possibility of losses. Thus, if an individual identifies with the profile of the Schumpeterian entrepreneur, he has a competitive advantage over other candidates for innovators.

Genetic mechanisms seem to affect how people deal with risk and uncertainty. Innovation demands from entrepreneurs a certain degree of balance between anxiety and courage. And, this assertive behavior can be developed by habits, training, rituals, among other techniques that can be learned. However, this behavior can also come programmed into the individual's DNA. In an article called "Warriors Versus Worries: The Role of COMT Gene Variants," psychiatrist and researcher Dan Stein suggests that certain personality traits, such as a tendency toward anxiety or impulsivity, may be influenced by specific genes. For example, studies have identified that certain variants of the COMT gene are associated with individual differences in dopamine regulation in the brain, which can affect the tendency toward anxiety.

Furthermore, when considering the influence of genetics on human behavior, it is important to include another relevant topic: epigenetics. Epigenetics refers to enduring modifications to DNA that do not entail modifications to the sequence itself. These changes can be influenced by environmental factors such as nutrition, stress, and exposure to toxins, and can affect gene expression and, consequently, behavior. Understanding epigenetics can help explain how environmental factors can interact with genetics to influence human behavior [11]. Although epigenetics is still a developing area of research, some studies suggest that exposure to certain environmental factors can lead to epigenetic changes that can affect personality traits relevant to entrepreneurship, such as courage and resilience. For example, a recent study has shown that exposure to adversity in childhood can lead to epigenetic changes that affect the regulation of cortisol, a hormone associated with stress. These changes can increase the likelihood of developing anxiety disorders, but they can also lead to greater resilience in some people [12]. Another study indicated that nutrition during pregnancy can affect the expression of genes related to behavior in children, including impulsivity and attention. These results suggest that proper nutrition may be important for the development of personality traits relevant to entrepreneurship [13].

At this point, it is worth highlighting an intriguing way of presenting the entrepreneurial spirit. A research conducted by Daniel Lerner and his team at the IE Business School in Madrid investigated the medical and professional backgrounds of 74,291 women from Denmark. Women infected with the *Toxoplasma gondii* parasite were found to be more likely to found a startup, 27% more likely to find multiple ventures, and more than twice as likely to find their own businesses alone compared to other uninfected women. Furthermore, the startups created by the infected women were, on average, more successful than those created by their uninfected peers. It is concluded, therefore, that the presence of the parasite may be related to an increase in the entrepreneurial spirit in women [14].

Rodents infected with the *Toxoplasma gondii* parasite have been observed to display behavioral changes, including reduced risk aversion. This may include more active and exploratory behavior, as well as a reduced fear of cats. Some researchers suggest that these behavioral changes could have similarities with entrepreneurial traits. This association between parasite infection and behavioral changes is also seen

in humans, with increasing evidence that infection can alter neurotransmitter and hormone production, resulting in changes similar to rodent behavior. People infected with the parasite may have increased extroversion and greater risk tolerance, which may be reflected in behaviors such as involvement in traffic accidents or drunken swimming [15].

Although biology has brought enormous advances to the science of behavior, ethical limits prevent organizations from conducting experiments with their collaborators, including genetic, epigenetic, hormonal tests, and forays into the Fungi Kingdom. Therefore, the role of culture in innovative behavior is crucial and more easily adopted as a solution. Indeed, it is the only possible means of managing human behavior. Although there are many areas of study in this field, in this work, we will focus on the field of memetics.

It is a field of study dedicated to understanding how ideas, behaviors, beliefs, and other cultural information in a society propagate. Memes are units of information passed from person to person, just as genes are passed from generation to generation. Therefore, memetics explores how memes spread and evolve within human culture [16]. Entrepreneurs can use memetics to better understand how ideas spread related to the problem of cognitive biases work within their own teams and organizations. They can use “organizational culture” techniques to create a culture that promotes, for example, solutions for dealing with loss aversion in innovative projects.

And, memetics can help make better decisions in contexts of risk and uncertainty in several ways. For example: understanding cultural and behavioral patterns; understanding how the information was propagated, that is, the reliability of the information source; identifying market trends; developing effective communication with people of interest.

An effective, but less specific, way to deal with existing problems in the face of risk situations is a technique developed by professors Richard Thaler and Cass Sunstein, in the book “Nudge: How to make better decisions about health, money and happiness.” Above all, the architecture of choice alters a person’s behavior in predictable ways without prohibiting that choice and, if so, significantly altering their economic incentives. Choice architecture seeks to improve people’s decisions by strategically organizing the information and options presented to them. Compared to common economics and management approaches (such as education and financial incentives), choice architecture is more effective at improving people’s decisions. This is because these methods depend on the ability of individuals to act in their own interest, something that is often not the case. Furthermore, these methods try to change how people process information and make decisions, which can be difficult to achieve [17].

The behavioral economics department at Harvard University has been breaking new ground in applying the architecture of choice. These insights can help economic agents to adopt policies to better deal with cognitive biases. This can be done by taking the following five steps [18]:

- In the first step, the goal is to understand how decisions are made. Therefore, it is necessary to know the animal spirit (system 1) and the rational side (system 2).
- Second, the problem must be defined. For this, it is necessary to consider that behavioral economics tools are more effective when: human behavior is at the heart of the problem; people are not acting in your best interest, and; the problem can be precisely defined.

- Third, the manager must diagnose the underlying causes. To determine whether a decision is the result of insufficient motivation or cognitive biases, managers must ask two questions: Is the problem caused by people failing to take any action? Are people acting, but in a way that introduces systematic errors in the decision process?
- Fourth, it is time to design the solution. The goal is to improve people's decisions by carefully structuring how information and options are presented to them. For this, it is necessary to unleash the animal spirit, engage the rational system, and bypass both systems.
- Finally, the manager must rigorously test the proposed solution to avoid costly mistakes. Testing can help managers avoid costly mistakes and provide insights that lead to even better solutions.

Efforts to improve decision-making through behavioral economics can be seen in business, the public sector, and academia. There are internal laboratories, annual events, courses, study centers, and even government offices dedicated to the subject of behavioral economics. However, few of these centers are dedicated exclusively to the study of behavioral economics applied to innovation.

The field of behavioral economics has identified several biases throughout its existence, including loss aversion. Despite this, biases are inevitable. But it is possible to make better decisions using behavioral economics—and neuroscience.

It is essential to emphasize, however, that there are inherent limitations to the proposals outlined in this study. Starting with the criticism of the entrepreneur model presented by Joseph Schumpeter. The main criticisms being: lack of consideration for the influence of the external environment; overemphasis on technology; limitations in the definition of entrepreneurship; unrealistic assumptions about the competition; and limited focus on the role of government [19].

While behavioral genetics has contributed to the understanding of human behavior, it has also been criticized for its oversimplification, confirmation bias, lack of regard for the environment, ethical concerns, and incomplete understanding of heredity [20].

Epigenetics is a fascinating research area that offers possibilities to improve our understanding in many fields of biology and medicine. However, it is crucial to remain constructively skeptical of overstatements and recognize that the interpretation of epigenetic data can be complex and ambiguous. Therefore, it is important that epigenetic studies are conducted with methodological rigor and that their results are interpreted with caution.

Some of the main criticisms of memetics include the lack of solid empirical evidence, the lack of conceptual clarity, the difficulty in isolating cultural units, the lack of regard for context, and the risk of cultural reductionism. Critics argue that memetics is a theory with little empirical foundation, unclear, and imprecise in the definition of its concepts, and that often does not consider the social, historical, and cultural context in which ideas and behaviors develop and spread [21].

The main difficulty in carrying out this study was the complexity of the subject in relation to scientific advances in behavioral science. Dealing with so many topics proved to be a challenge, absolutely necessary, for the development of a framework on the subject of prospect theory as an analytical basis for the decision of risk and uncertainty in innovation.

Nevertheless, it is important to leave clues for future investigations. As follows:

- Deepening the topics of genetics, epigenetics, and memetics;
- The use of experimental research through behavioral games involving biases related to prospect theory;
- Brain imaging mapping while the decision-maker makes a choice involving financial gains and losses in an innovation project;
- Seek partnerships for the development of case studies in organizations that have applied prospect theory in decision-making, especially in innovation.
- Focus on situations related to the process of innovation in products and services.
- Analyze decision-making involving risk and uncertainty, but in the entrepreneur's environment, or as close to it as possible.

In short, innovation brings with it risks that can generate negative effects and loss aversion. However, Schumpeterian entrepreneurs seem always willing to take risks, which gives them a competitive advantage over other would-be innovators. How people deal with risk and uncertainty can be influenced by genetic and epigenetic mechanisms, which affect gene expression and human behavior. The dissemination of ideas and behaviors in a society is also greatly influenced by cultural factors. Entrepreneurs can use memetics and organizational culture to create a culture that promotes solutions for dealing with loss aversion in innovative projects. In addition, an effective technique for dealing with risk is choice architecture, which alters behavior in predictable ways without prohibiting choice. In short, while the risks associated with innovation cannot be eliminated, the tactics and strategies mentioned in this text can help entrepreneurs manage them more effectively.

4. Conclusions

The prospect theory explains how people make decisions in uncertain situations and evaluate choices in terms of potential gains and losses in relation to a reference point, rather than calculating expected utility. In fact, the prospect theory questions the idea of a single theory of human behavior being normative and descriptive. The prospect theory shows that choices can be structured in different ways, even with the same outcomes, differing from orthodox economics.

Above all, human decisions can be influenced by norms, habits, and personal characteristics of those making them, and these factors can bias the choice of alternatives—as shown by the prospect theory. Human perception is also imperfect, and changes in perspective can alter the relative size of objects and the level of desire for each option. For example, a change in perspective regarding a problem can bias the choice of alternatives. Additionally, furthermore, when it comes to choices involving gains, people tend to be risk-averse, but they tend to seek risk in choices involving losses.

On the other hand, all theories have flaws and are not infallible, even if they are the best explanation of a phenomenon or accepted by the majority. The prospect

theory is no exception. In the words of Professor Daniel Kahneman himself, the theory cannot deal with disappointments and does not consider regret.

Furthermore, the prospect theory is also criticized for not being able to explain the irrational decision-making of human beings. In this sense, it is necessary to resort to other areas of knowledge, such as neuroscience, to obtain more comprehensive explanations.

Entrepreneurs are motivated by potential gains, but need to take calculated risks. In this way, the prospect theory applies to the search for innovation by entrepreneurs. The theory helps to evaluate and manage risks, considering expected losses and gains, norms, habits, and personal characteristics. Entrepreneurs should consider these factors and seek opportunities that achieve their goals and minimize the risks involved.

In essence, innovation is the materialization of a brilliant idea in the market, either by the entrepreneur's own initiative or by the existence of a need to be met. Generating direct and indirect gains for the innovator, it can happen on three platforms: product, service, and delivery. Furthermore, innovation encompasses the entire process of developing ideas to achieve a return and comprises three phases of action, each with a different outcome. They are: conception of the idea, commercialization, and concretization.

However, it is important to differentiate "invention" from "innovation." Invention is the making tangible of an original idea under the prism of a product or process, while innovation is the action of this commercialized product or process, including its wide acceptance in the market.

Consequently, entrepreneurship emerges as a concept related to innovation, as enterprise is the realization of new combinations, and entrepreneurs are individuals whose function is to carry them out. Entrepreneurs generate disruptive innovations that disturb existing markets, generating above-average profits for pioneer companies, and attracting imitators.

Entrepreneurs, described by Schumpeter, have a certain advantage over other potential innovators. This is because Schumpeterian entrepreneurs tend to seek maximum risk, as no one knows what might happen in the face of a possible innovation.

On the other hand, it seems that genetic mechanisms influence how people deal with risk and uncertainty. In innovation, entrepreneurs are required to find a balance between anxiety and courage.

Additionally, when considering the genetic influence on human behavior, it is important to mention another relevant topic: epigenetics. Epigenetics refers to lasting changes in DNA that do not involve alterations in its sequence. Environmental factors, such as nutrition, stress, and exposure to toxins, can influence these changes, affecting gene expression and, consequently, behavior.

Entrepreneurs can apply memetics to improve their understanding of how ideas are disseminated and also to understand how cognitive biases affect their teams and organizations. In addition, they can use "organizational culture" techniques to create a culture that encourages innovative solutions and helps deal with loss aversion in their projects.

Interestingly, the presence of the parasite *Toxoplasma gondii* has been linked to behavioral changes in rodents, including a reduction in risk aversion. This can lead to more exploratory and active behavior, as well as a decrease in fear of cats. As a result, some researchers propose that these behavioral changes may be related to entrepreneurial traits.

Despite significant advances in biology in understanding human behavior, ethical issues prevent organizations from conducting experiments with their employees,

including genetic, epigenetic, hormonal tests, and studies involving fungi. Therefore, the role of culture in innovative behavior is crucial and more feasible as a solution, in fact, the only possible way to manage human behavior.

Additionally, behavioral genetics has contributed to understanding human behavior, but has been criticized for oversimplification, confirmation bias, ignoring the environment, raising ethical concerns, and having an incomplete understanding of heredity. The same is true of epigenetics, as criticism can be made that the theory of memetics is poorly grounded and does not consider the social, historical, and cultural context in which ideas and behaviors develop and spread.

In addition to the mentioned alternative approaches, behavioral economics offers a solution to improving economic decisions—choice architecture. This technique seeks to improve people's choices through the strategic organization of available information and options. Compared to conventional approaches to education and financial incentives in economics and management, choice architecture has proven more effective in improving people's decisions.

This study faced difficulties due to the complexity of the topic in relation to scientific advances in behavioral science. However, it is possible to say that the objective of presenting the prospect theory as an integral part of decision-making in business innovation, especially in the context of risk and uncertainty, was achieved.

The study in question has great importance for those interested in the topics of behavioral economics and innovation, as it innovatively addresses decision-making in situations of risk and uncertainty, particularly in the context of innovation projects. This is especially relevant for expanding the scope of behavioral economics and innovation. Furthermore, it is important to note that there is a lack of specific scientific productions on the application of prospect theory in the area of innovation, which makes this study even more significant.

For future researchers who wish to investigate prospect theory for innovation, there are several clues to explore. It is recommended to deepen knowledge about topics such as genetics, epigenetics, and memetics, as well as the use of behavioral games to study biases related to prospect theory. Another possibility is to perform brain imaging mapping during decision-making in financial innovation projects. Case studies in organizations that have applied this theory to decision-making can provide valuable insights. It is also important to focus on specific situations related to the innovation process in products and services. Finally, it is essential to analyze decision-making involving risk and uncertainty in the entrepreneurial context, offering insights for more assertive decision-making in innovation projects.

Finally, entrepreneurs who take more risks have an advantage in innovation. Culture and genetic mechanisms influence how people deal with risks. Entrepreneurs can use culture to create solutions to deal with loss aversion, and the choice architecture technique serves to deal with risks. Although risks cannot be eliminated, entrepreneurs can manage them better using these strategies, thus bypassing cognitive biases.

Conflict of interest

The authors declare no conflict of interest.

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